Globalizing S&T Indicators:
How Statisticians Responded
to the Political Agenda on Globalization

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Introduction

In the 1990s, industrial competitiveness, or the capacity of firms to produce and sell goods and services, was on every government's lips. [1] The OECD was no exception, and conducted several studies on industrial competitiveness. What was characteristic of these works was that, with time, they increasingly came to be linked to globalization: "The concern with competitiveness is not new (…). However, within the current context of the globalization of product and capital markets and the rapid diffusion of know-how, meeting the competitiveness agenda has assumed greater urgency". [2]

According to every analyst, the competitiveness of a nation is much more difficult to define than that of a firm. [3] Broadly defined, however, it refers to at least three elements. First, to the capacity of a country to sell its products and services in other countries. Here international trade is the traditional indicator for assessing the countries' competitiveness, and early on, the OECD Directorate for Science, Technology and Industry (DSTI) developed indicators on high technology trade. [4] The second way to compare countries according to competitiveness is by looking at productivity. Again, the DSTI conducted a whole program of work in the 1990s that compared the productivity of OECD member countries and tried to explain the differences as attributable to technology. [5] Third, the competitiveness of countries refers to the factors, or the national environment, that are the

[1] For an overview of national reports, see: OECD (1996), *Industrial Competitiveness*, Paris.
[2] OECD (1995), *High Level Forum on Industrial Competitiveness: Draft Synthesis of the Discussions*, DSTI/IND (95) 18, p. 3.
[3] P. Krugman (1997), *Pop Internationalism*, Cambridge (Mass.), MIT Press.
[4] B. Godin (2005), The Obsession for Competitiveness and its Impact on Statistics: the Construction of High Technology Indicators, *Research Policy*, forthcoming.
[5] B. Godin (2004), The New Economy: What the Concept Owes to the OECD, *Research Policy*, 33 (5), pp. 679-690.

major determinants of the location and of the investment decisions of firms: "In all OECD countries, a major impact of globalization on government policy has been to focus policymakers' attention to the importance of the framework conditions for business activity. In global competition in product and capital markets, and ensuing mobility of production capacity in trade exposed sectors, domestic level of investment, employment and earnings are heavily influenced by the framework parameters that affect local firms' productivity, cost-effectiveness and innovativeness. These factors make the national business sector more or less attractive to internationally mobile investment capital, and to localization decisions by multinational corporations". [6]

In 1994, the OECD embarked on a project using benchmarking indicators precisely for comparing the characteristics, strengths and weaknesses of domestic business environments, that is, the framework conditions of OECD countries. [7] Eight variables were finally chosen to define competitiveness and to benchmark countries: research and development (R&D) infrastructure, educational profile of the labour force, corporate governance environments, employment regulations, labour costs, corporate taxation, energy costs, telecommunication costs and infrastructures. The results were published under the umbrella of globalization in 1997. [8] For the OECD, these factors were framework conditions for decisions of firms to globalize: "in rapidly globalizing OECD economies, differences in framework conditions for industry are having an increasing impact (…)". [9]

But what is globalization? And how should we measure it? This paper looks at the efforts of the OECD to define globalization, a concept that still remains fuzzy today, and to develop standardized indicators. It develops the thesis that globalization is not a new

[6] OECD (1996), *Framework Conditions for Industrial Competitiveness: Past Progress and Next Steps*, DSTI/IND (96) 14, p. 2.
[7] OECD (1993), *Framework Conditions for Industry: A New Policy Paradigm*, DSTI/IND (93) 31; OECD (1994), *Framework Conditions for Industrial Competitiveness: the OECD Industry Committee Project*, DSTI/IND (94) 4; OECD (1994), *Cadre des activités industrielles: résumé et conclusions de la reunion "méthodologie et plan de travail"*, DSTI/IND (94) 11.
[8] OECD (1997), *Industrial Competitiveness: Benchmarking Business Environment in the Global Economy*, Paris.
[9] OECD (1994), Framework Conditions for Industrial Competitiveness: the OECD Industry Committee Project, *op. cit.* p. 4.

phenomenon but reflects policy-makers and statisticians' new interest in globalization. The first part discusses the conceptual framework that the OECD developed in the 1990s to analyze the globalization of economies. The framework centered on foreign direct investment (FDI) as the main characteristic of globalization. The second part analyzes the impact of both globalization and OECD work on science and technology statistics. As technology was identified as the second characteristic of globalization, several science and technology statistics came to be revised or reconsidered to introduce the dimension of globalization. The last section discusses the empirical results emerging from the OECD work.

The Globalization Framework

The current statistical work of the DSTI owes its orientation partly to the *Technology and Economy Program* (TEP) of the early 1990s, which identified globalization as one of the eight topics that should be extensively studied. In fact, the conference that launched the TEP concluded that the concept of globalization was fuzzy, subjective, badly defined and a hotchpotch of ideas. [10] SYears later, globalization was still qualified as a "fairly vague and imprecise concept". [11] Certainly, international trade has grown by a factor of 16 in real terms since 1950, and foreign direct investment (FDI) by 25 times since 1970. [12] But, "none of these components of economic globalization is actually new", admitted the OECD; "rather, it is their intensity and multiplicity, which gathered pace in the 1980s and 1990s, that are creating a new world-wide economic system". [13] Internationalization has taken new forms, and it was to these new forms that the OECD applied the term globalization: "International trade can no longer be considered as being virtually the sole vector for the penetration of foreign markets: international investments and transfers of technology now play important parts in this process". [14] "For the OECD, a distinctive

[10] OECD (1992), *Technology and the Economy: The Key Relationships*, Chapter 10, Paris, p. 232.
[11] OECD (1996), *Possibility of Preparing a Manual on Globalization Indicators*, DSTI/EAS/IND/WP9 (96) 8, p. 2.
[12] OECD (1998), *Globalization and Industry Performance*, DSTI/IND (98) 11.
[13] OECD (2001), *Manual on Economic Globalization Indicators*: *Chapter 1*, DSTI/EAS/IND/SWP (2001) 1, p. 4.
[14] OECD (1992), *Indicators of the Globalization of Industrial Activities*, DSTI/STII/IND/WP9 (92) 1; OECD (1996), *Globalization and Competitiveness: Relevant Indicators*, OCDE/GD (96) 43.

feature of globalization is the division of firms' operations into separate segments carried out in different countries. The most prominent features of globalization are foreign direct investment, various aspects of international trade, and international inter-firm collaboration. [15]

In the view of the OECD, these new forms of internationalization were not being appropriately measured. "Until [the 1990s], all indicators of competitiveness were based exclusively on international trade" [16] and "were proving a less effective guide to policymaking". [17] "Many aspects of globalization will only be understood through collection and examination of new internationally comparable data and case studies", declared the OECD. [18] But there was a great deal of data for which international comparability was not satisfactory and required harmonization. [19]

These two limitations – the fuzziness of the concept and the inadequacy of indicators – required coordination of the then-current studies to pull the work together into a more coherent whole. [20] Above all, what was needed was a framework, as suggested by the US delegate: "work has been underway in a number of OECD committees studying the impact of a range of domestic policies on globalization. The US believes these crosscutting proposals require coordination", that is a framework including sectoral studies and horizontal statistical analysis. [21]

The OECD's program of work on globalization started in the early 1990s with the following definition: "Globalization is the outcome of the progressive international expansion of firms since World War II. Firms strategies have shifted from exporting,

[15] OECD (1996), *Globalization of Industry*, Paris, p. 15.
[16] OECD (1992), Indicators of the Globalization of Industrial Activities, *op. cit*. p. 5.
[17] OECD (2000), *Manual on Economic Globalization Indicators: General Presentation*, DSTI/IND (2000) 16, p. 2.
[18] OECD (1992), *Industrial Policy in OECD Countries: Annual Review 1992*, Paris, p. 195.
[19] OECD (1996), Possibility of Preparing a Manual on Globalization Indicators, *op. cit*. p. 3. See also: OECD (1998), *Database on the Activity of Foreign Affiliates in OECD Countries and National Firms' Affiliates Abroad*, DSTI/EAS/IND/SWP (98) 15.
[20] OECD (1992), *Globalization of Industrial Activities: Globalization Framework*, DSTI/IND (92) 45, p. 3.
[21] OECD (1992), *Globalization of Industrial Activities: Globalization Framework*, DSTI/IND/WP9 (92) 6/07, p. 3.

through local sales networks and local assembly, to fully integrated foreign operations with local headquarters functions and networks of suppliers and co-operating firms". [22]

The OECD identified two sets of reasons for studying the phenomenon. First, policy issues: "Lasting solutions to many problems facing governments can now only be found at the world level: environment, trade, technology, financial markets, capital flows, foreign direct investment". [23] According to the OECD, policy issues concerned the concentration of economic power into a few companies, the low level of local sourcing and linkages between foreign firms and national suppliers, the subsidization of foreign investment and constraints on inward investment, the impact on small businesses, and intellectual property rights. In fact, for years, fears had been expressed concerning multinationals and foreign takeovers. As the US National Research Council's Committee of Foreign Participation in US R&D reminded its readers: foreign participation in US R&D may weaken the nation's technology base, increase US dependence on foreign sources of technology, undermine military strength, or shift jobs and profits away from the United States. [24]

Apart from the above policy issues, however, imperatives on economic growth came to dominate the rhetoric in the mid 1990s: "Industries which are globalizing faster perform better in a measurable way from industries which are less exposed to globalization". [25] Briefly stated, globalization had a significant impact on economic productivity.

In 1991, the Industry Committee asked its WP9 (Industrial Statistics) to include the development of new indicators on the "globalization of industrial activities" in its program of work. In fact, "most of the indicators currently available are purely national in conception (…)". [26] Work was suggested on the following indicators: foreign investments in production and trade, mergers and acquisitions, agreements and alliances,

[22] OECD (1992), *Globalization of Industrial Activities: Overview of Work*, DSTI/IND (92) 28, p. 4.
[23] OECD (1991), *Indicators of the Internationalization of Industrial Activities*, DSTI/STII/IND/WP9 (91) 3, p. 3.
[24] P.P. Reid and A. Schriesheim (ed.) (1996), *Prospering in a Global Economy: Foreign Participation in US R&D: Asset or Liability*, Washington: National Academy Press, p. V.
[25] OECD (1998), Globalization and Industry Performance, *op. cit*. p. 4.

concentration, intra-branch and intra-product trade, patents, Technological Balance of Payments (TBP), and location of R&D centers.

To launch this work program, a workshop on Globalization Indicators was held in June 1993, and from then on, WP9 held a special annual session on globalization. [27] Within WP9, foreign direct investment was identified as a priority for measurement, particularly the activity of foreign affiliates. Two main projects came out of the workshop. First was a databank on foreign affiliates. The first OECD survey on the activities of foreign affiliates had already been conducted in 1989, and an analysis published in 1994 (*The Performance of Foreign Affiliates in OECD Countries*). WP9 extended the databank with a survey of the activities of affiliates of national firms abroad (multinationals) (*Activities of Foreign Affiliates in OECD Countries*, 1997). The databank now includes 18 variables, among them R&D, and is concerned with inward [28] and outward [29] investments, for both manufacturing and services (*Measuring Globalization*, 2001). The databank was also made compatible with data from industrial surveys.

The second output from the workshop was related to a suggestion to develop methodological guidelines on FDI. [30] The suggestion gave rise to the idea of a manual on economic globalization indicators in 1996. [31] Five areas were suggested for measuring globalization and for harmonizing national statistics: a definition of the concept itself, trade, direct investment, employment, and technology. Employment was later deleted.

The manual, now called handbook, [32] to be published in 2004, [33] defined globalization as follows: a "phenomenon in which markets and production of different countries become

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[26] OECD (1991), Indicators of the Internationalization of Industrial Activities, *op. cit*. p. 3.
[27] OECD (1993), *Workshop on Globalization Indicators*, DSTI/EAS/IND/WP9 (93) 5; OECD (1993), *Workshop on Globalization Indicators*, DSTI/IND/RD (93) 5.
[28] Activities of foreign affiliates in each country.
[29] Affiliates of national firms abroad.
[30] OECD (1993), Workshop on Globalization Indicators, *op. cit.*
[31] OECD (1996), Possibility of Preparing a Manual on Globalization Indicators, *op. cit*.
[32] In the end, "manual" was changed to "handbook" because the OECD judged the document not mature enough. The term manual, however, remains in the French version. Personal conversation with T. Hatzichronoglou, 21 May 2004.
[33] OECD (2004), *Handbook on Economic Globalization Indicators*, DSTI/EAS/IND/SWP (2004) 1.

increasingly interdependent through the changes induced by the dynamics of trade, capital and technology flows – changes of which the primary vehicles are multinational enterprises. Thanks to information and communication technologies, such firms are organized into transnational networks in a context of intense international competition which also extends to local firms, as well as to other spheres of each country's economic and social life". [34]

The handbook developed three sets of indicators: *trade* in goods and services, foreign direct *investment* by multinational firms, and internationalization of *technology*. Three sets of indicators were also suggested for measuring the internationalization of technology: R&D expenditures, technology receipts and payments, and high technology products.

The Internationalization of Technology

The OECD identified three phases in the process leading to globalization. [35] The first was concerned with trade in products (and services). This phase is called internationalization. The second, called multinationalization, was concerned with the increased use of direct investment as a strategy by firms to expand. The last is globalization proper. It is characterized, among other things, by the relocation of R&D centers. [36]

For the OECD, technology was an important factor explaining globalization: "Technology is one of the main driving forces behind globalization, thanks in particular to the growth in and acceleration of the dissemination of new information and communication technologies". [37] "Probably the most important change in firm strategies to improve competitiveness is their emphasis on investment in intangible assets; this shift

[34] OECD (2001), Manual on Economic Globalization Indicators, *op. cit*. p. 4.
[35] OECD (1992), *Globalization of Industrial Activities: Four Case Studies*, Paris; T. Hatzichronoglou (1999), *The Globalization of Industry in OECD Countries*, STI Working Papers 1999/2, DSTI/DOC (99) 2.
[36] For variations on such taxonomies, see: D. Hamdani (2003), Global or Multinational: It Matters for Innovation, *Innovation Analysis Bulletin*, Statistics Canada, 88-003, pp. 3-4.
[37] OECD (1996), Possibility of Preparing a Manual on Globalization Indicators, *op. cit*.

is part of the larger move towards a more knowledge-based economy". [38] The rhetoric goes back to the TEP Conference, which insisted on the role of technology in the globalization process. [39]

The early draft version of the handbook originally covered five forms of globalization with regard to technology: [40] R&D, patents, trade in disembodied technology (technology payments and receipts), international technology alliances between firms, and high-technology products. It finally centered around three: [41] R&D, technology diffusion (payments and receipts), and high-technology trade. The rationale for deleting the other two series of indicators was one that was offered as early as 1993 at the workshop on globalization, which suggested dropping work on collection of international data on mergers and acquisitions and collaboration agreements between firms because these data "are collected mainly by private sources without any involvement of official statistical services". [42] The handbook on globalization added that such data require further methodological analysis, but also stated that these areas "would raise some problems because most of the basic data have until now been collected by private sources. Consequently, the harmonization of data, which is one of the main objectives of this manual, becomes more difficult". [43]

While this argument is true for technological alliances between firms, it is not for patents. Data on patents come from public patent offices. Moreover, the DSTI launched a whole program of work on patents recently, based on patent families, [44] which owes its existence partly to the globalization framework. [45] Since 2002, the indicators on patent families have been judged sufficiently developed to be included in *Main Science and*

[38] OECD (1997), *Industrial Performance and Competitiveness in an Area of Globalization and Technological Change*, DSTI/IND (97) 23, p. 3.
[39] OECD (1991), *TEP: International Conference Cycle*, Paris; OECD (1992), Technology and the Economy: The Key Relationships, Chapter 10, *op. cit*.
[40] OECD (1999), *Manual on Globalization Indicators*, DSTYI/IND/STP/SWP/NESTI (99) 1.
[41] OECD (2002), Manual on Economic Globalization Indicators, *op. cit*.
[42] OECD (1993), Workshop on Globalization Indicators, *op. cit.*, p. 17.
[43] OECD (2002), Manual on Economic Globalization Indicators, *op. cit*. p. 3.
[44] OECD (2000), *Counting Patent Families: Preliminary Findings*, DSTI/EAS/STP/NESTI/RD (2000) 11; OECD (2001), *Patent Families: Methodology*, DSTI/EAS/STP/NESTI (2001) 11.

Technology Indicators (MSTI). The same is true for the other deleted statistics: the lacunae never prevented the OECD from using the statistics and conducting whole analyses based on them. [46]

Be that as it may, the manual was the occasion for the DSTI to review its science and technology statistics at three levels, to which we now turn: redefining GERD (Gross Expenditures on R&D), resuscitating the TBP indicator, and revising statistics on government funding of R&D. [47]

Measuring the Internationalization of R&D

In 1993, the workshop on globalization suggested that the "detailed data reveal that [the recent R&D] decline may be attributed to the decision by several major companies to relocate their R&D laboratories abroad. These companies have also acquired a number of foreign R&D laboratories through mergers and acquisitions". [48] There was therefore a need to redefine the concept of the national R&D effort in the context of globalization: "Until now the attention of the authorities in every country has focused essentially on research carried out inside their own borders. However (…) it is important to take into account that a significant portion of R&D carried out inside a country' national borders is intended for foreign markets and, conversely, that a share of the R&D carried out abroad is intended for the domestic market". [49]

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[45] OECD (1999), *The Internationalization of Technology Analyzed with Patent Data*, DSTI/EAS/STP/NESTI (99) 3.

[46] See, for example: OECD (2000), *Changing Patterns of Industrial Globalization: International Strategic Alliances*, DSTI/IND (2000) 2; Nam-Hoon Kang and S. Johansson, *Cross-Border Mergers and Acquisitions: Their Role in Industrial Globalization*, DSTI/DOC (2000) 1; OECD (2001), *Science, Technology and Industry Scoreboard*, Paris; OECD (2002), Industrial Globalization and Restructuring, in *Science, Technology and Industry Outlook*, Paris, pp. 203-227.

[47] Indicators on high technology were already well developed, and nothing new, with regard to globalization, was suggested in the manual on economic globalization. See B. Godin (2003), *The Obsession for Competitiveness and its Impact on Statistics: The Construction of High Technology Indicators*, Project on the History of S&T Statistics, Montreal.

[48] OECD (1992), Indicators of the Globalization of Industrial Activities, *op. cit*. p. 5.

[49] OECD (2004), *The Internationalization of Industrial R&D: Policy Issues and Measurement Problems*, DSTI/EAS/STP/NESTI (2004) 24, p. 3.

WP9 suggested improving, together with the Group of National Experts on Science and Technology Indicators (NESTI), the indicators on the R&D activities of foreign firms in domestic markets, and of national firms abroad. Until now, multinational firms have never been identified as a distinct category of firms, neither in national R&D surveys nor in the Frascati manual. The R&D expenditures of a country's industry (Business Expenditures on R&D or BERD) is currently defined as the sum of the R&D expenditures by nationally controlled firms in country i plus R&D expenditures by affiliates owned by firms from countries j and carried out in country i. The handbook on economic globalization indicators suggested that a firm's nationality takes precedence, rather than the country in which its research activities are carried out. Using this approach, a country's business R&D effort would consist of the research conducted on its territory by domestically-controlled firms and by affiliates of those firms abroad, excluding research done locally by foreign-owned firms. The handbook therefore suggested a series of appropriate indicators: R&D activities of foreign affiliates in each country (inward investment), of affiliates of national firms abroad (outward investment), and of parent companies in their home countries (see Appendix).

The survey and the databank on the Activities of Multinational Firms was the envisaged source of data for the indicators, since they include R&D expenditures of affiliates of national firms abroad since the mid 1990s – to which R&D activities by parent companies have been added recently. However, a second source of data came to be available: the OECD accepted to modify its international survey on R&D. [50] For years, the survey collected data on funding of R&D from abroad and to other countries, but no distinction was made between national firms and foreign affiliates. In the case of external funding of industrial R&D, a distinction is now made in the survey between BERD (firms' domestic expenditures on R&D) and NBERD (national firms' expenditures on R&D). Moreover, the last edition of the Frascati manual included in its sectoral classification of private enterprise a distinction among "enterprises not belonging to any

[50] OECD (1996), *Collection of R&D Data in Connection with Work on Globalization*, DSTI/EAS/STP/NESTI (96) 11; OECD (1998), *Internationalization of Technology: Discussion Paper*, DSTI/EAS/STP/NESTI (98) 9; OECD (1999), *Data Collection on the Internationalization of Industrial R&D*, DSTI/EAS/STP/NESTI (99) 8.

group, enterprises belonging to a national group and enterprises belonging to a foreign multinational group". [51] The challenge remains that of persuading countries to collect such information. [52]

Renewed Interest in the Technological Balance of Payments

The Technological Balance of Payments (TBP) has always been a criticized indicator. The problems are in fact many, [53] but the main ones regard methodological concerns (limited international comparability of the data and heterogeneous sources) and interpretation (a negative balance, for example, can be a positive sign for a country's economy). It is therefore surprising to find the TBP selected as an indicator for measuring globalization.

In fact, according to the OECD, globalization provided an opportunity – a framework – for interpreting technological payments and receipts by putting the indicator in a *systemic* perspective, that is, combining technological indicators (embodied technology flows like inter-industrial flows, high-technology flows, trade by foreign affiliates) and non-technological indicators (like the TBP). According to the OECD, the concept of globalization makes possible a different (sequential) vision of economic phenomena: direct investment flows generate exports from the investing countries (or imports from the host country) which are accompanied by transfers of technology and know-how, and by capital movements. [54]

Despite the usefulness of the indicator for the globalization framework, the DSTI has yet to publish analyses on technology flows. In the past, the DSTI conducted very few analyses on technological payments and receipts, only including tables in *MSTI.* It

[51] OECD (2002), *The Measurement of Scientific and Technological Activities: Proposed Standards Practice for Surveys on Research and Experimental Development*, Paris, p. 61.
[52] On the availability of data in member countries, see: OECD (2004), The Internationalization of Industrial R&D: Policy Issues and Measurement Problems, *op. cit*. See also the appendix below.
[53] B. Godin (2002), *Measuring Output: When Economics Drives Science and Technology Measurements*, Project on the History of S&T Statistics, Montreal.
[54] OECD (1996), *Technology Balance of Payments Indicators Within the Framework of the Activity on Globalization*, DSTI/EAS/STP/NESTI (96) 10, p. 5.

remains to be seen whether the OECD is serious about its new rationale on globalization. If investment flows, rather than trade, characterize globalization, then technological flows (payments and receipts) should figure prominently in any analyses of globalization.

Other Impacts of Globalization on S&T Statistics

In the early 1990s, some people began to wonder whether increasing internationalization of R&D activities might not have resulted in an incomplete picture of public R&D funding. In fact, the share of Gross Expenditures on R&D (GERD) financed by government declined from one-half in 1975 to about one-third in 1995. The reasons were many – a decline in defense R&D, increased use of fiscal incentives – but the OECD *Technology, Productivity and Jobs* project identified the internationalization of R&D as having a major impact on the traditional measure of the government contribution to R&D. [55] Greater use was being made of international programs and facilities abroad, and these were badly measured.

Government R&D financing can be measured in three ways: 1) from GBAORD (Government Budget Appropriations or Outlays for R&D) derived from budgetary documents, 2) from the GERD (where statistics on government R&D come from a specific survey), and 3) from the GNERD (Gross National Expenditures on R&D), which measures the total amount of R&D financed by national sources. GNERD comprises R&D performed in the country and financed by national sources (GERD minus funds from abroad), plus extramural payments by national sources for R&D performed abroad.

The problem identified by the OECD was that government payments to international organizations were not included in R&D performed abroad. European countries, for example, included neither the estimated R&D content of their contribution to the European Community budget (Framework program, CERN, ESA), which amounted to 14% of GERD in 1995, nor their receipts from abroad, as government R&D. Although the latter was of little statistical consequence in countries with large R&D efforts, its

[55] OECD (1998), *Technology, Productivity and Job Creation: Best Policy Practices*, Paris, Chapter 3.

effects were much more strongly felt by small R&D-intensive countries, and in fact were twice as intense in Greece and Ireland. [56]

In the end, the OECD concluded that statistics on government financing of R&D did not decline because greater use was being made of programs and facilities abroad, but that they merely provide, according to some countries (European countries and Canada), an incomplete picture of government funding. The discrepancies led the DSTI to construct new estimates and suggest standards, [57] and circulate a *Sources and Methods* paper documenting national statistics on public funding of R&D. [58]

What Did the Numbers Say?

To date, the DSTI has made very few uses of its new statistics. First, very few countries provide data on NBERD. Second, the database on the Activities of Foreign Affiliates in OECD Member Countries is limited by "the availability of data, which suffers from small samples, short time series and a lack of information on a broader range of countries and industrial sectors". [59] Nevertheless, two kinds of output on science and technology came from a decade of efforts: one analytical study on the internationalization of R&D, and a series of indicators.

There have always been analyses of globalization in the *STI Outlook* series (started in 1992), but these were very brief and used non-standardized data. [60] The first standardized empirical analysis appeared in a short chapter entitled *The Role of Technology* in *The Performance of Foreign Affiliates in OECD Countries* published in 1994. In the view of

[56] OECD (1997), *Treatment of European Commission Funds in R&D Surveys: Summary of National Practices*, DSTI/EAS/STP/NESTI/RD (97) 3; OECD (1998), *Measuring the Internationalization of Government Funding of R&D*, DSTI/EAS/STP/NESTI (98) 3.
[57] OECD (1998), Measuring the Internationalization of Government Funding of R&D, *op. cit.*
[58] OECD (1998), *Measuring the Internationalization of Government Funding: Sources and Methods*, DSTI/EAS/STP/NESTI/RD (98) 2.
[59] OECD (1997), *Globalization of Industrial Research: Background Paper*, DSTI/STP/TIP (97) 6, p. 6.
[60] OECD (1992), *Science and Technology Policy: Review and Outlook*, Paris, pp. 36-38, 87-100; OECD (1996), *Science, Technology and Industry Outlook*, Paris, pp. 61-71; OECD (2000), *Science, Technology and Industry Outlook*, Paris, pp. 41-49; OECD (2002), *Science, Technology and Industry Outlook*, Paris, pp. 45-50, 81-85, 203-225.

the OECD, setting up laboratories outside the country of origin and the extension of co-operation agreements and alliances (technoglobalism) were the decisive elements in the technological changes that took place in the 1980s (p. 61). The publication reported that the proportion of R&D carried out by foreign affiliates tended to increase steadily, but that the share of R&D carried out by foreign affiliates was generally smaller that that of their turnover or production (p. 63). The R&D intensity of foreign affiliates was generally low, except in the United States, where it was twice as great as the national average in pharmaceuticals, three times as great in chemicals and four times as great in mechanical engineering (p. 65).

Table 1.
OECD Publications on Globalization

Trade, Investment and Technology in the 1990s, 1991.
International Direct Investment, 1992.
Globalization of Industrial Activities: Four Case Studies, 1992.
International Direct Investment: Policies and Trends, 1993.
The Performance of Foreign Affiliates in OECD Countries, 1994.
Globalization of Industry: Overview and Sector Reports, 1996.
Globalization and SMEs, 1997.
Towards a New Global Age: Challenges and Opportunities, 1997.
Activities of Foreign Affiliates in OECD Countries, 1997.
Internationalization of Industrial R&D: Patterns and Trends, 1998.
Measuring Globalization: the Role of Multinationals in OECD Economies, 2001.
Manual on Economic Globalization, 2003.

The study was followed two years later by a second one. As for the above title, *Globalization of Industry* (1996) was not devoted to R&D, but science and technology figured regularly in the analysis. The study started by defining globalization as follows:

> Globalization of industry refers to the trans-border operations of firms undertaken to organize their development, production, sourcing, marketing and financing activities (…). Historically, international expansion was mainly through trade, followed in the 1980s by a major increase in international direct investment and inter-firm collaboration. What has changed recently is that firms have used new combinations of international investment, trade and international collaboration to expand internationally and achieve greater efficiencies. International strategies of the past, based on exports, and multi-domestic strategies based on sales in separate foreign markets, are giving way to new strategies based on a mixture of cross-border operations – foreign investment, exports and sourcing, and international alliances (…). At macroeconomic level, the term globalization refers to the emergence of new patterns in the international transfer of products and knowledge by three main routes: international trade, international direct investment, and international collaboration agreements (pp. 19-20).

The study then looked at a series of indicators that revealed the following trends:

- International trade now represented 20% of GDP. The greatest growth was observed in Europe and Asia (p. 26) and in transportation equipment and materials (p. 29). OECD member countries were shown to concentrate their efforts in high technology sectors (p. 32). Trade in intermediary goods was also on the increase, mainly for products with high R&D efficiency ratios (p. 33).
- Intra-firm exchanges (data for the United States and Japan only): a third of exchanges were between firms of the same group, and in sectors of high R&D intensity (p. 34).
- Direct investment: foreign direct investment increased more rapidly than GDP or trade between 1970 and 1990. The destination was first the United States, but Europe had now become the preferred location (p. 37). FDI concerned primarily manufacturing (30-45%) (p. 38), and was often achieved through mergers and acquisitions.
- Foreign Affiliates: foreign affiliates were responsible for a growing share of production in many industrial sectors and had better economic performance than national firms: production, value-added employment, productivity, salaries (p. 45). However, their R&D intensity is less than national firms, except in small countries like Canada (where it was almost equal) or the United States (where it was higher) (p. 48-49).

- Inter-firm agreements: Collaborative agreements had increased by 10% annually since the 1980s (p. 51). They occurred mainly in high technology sectors, and concerned mainly big firms (except for pharmaceuticals and biotechnology).
- Small and Medium Sized Enterprises (SMEs) had not yet globalized. Only about 25% had, versus 50-66% for larger firms (p. 62). When they did, they did so mainly through trade.

The first real study entirely devoted to the internationalization of R&D was published in 1998. The DSTI estimated that R&D handled by foreign affiliates accounted for about 11 per cent of industrial R&D in the mid 1990s. [61] This varies, however, by country, from 5% in the case of Japan to 60% for Ireland. It also varies by industrial sector: those most likely to globalize were high-technology industries. [62]

Despite these results, the study admitted that it underestimated the level of internationalization, because a large number of countries have data on the R&D activities of foreign subsidiaries in their own countries, but not on their own countries' firms abroad:

> In view of the fact that, until now, most firms' laboratories have been located in OECD Member countries, the available data should give some indications of the level of internationalization of R&D functions. Over the last few years, however, more and more firms have been setting up R&D centers outside the OECD Member countries. This means that the information available underestimates the real level of R&D internationalization. In addition, the available data for all but a few of the largest countries only cover a relatively short period, and cannot really reflect the magnitude of these changes.

Nonetheless, the year 2001 saw the introduction of two innovations in science and technology indicators with regard to globalization. First, regular indicators on globalization started to be included in *MSTI.* To the data on GERD financed from abroad (published since the 1990 edition), tables were added, starting with the 2001 edition, on

[61] OECD (1998), *Internationalization of Industrial R&D: Patterns and Trends*, Paris, 1998. See also: OECD (1998), *Globalization of Industrial R&D: Policy Implications*, DSTI/STP/TIP (98) 4.
[62] OECD (1997), Globalization of Industrial Research: Background Paper, *op. cit.*

the R&D expenditures of foreign affiliates. Second, the 2001 edition of the *Scoreboard of STI Indicators* included a whole section of indicators on globalization, some of which were concerned with science and technology (Table 2).

Table 2.
Globalization Indicators
(OECD *STI Scoreboard 2001*)

Global Integration of Economic Activity

International trade
Exposure to international trade competition by industry
Foreign direct investment flows
Cross-border mergers and acquisitions
Activity of foreign affiliates in manufacturing
Activity of foreign affiliates in services
Internationalization of industrial R&D
International strategic alliances between firms
Cross-border ownership of inventions
International cooperation in science and technology
Technology balance of payments

Economic Structure and Productivity

International trade by technology intensity
International trade in high and medium-high-technology industries

The work on globalization has yet to really bear fruits with regard to science and technology. This can be explained by two factors. First, the work on globalization illustrates the lag between a concept and policy demands on one hand, and the response of statisticians on the other. It takes at least ten years, or more, to develop appropriate and reliable statistics and indicators. Second, the concept (globalization) competes with others when it comes to developing and organizing statistics into conceptual frameworks for policy purposes: high technology, national systems of innovation, knowledge-based economy, and the new economy. The latter two came to dominate OECD work in the mid 1990s.

Conclusion

In the 1980s, economists and statisticians began measuring an increase in international trade among OECD member countries. Trade was only one facet of internationalization, however. In fact, several admitted that internationalization was badly measured, since new forms have appeared, among them foreign direct investment. The OECD gave itself the task of developing standardized methodological rules on three aspects of measuring internationalization: trade, FDI and technology. With regard to technology, three sets of indicators were suggested: R&D, TBP and high technology.

Globalization is a term or label assigned to the growth of internationalization and to its new forms. It is above all a rhetorical concept. Many authors admit that nothing really new defines globalization. The OECD itself seems to agree. After characterizing the global economy using elements different from the previous period, where international trade was the driving force, the OECD continues: "trade is still the most substantial form of integration into the global economy". [63] In fact, the same rhetoric defines other popular concepts at the OECD, like the knowledge-based economy. One characteristic of the discourses on the knowledge-based economy was that the phenomenon was not new, but simply more present: "although knowledge has always been a central component in economic development, the fact that the economy is strongly dependent on the production, distribution and use of knowledge is now being emphasized". [64]

What, then, is the function of such labels? They help to place an issue on the policy agenda and capture the political attention – and consequently give statisticians further topics to work on. The whole process works as follows. In general, work proposals come either from the OECD Secretariat (and/or committees) or from the ministers (often under the influence of a specific country). Studies are then conducted by the Secretariat, with a view to presentation to a ministerial conference. The conference, in turn, generally under the advice of the OECD officials themselves, asks for more work. This is how projects

[63] OECD (2001), Manual on Economic Globalization Indicators, *op. cit*. p. 17. See also p. 3 above.

extend and build on previous ones. In 1998, for example, the meeting of the Industry Committee at the ministerial level was presented with work done up to date, and recommended that the OECD advance the analysis of globalization, its implications for firm and sector performance, and how governments can pursue policies whereby the benefits of globalization are fully realized. This was a necessary step for consolidating the work on globalization and continuing its development.

Nevertheless, one should not be too cynical. The concept of globalization has allowed the OECD to develop new indicators, and initiates studies on new dimensions of science and technology. R&D from foreign affiliates was one example, as is work in progress on patent families, and migration of highly-qualified personnel.

[64] OECD (1996), The Knowledge-Based Economy, in OECD, *Science, Technology and Industry Outlook*, Paris, 1996, p. 262.

Appendix

(OECD, *Manual on Economic Globalization Indicators*)

Basic Indicators of the Internationalization of Industrial R&D

Indicator	Availability		
	A	**B**	**C**
1. R&D performed by foreign affiliates in host countries (inward investments)			
Performance			
· Total R&D performed by affiliates	X		
· Total R&D performed for affiliates		X	
· Number of researchers in foreign affiliates	X		
· R&D expenditures of affiliates themselves on behalf of:			
- The parent company or other affiliates in the same group		X	
- Other firms under national control		X	
- Other foreign firms in the host country or in other countries		X	
· R&D performed by affiliates			
- Greenfields			X
- Acquisitions			X
Financing			
· R&D financed by foreign sources (all firms)	X		
· R&D financed by affiliates themselves			
Types of Costs			
- Wages			X
- Other ordinary costs			X
- Capital spending (land, equipment, etc.)			X
Subcontracting			
· Affiliates R&D subcontracted out to:			
- The parent company abroad			X
- Other affiliates in the same group			X
- Other firms under national control			X
- Other foreign firms			X
- Local universities or public or private research centres			X
· R&D as a business service	X		
R&D Target Markets			
· Customizing products for local markets		X	
· Development of new technologies for world markets		X	
2. R&D performed by offshore affiliates of national firms (outward investments)			
Performance			
· Total R&D performed by affiliates		X	
· Total R&D performed for affiliates		X	
· Number of researchers in offshore affiliates of national firms		X	
· R&D expenditures of these affiliates on behalf of:			
- Themselves		X	
- Their parent companies		X	
- Other affiliates in the same group		X	
- Other national firms in the host country		X	
- Other firms		X	
		X	

Indicator	Availability		
	A	**B**	**C**
· R-D performed by affiliates			X
- Greenfields			X
- Acquisitions			
R&D Target Markets			
· Customizing products for local markets		X	
· Development of new technologies for world markets		X	
3. R&D performed by parent companies in their home countries		X	
· Total R&D expenditures of parent companies (home countries)		X	
· Number of parent company researchers		X	
· Parent company R&D expenditures on behalf of offshore affiliates		X	
· Parent company R&D expenditures on behalf of the home country government		X	
· Parent company R&D expenditures on behalf of other national firms			
4. Degree of globalization (2)			
· R&D expenditures performed abroad by national firms, as compared with R&D expenditures of all firms in the home country		X	
· R&D expenditures performed abroad by affiliates of national firms, as compared with parent company expenditures at home			
· Number of researchers in offshore affiliates of national firms as compared with number of researchers in all firms in their home countries		X	
· Proportion of R&D in host countries under foreign control	X	X	
· Number of researchers of foreign affiliates in the host countries			
· Total R&D expenditures of firms under national control within and outside each country		X	

A= Available in **most** OECD countries
B= Available in **some** countries only
C= Desirable in the long term but **not available**

Basic Indicators Involving Transfers of Disembodied Technology

Indicator	Availability		
	A	**B**	**C**
· Aggregate technology payments (manufacturing, services)	X		
· Aggregate technology receipts (manufacturing, services)	X		
· Payments and receipts from:			
- Patents and inventions	X		
- Licensing	X		
- Trademarks, designs	X		
- Technical studies	X		
- Technical assistance	X		
Industrial research	X		
· Technology payments and receipts between parent companies and affiliates		X	
· Technology payments and receipts broken down by industrial sector		X	
· Technology payments and receipts broken down by countries of origin and destination		X	
· Payments and receipts from old and new contracts		X	
· Payments/R&D expenditure and income/R&D expenditure	X		
· Average size of the firms involved			X
· Percentage of patents that are marketed			X
· Share of output by sector produced under foreign license			X

A= Available in **most** OECD countries
B= Available in **some** countries only
C= Desirable but **not available**

Basic Indicators Involving High-Tech Trade

Indicator	Availability		
	A	**B**	**C**
· High-tech exports and imports	X		
· Penetration of imports (sectoral approach)	X		
· Export rate (sectoral approach)	X		
· Contribution of high technology to the trade balance	X		
· Geographic concentration of exports	X		
· Comparative advantages	X		
· Exposure to foreign competition in the domestic market	X		
· Exports and imports of foreign affiliates		X	
· Contribution of foreign affiliates to the overall trade balance		X	
· Imports from firms' own offshore affiliates		X	
· Intra-firm trade		X	
· Intra-regional trade	X		

A= Available in **most** OECD countries
B= Available in **some** countries only
C= Desirable but **not available**