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Technological gaps: an important episode in the construction of S&T statistics

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Abstract

Since the early 1960s, the OECD has been an important "think tank" in the area of science and technology policy. To the OECD, we owe the development of various statistical analyses, standards and norms for evaluating and, more importantly, for ranking countries on their scientific and technological performances. This paper traces the origins of this practice of ranking countries to the debate over technological gaps between the United States and Western Europe in the late 1960s. It shows how the OECD documented these gaps in a series of statistics that would form the basis for its later work on best practices, benchmarking exercises and scoreboards of indicators.

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1. Introduction

The OECD has been an important actor in the field of science and technology policies. As early as 1961, the organization promoted the setting up of national departments specifically devoted to science and technology policy [1,2], started periodic reviews of national policies[1], developed a program of study on the economics of research and published regular thematic studies based thereon [3], and developed standardized methodological manuals for the collection of data on science and technology [4]. However, the history of the OECD on these matters, and its influence on Member countries, remains to be written.

One element that characterized the OECD work was its comparative basis. It is

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[1] Started in 1964, the series would cover every OECD Member country.

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commonplace to argue that the only way for a country to assess its performance in science and technology is by comparing its efforts to those of the past, or to those of other countries. Indeed, most national policy documents start by drawing a picture of the world context or of their main competitors, often illustrated with statistics. The OECD is no exception to this rule. As an international organization, the OECD has always looked at science and technology policies within a comparative framework. A given country was distinguished, categorized and evaluated either against other countries, or according to standards or norms, the latter being those of the "best-performing" country. Today, at the OECD at least, this philosophy of examining policy manifests itself through studies on best practices, benchmarking exercises, and scoreboards of indicators.

This paper describes and analyzes the origins of this practice of ranking countries with regard to science and technology. The first such exercise was conducted 40 years ago, in the context of the debate on technological gaps. In the 1960s, French bureaucrats [5] and journalists [6] launched a debate on the American domination of European science and technology. Echoing UK Prime Minister Harold Wilson[2], J.-J. Salomon, head of the Science Policy Division at the OECD Directorate for Scientific Affairs (DSA), summarized the debate in the following terms [8]:

> Le développement technologique des États-Unis serait ainsi le signe d'un palier nouveau dans la croissance (et la puissance) auquel les pays européens, en dépit de leurs progrès, se découvriraient menacés de ne pas pouvoir accéder (p. 761). [Le vrai débat] est dans les conséquences à moyen et long terme que peut entraîner la différence d'échelle entre l'entreprise scientifique et technique aux États-Unis et en Europe, c'est-à-dire dans la menace de domination qu'elle comporte. Pour les pays industrialisés, c'est peut-être sur le terrain de la science et de la technique que se joue leur indépendance de demain (p. 774).
>
> [The technological development of the United States would thus represent a new level of growth (and power) that the European countries, despite their progress, have found themselves in danger of not achieving (p. 761). [The real debate] is in the possible medium and long-term consequences of the difference in the scale of scientific and technological effort between the United States and Europe, that is to say in the potential threat of domination that this difference entails. For the

[2] I fear "un nouvel esclavage industriel par lequel, nous, en Europe, fabriquerons seulement les produits conventionnels de l'économie moderne, en devenant de plus en plus dépendants de l'appareil industriel américain pour tout ce qui sera de la technologie avancée, pour tout ce qui sera déterminant à l'âge industriel, à partir des années 1970–1980": H. Wilson, cited in J.-J. Servan-Schreiber (1967) [6], Le défi américain, Paris: Denoel, p. 91, "an industrial helotry under which we in Europe produce only the conventional apparatus of a modern economy, while becoming increasingly dependent on American business for the sophisticated apparatus which will call the industrial tune in the 70s and 80s." H. Wilson, cited in J.-J. Servan-Schreiber (1968) [7], The American Challenge, translated from the French by Ronald Steel, New York: Atheneum, p. 78.

industrialized countries, the fate of their independence may well be decided on the playing field of science and technology (p. 774).]

The OECD took part in the debate with an important quantitative analysis aimed at documenting the issue. Nine sector studies, one analytical report and a synthetic one were published between 1968 and 1970. This was the first exercise to compare countries based on several indicators in order to draw policy lessons, and it was an important one: thereafter, the OECD systematically situated its policy and statistical analyses within such a comparative framework. The United States, and particularly its performances on R&D, became the ideal yardstick with which to compare other OECD countries.

Whether the statistics helped shape policy agendas and priorities in OECD Member countries remains to be assessed empirically. One thing is certain, however: the OECD publication on technological gaps set up the model for following OECD studies on science and technology. Thereafter, comparing and, above all, ranking countries became one of the main tasks to which the OECD's analytical and statistical reports were devoted.

The first part of this paper shows what the debate on technological gaps owes to the issue of the productivity gap in the 1950s. After World War II, the United States offered its help for the reconstruction of Europe, but it was conditional help: the Marshall Plan was placed under the umbrella of increasing productivity. It was in this context that science and technology came to be widely discussed in Europe. The second part of this paper documents the OECD preoccupation with R&D discrepancies between the United States and Europe, which led to the study on technological gaps. It documents how one side of the debate used numbers to support its own case, while the other turned rather to qualitative arguments. In the end, the debate faded, but gave rise to a regular statistical series, which ranked countries against the best performer. The third part of this paper examines subsequent extensions of this practice of ranking countries. The source of American performance identified during the gap exercise, namely innovation, began to drive the measurement of science and technology toward industrial statistics: beyond ranking countries on their overall GERD/GNP[3], rankings on specific performance such as share of industrial R&D and high-technology intensity, for example, were emphasized as supplementary 'normative' goals toward which all countries should aim.

2. The productivity gap

In 1948, the United States launched the European Recovery Program (ERP) or Marshall Plan, aimed at participating in the reconstruction of Europe. $5 billion was devoted "to stimulate greater efficiency in European industrial production through

[3] Gross Expenditure on Research and Development (GERD) as a percentage of Gross National Product (GNP).

the introduction of American production techniques, styles of business organization, and labor-management partnerships. The vehicles for achieving this goal included a variety of technical-assistance projects, engineering schemes, and productivity surveys that were launched in Europe with the aid of American experts…" [9]. For the Americans, the panacea for European economic recovery was to increase productivity [10–12]. The 'productivity movement', originally launched by the Marshall plan, was also amplified by Great Britain[4]. In 1948, L. Rostas, a statistician in the British Board of Trade (Department of Trade and Industry), published an influential report comparing the productivity of British and American industry, and showing a considerable disparity, or gap, in favor of the United States in most of the 20 or more industrial sectors studied [13]. At the same time, the newly-created British Advisory Council on Science and Technology (ACST) set up a group of industrialists, trades union representatives, scientists and engineers to report on how science and technology could best contribute to increasing the nation's industrial productivity. The report (the Gibbs report) stated that, in the short run, research could have little effect on productivity levels [14]. Any efforts should focus on inculcating a rational, scientific approach within industry, and by adapting operational research methods that had been so successful during the war. These were also the solutions favored by the British Committee on Industrial Productivity[5], and the Anglo-American Council on Productivity (ACCP), which participated actively in the organization of the US Technical Assistance and Productivity Program segment of the ERP.

To manage and distribute American aid, the European countries created the OEEC (1948) at the request of the United States. In 1949, the Council of the OEEC set up a group of experts (Working Party no. 3), which conducted a regular program of work on productivity supervised by a committee for Productivity and Applied Research, which was established in 1952. In the following year, after expiration of the Marshall Plan, the OEEC established the European Productivity Agency (EPA) as a condition for receiving a second program of aid from the United States ($100 million). By 1955, the EPA had an operating staff of 200, representing some 45% of the OEEC's total operating staff [15].

When the EPA was first established, European economic recovery was practically completed, but "the original attitude of mind still persisted. The tendency was still to try above all to make up the ground lost in Europe… The high productivity of American firms was due to their operating conditions as much as to their technical advances…" (OEEC, 1959a, p. 5) [16]. The EPA therefore continued the type of project initiated by the ERP. According to R. Grégoire, director of the EPA, over the period 1953–58, three phases characterized the Agency [17]. The first phase he called "technological", and it was driven by the "illusion que les États-Unis avaient découvert, grâce à la guerre, tant de nouveaux procédés, tant de nouvelles méthodes de production, que pour combler l'écart il fallait avant tout essayer de rattraper cette

[4] A. King (1992), *The Productivity Movement in Post-War Europe*, 18 pages, unpublished.

[5] See: *First Report of the Committee on Industrial Productivity*, Cmd. 7665, London: HMSO; *Second Report of the Committee on Industrial Productivity*, Cmd. 7991, London: HMSO.

avance technologique" (p. 208), "*illusion that, because of the war, the United States had discovered such a large number of new procedures and production techniques that to close the gap we had to first and foremost catch up to their technological lead.*" In a study on the role which American investment played in assisting the post-war economic recovery of Western Europe, the OEEC summarized this view as follows: "United States capital [carried] with it improved technology, efficient production and sale methods, patents, management, skilled personnel and fresh ideas, all elements from which the economies of the most advanced European countries can derive higher productivity" (OEEC, 1954, p. 31) [18]. The belief in American technology led to study missions in the United States, the diffusion of scientific and technical information (conferences, centers, digests, surveys), and activities focusing on cooperation in applied research.

The second phase of the EPA was motivated by the idea that it was managerial and social factors that were responsible for productivity: "la différence entre la productivité moyenne des entreprises américaines et celle des entreprises européennes s'expliquait avant tout par une meilleure conception de la gestion des entreprises et par un meilleur climat social" (p. 212), "*the difference between the average productivity of American firms and that of European firms is above all due to better business management and a better social climate.*" The EPA therefore decided that it should "concentrate mainly on management problems and the improvement of co-operation between management and labour" (OEEC, 1959a, p. 5) [16]. This led to missions and conferences of experts, but also to the establishment of training centers on management and national productivity centers, conferences on administration and organization of research, inculcating scientific methods within industry (operational research), developing productivity-measurement techniques, and surveys on the attitudes of labour towards technological change[6].

The third and final phase saw a return to technological considerations: "on semble avoir découvert…l'extraordinaire deficit de personnel technique en Europe" (p. 216), "*we seem to have discovered…an extraordinary shortage of technical personnel in Europe*". Europe was now afraid "of being outdistanced by the United States and the USSR" [19]. By 1957–58, it was recognized that "new technological developments were important elements in determining the long-term rate of growth" (p. 6) [16]. "The strictly narrow concept of productivity, which was appropriate to the economic situation when the Agency was created, should now give way to a wider concept", claimed WP26 on the future of the EPA (p. 8) [16] In the views of several people and organizations, however, the emphasis should certainly continue to be placed more on management factors[7]. In fact, two groups of countries struggled over this issue at the EPA. One was concerned with 'traditional' activities, which were those pertaining to increasing productivity (the Nordic group of countries, plus Belgium), the other with problems relating to science and technology, notably the training of scientific and technical personnel (France, Italy, US, OEEC's Secretariat)

[6] A. King, The Productivity Movement in Post-War Europe, op. cit.
[7] See also: Kuisel (1988; 1993) [20,21].

[22]. But for WP26, it was clear that science and technology "should be given relatively more importance in the future Agency programmes than they have had in the programmes of the EPA" (p. 8) [16]. Indeed, the OEEC had also been starting to become more active in the field of science and technology for some years[8], mainly because "the future development of the European economy demanded increased numbers of highly trained scientists and technologists"[9] [23].

The *rationale* of WP26 concentrated on comparing European and American performance: "Between the highly developed, science-based industries of the United States and the explosive development of Russian technology, Europe sits uneasily…True, Europe has the great advantage of the tradition and maturity of its scientific institutions, and particularly those for fundamental research…But this is not enough…Europe has, as a region, been slow to exploit in production the discoveries of its laboratories" (p. 2) [24]. "It is no longer possible for each of its constituent countries to undertake the amount of research necessary for its security and prosperity"(p. 2–3) [24]. But "most of our governments have evolved little in the way of a coherent national science policy, while the concept of scientific research and development as an important and integral feature of company investment is foreign to the thought of most of European industry"(p. 3) [24]. The working party proposed the merging of the EPA Committee of Applied Research (CAP) and the OEEC Committee of Scientific and Technical Personnel (CSTP) under a Committee of Scientific Research (CSR), and the setting up of a 7–10 year program based on the Wilgress report[10]. Indeed, in 1959, D. Wilgress was asked by the Secretary-General to survey Member countries on their approaches to science and technology. He reported [27]: "It is in Western Europe that most of the great scientific discoveries have taken place…but in the race for scientific advance, the countries on the Continent of Europe stood comparatively still for more than two decades while the Soviet Union and North America forged ahead" (p. 14). The sources of the problem were many: the educational system was "better fitted for turning out people trained in the liberal arts than in science and technology" (p. 14); there were prejudices against those who work with their hands and few applications of the results of science; there was also a lack of resources for science, too great an emphasis on short-run profits and not enough on investment for the future, small-sized firms were not very science-minded, and university facilities and technical training were inadequate (pp. 14–23).

It was in this context that the newly created OECD (1961) turned to the promotion of national science policies. To better enlighten these policies, the OECD would

[8] Four areas characterized the activities of the organization: 1) creation of an atmosphere of public understanding (for which it organized conferences on the administration and organization of research, and programs for the improvement of basic education), 2) provision of scientists and engineers (for which a working party on shortages was set up, countries reviewed and international surveys conducted); 3) cooperation in applied research (road, water, ships, metal, etc.), and 4) dissemination of scientific information (by, among other things, networking the national information centers concerned, by STI in Eastern Europe, by SME; by conducting surveys on industrial needs).

[9] R. Sergent (1958), *Coopération scientifique et technique: note sur les activités de l'OECE*, Memorandum, January 22.

[10] See also [16,25,26].

conduct R&D surveys and economic studies of science. By then, however, a model had already been established: the OECD borrowed the EPA notion of the productivity gap, which became the technological gap.

3. Technological gaps

The first international survey on R&D, in which 15 countries participated, was conducted in 1963–64. The analysis of the results was presented at the second OECD ministerial meeting on science in 1966, and published officially in 1967 [28]. A methodological document followed one year later [29].

The report was designed to examine the level and structure of R&D efforts in Member countries. Three kinds of analysis of R&D data were conducted—these would become the standards used in the ensuing decades: 1) general measures or indicators in absolute (GERD) and relative terms (GERD/GNP), 2) break-downs of R&D expenditures by economic sector, R&D objective and type of activity, and 3) specific analyses of economic sectors: government, business, higher education, non-profit. The report was considerably influenced by the first international analyses of R&D conducted by C. Freeman et al. and published by the OECD in 1965 [3]. The authors showed, among other things, that the United States spent about four times as much on R&D as Western Europe. They suggested three main ways in which “substantial differences in the scale of resources committed to R&D between the United States (and the USSR) on the one hand, and Western Europe on the other” might be expected to diminish: establish and operate joint European R&D programs, benefit from knowledge transfers by multinational firms and, above all, increase the supply of scientists and engineers (pp. 64–67). The terms of future OECD statistical studies were fixed from that point on.

The OECD analysis of the first international statistical year (ISY) results was conducted by groups of countries, classified according to size and economic structure. The United States was chosen as the ‘arithmetic’ standard (index = 1000) (p. 18), and the graphs of the report pictured accordingly. The United States was put in its own category, followed by ‘sizable industrialized countries’, ‘smaller industrialized countries’, and ‘developing countries’ (p. 8)[11]:

1. United States;
2. France, Germany, Italy, Japan, United Kingdom;
3. Austria, Belgium, Canada, Netherlands, Norway, Sweden;
4. Greece, Ireland, Portugal, Spain, Turkey.

The report concentrated on the discrepancies between the United States and European

[11] Another categorization aimed to group European countries into broader economic entities, more similar in size to the United States, was also used: Western Europe, and Common Market countries. But the same trends were observed: “The United States spends three times as much on R&D as Western Europe and six times as much as the Common market” (p. 19).

countries. It showed that the United States' GERD was highest in absolute terms as well as per capita (p. 15), and it had the most scientists and engineers working on R&D (p. 17). "There is a great difference between the amount of resources devoted to R&D in the United States and in other individual Member countries. None of the latter spend more than one-tenth of the United States' expenditure on R&D…nor does any one of them employ more than one-third of the equivalent United States number of qualified scientists and technicians", reported the OECD (p. 19).

Finer analyses[12] were conducted at three levels. Firstly, four basic sectors—government, non-profit, higher education, and business enterprise—were analyzed. The OECD measured that "in all the sizable industrialized countries except France, about two-thirds of the GERD is spent in the business enterprise sector" (p. 23). "In the developing countries [of Europe] R&D efforts are, conversely, concentrated in the government sector" (p. 25). The OECD also showed that industrial R&D was highly concentrated: "83% of total industrial R&D is carried out by the 130 companies [mainly American] with R&D programmes worth over $10 million each" (p. 43), and "government supports a higher proportion of R&D in selected industries [aircraft, electrical, chemical] in the United States than any other industrialized Member country" (p. 51).

Secondly, R&D objectives were examined within three broad areas: 1) atomic, space and defense, 2) economic (manufacturing, extraction, utilities, agriculture, fishing, forestry), 3) welfare and miscellaneous (health, hygiene, underdeveloped areas, higher education). The results showed, among other things, that two-thirds of the United States' total R&D resources were devoted to the first category (p. 28).

Finally, research activities were broken down by type—basic, applied and development. It was calculated that the United States (and the United Kingdom) spend more on development than any other category (p. 34). Also noteworthy was the fact that "the higher education sector is less important than might be expected, undertaking less than half of total basic research in the United Kingdom and the Netherlands, and less than two-thirds in all other industrialized countries except Norway" (p. 34).

This study launched the generalized use of the GERD/GNP indicator. First conceived in the thirties [31], the indicator was conventionalized in the first edition of the Frascati manual (pp. 34–6) [4]. The American GERD/GNP ratio of the time, that is 3%, as mentioned in the first paragraphs of the first edition of the Frascati manual (p. 5), became the ideal to which Member countries would aim, and which the OECD would implicitly promote: national governments systematically introduced the target in their policy objectives[13], the OECD regularly compared countries within each of its *Reviews of National Science Policy* and, within its *Science and Technology Indicators*[14] or *Science and Technology Policy Outlook*[15] series, and constructed groups of countries according to their levels of GERD/GNP; the United Nations and

[12] These looked at both the sources and the performance of R&D.
[13] For an example, see: [32].
[14] See particularly the first edition: OECD (1984a, p. 24–25) [33]
[15] See, for example: [34].

UNESCO developed specific GERD/GNP objectives for developing countries[16], as well as objectives for funding of developing countries from developed countries (United Nations, 1971b) [105].

In the history of science and technology policy, the indicator was largely used by governments for normative purposes, however: “the strength, progress and prestige of countries are today measured in part by their achievements in science and technology, scientific excellence is more and more becoming an important national goal. National resources are therefore increasingly devoted to research and development” [2][17]. A country not investing the ‘normal’ or average percentage of GERD/GNP always aimed for higher ratios, generally those of the best-performing country: “the criterion most frequently used in assessing total national spending is probably that of international comparison, leading perhaps to a political decision that a higher target for science spending is necessary if the nation is to achieve its proper place in the international league-table” (p. 50) [38].

As early as 1967, however, the OECD warned countries against uncritical use of the indicator [28]: “Percentages of GNP devoted to R&D are useful in comparing a country’s R&D effort with resources devoted to competing national objectives or to track its growth over time. International comparisons of GNP percentages are, however, not good yardsticks for science planning” (p. 15). “The percentage of GNP devoted to R&D varies directly with per capita GNP. [But] this appears to be true at the top and bottom of the scale” only (p. 19).

Again in 1975, the OECD stated [39]: “Around the time of the publication of the first ISY results, many Member countries were expanding their R&D efforts and the percentage of GNP devoted to R&D was considered an important science policy indicator for which targets were to be set. This enthusiasm for GNP percentages has waned. For most, growth has seldom reached the more optimistic targets (notably the oft-quoted figure of 3% of GNP)” (p. 23).

Despite these criticisms, it was the OECD itself that contributed to the widespread use of the indicator. In every statistical publication, the indicator was calculated, discussed, and countries ranked according to it, because “it is memorable” (p. 26) [33] and is “the most popular one at the science policy and political levels, where simplification can be a virtue” (p. 111) [40][18]. The practice was not without its dangers, however. Firstly, as the OECD itself admitted, “international comparisons might lead to a situation where, for prestige reasons, countries spend more on R&D than they need or can afford” (p. 50) [38]. Secondly, the indicator said nothing about the relationship between the two variables: is the GNP of a country higher because it performs more R&D, or are R&D expenditures greater because of a higher GNP? [41].

[16] See, for example: United Nations [35,36].

[17] For an early statistical analysis comparing countries in these terms, see: [37].

[18] The French translation reads as follows: “le plus prisé parmi les responsables de la politique scientifique et des hommes politiques, pour lesquels la simplification se pare parfois de certaines vertus” (p. 119).

> R&D expenditures and the gross national product show a high degree of correlation. The conclusion, of course, cannot be drawn that one of these is cause and the other effect—in our modern economy they are closely inter-linked and that is the most we can say [42][19].

Finally, the indicator and the comparisons based upon it do not take diversity into account [44]. Despite these warnings, national governments continued to use the indicator to argue for higher and higher ratios of GERD/GNP, that is, ratios like that of the United States. According to a recent OECD mini-survey, the indicator is still the most preferred by Member countries, well ahead of any output indicator [45]. Thus, the OECD erred in 1974 when it wrote: "The search for "Magic Figures" of the 1960s, namely the percentage of GNP spent on R&D, has lost much of its momentum and relevance" [46].

The context within which the OECD introduced its 1967 report on R&D was the then-current debate on technological gaps. The organization refused, however, to use either the term "debate" or "gaps": "It is hoped that this report will contribute to the clarification of existing public discussions on this matter, in particular in connection with technological disparities between Member countries" (p. 5), that is between the United States and Western Europe.

The statistics of the report, as well as the Freeman/Young report, would largely feed the debate on gaps[20]. Everyone found something in the OECD study to document its own case. Numbers were cited by the pro-gap theorists—mainly Europeans who reminded people that the United States' effort was much above Europe's at 3.4% of GNP—the skeptics who proposed the theory that the American superiority was due only to defense (62% of R&D), and not civil R&D, and the Americans themselves: US performance came mainly from the efforts of industry on development (over 65% of R&D), which Europe could emulate.

For the Americans, the problem of Europe was a management problem: applying available technology. D. F. Hornig, special assistant for Science and Technology, and appointed in November 1966 by President Johnson to study the issue, stated: "McNamara said it was a management gap, some of us said it was an education gap, but Pierre Masse in France, I think put it together best. He said, "It all adds up to an attitude gap". We educate more people; we educate them to a higher level; we find our management is more enterprising…"[48]. To clarify the issue, his colleague I. L. Bennett, assistant director at the OST (Office of Science and Technology), suggested in the newspaper *Le Monde* (p. 5) [49]: "ce que je préconise, c'est une tentative organisée et concertée pour démystifier l'écart…Ce n'est qu'en faisant la distinction entre les faits réels et les illusions engendrées par une réaction émotionnelle ou par l'opportunisme politique que l'on pourra définir les vraies dimensions du problème…À cette fin, nous avons soutenu de tout cœur l'étude

[19] See also Salomon (1967: 912–917) [43].

[20] Despite the fact that C. Freeman later emphasized that he did not used the expression/technological gap" (p. 463) [47], he used the term "gap" several times in his study with A. Young (pp. 63 and 65) [30], especially when dealing with international disparities.

majeure sur les secteurs industriels qui est en cours à l'OCDE", *an organized and concerted attempt to demystify the gap…It is only in distinguishing between the real facts and the illusions engendered by an emotional reaction or by political opportunism that we will be able to define the real dimensions of the problem…To this end, I have wholeheartedly supported the major study of industrial sectors currently underway at the OECD".*

In general, "American officials tended to dismiss the technological gap with Europe as a non-problem, or at least as a problem that the US government can do little to help solve. While admitting that the United States is ahead of Europe in computers, electronics, aviation and space, Americans point out other areas where the United States is behind—metallurgy, steel, and shipbuilding. They also note the German superiority in plastics, the Dutch preeminence in cryogenics, and the positive balance of trade for the European Economic Community in synthetic fibers…If the Atlantic Community nations are really at a technological disadvantage vis-à-vis the United States today, how have most of them managed to outstrip the United States in production growth and in expansion of their foreign trade during the last decade?" [50].

R. H. Kaufman, vice-president of the Chase Manhattan Bank, was representative of the American position. At a conference organized by the Atlantic Institute in Rome in 1968, he suggested: "Much of the confusion regarding technology stems from conflicting definitions" (p. 15) [51]. By this, Kaufman meant that innovation did not originate solely, or even mainly, in R&D, but that management, marketing and use of technologies were, for example, equally important. According to Kaufman, there were more lags than gap: "A gap suggests an inequality at one point in time—a vacuum that must somehow be filled. However, this is not completely accurate, for there has never been a uniform technological level between peoples…Leads and lags are normal phenomena [and] changed hands many times" (p. 17).

> "There is nothing new about Europe being technologically behind the United States in a number of fields", wrote Kaufman. "What is new is the mounting concern about a current or potential threat that these technological lags may pose for Europe, in particular, as well as for the whole world" (p. 22). "Europe's technological lags have been confined to certain industries; and up to now, they have hindered neither the region's economic growth, nor its balance of payments, nor its capacity to innovate." (p. 22).

But "why is there such a wide disparity between these findings and the strong feeling of many Europeans", asked Kaufman (p. 37)? He offered three explanations. Firstly, the "popular tendency to extrapolate developments in the spectacular industries [like computers and electronics] to the rest of the economy" (p. 37). Secondly, "the inadequate appreciation of the significance of the diffusion of technical knowledge across the Atlantic" (p. 40), that is, the inevitable international aspects of knowledge that manifest themselves in technology flows (patents and licenses) and foreign direct investments. Thirdly, social and political concerns: "European opinion is concerned that the world's productive effort may be undergoing a reallocation, with all advanced techniques and productivity improvements emanating from the United

States…Many Europeans resent the fact that US companies dominate certain of their industries” (p. 47). Other aspects of European anxieties identified by Kaufman related to the brain drain—a “highly emotional term invented by the British” (p. 48) – and to the nuclear age, where “a strong technological base is conducive to military power” (p. 49). “The lag is being used as an excuse to make improvements in Europe’s educational structure, its management practices, its salary scales for scientists and engineers, its industrial structure through mergers and consolidations, and its expenditures for instrumentation in R&D departments. And, of course, Britain has used the problem to bolster its case for joining the EEC” (European Economic Commission) (p. 50).

For Kaufman, the real causes of the European technological lag were: economic (labour shortage, small market, company size, competitive climate), technological (emphasis on basic rather than applied research), management (training of managers, commercialization), policies (fiscal policy, patent system), and social (labour, attitudes toward business, educational system) (pp. 52–80).

Other American authors offered similar analyses. For R. R. Nelson, gaps between US and Europe were a long-standing phenomenon that have existed for over one hundred years, but concern was “greatly sharpened in the early post World War II years when, as a result of the war, disparities between US and European economic capabilities were particularly great” (p. 12) [52]. “What is new is a far sharper awareness of the situation, and, among at least some Europeans, a relatively new deep-seated concern about its significance” (p. 15). Nelson offered four basic reasons for European concern: trade, international direct investment, science, and military strength (pp. 15–19). These “led some people to view certain consequences as inseparable—loss of foreign policy autonomy in certain key respects, reduced national control over the domestic economic system, and a threat to national economic well-being and growth” (p. 19). But, “to a considerable extent the power of the European economy to produce goods and services is as high as it is because of the technological progressivism of the United States” (p. 21). For Nelson, the debate was rather political: “Not being behind technologically in the most revolutionary fields has been, or is becoming, an aspect of national sovereignty” (p. 33), and equivalent to “assigning high value to independence options, and underestimating the price” (p. 34).

R. S. Morse from MIT held similar views: “Discussions about the technological gap are often undertaken by individuals who understand neither science and technology nor the problem associated with its application” (p. 84) [53]. “The United States has a greater total capability in advanced technology than any other country, but there is little evidence that such technology, per se, is solely responsible for its economic growth rate or standard of living” (p. 84). “If there is some gap between the US and Europe to which Europeans should direct their attention, it is not the technological gap, but rather a management gap” (p. 85–86). Morse then goes on to list a number of factors that seemed fundamental to rapid progress: cooperative environment (between university, government and business), personnel mobility (between sectors), attitude of top management, new enterprises, venture capital, competition.

To take one more example, J. B. Quinn (Dartmouth College) argued that the

United States had enormous, unprecedented advantages, assets, and potentials in international technological competition: market size, big companies with large R&D programs, more scientists and engineers, a flexible educational system, management practices (techniques for planning, evaluation and control of R&D). However, possession of these strengths did not necessarily mean that they were being utilized fully by industry and government [54].

Some Europeans agreed with the diagnosis. C. Freeman, author of the first study on international disparities in R&D, concluded: “To describe or to understand a “technology gap”, one must go beyond comparisons of R&D inputs” (p. 464) [47]: “it is clearly possible to have a highly productive R&D system but a disproportionately small flow of economically successful innovations and a slow rate of diffusion” (p. 464), because “successful innovations often demand management qualities of a higher order” (p. 466). In accordance with these specifications, Freeman concluded: “there are some grounds for believing that, both in the Soviet Union and in Britain (though for rather different reasons), the flow of profitable innovations and the speed of their diffusion has been somewhat disappointing in relation to the input of resources into growth-oriented R&D, and probably also in relation to the output of R&D” (p. 465).

J. J. Salomon, head of the OECD Science Policy Division in the 1960s, also admitted that there were disparities between the United States and Europe. Writing in the journal *Esprit*, under the pseudonym J. J. Sorel, he asserted: “S’il y a une plus grande aptitude des entreprises américaines à tirer parti des produits de la recherche, cela tient à des facteurs de conception et de gestion autant, sinon plus, qu’à des facteurs de dimension…Le technological gap est en grande partie un managerial gap” (p. 764,b) [8], *If American firms have a greater aptitude for getting the most out of research, it is as much, if not more, because of management and design factors than of…The technological gap is in large part a management gap*”.

J.-P. Poullier, consultant at the French National Center for Information on Productivity in Business, speaking at an Atlantic Institute conference held in 1968, concluded what only a European could have publicly said: “If a major objective of Europe is to catch up with the income and productivity of the United States, a high degree of emulation of the American pattern is unavoidable, for economics responds to a certain rigor and discipline. Europe may choose not to pay the price America paid, but then it must accept without infantile recriminations a level of income second to that of the United States. Frankly stated, a large number of comments and explanations of the technological gap are unworthy of the great cultural and intellectual environment on which Europeans like to pride themselves” (p. 125) [55].

Finally, A. Albonetti, director of international affairs and economic studies at the National Committee for Nuclear Energy (CNEN), using several statistics, demonstrated that there was a gap between Europe and the United States, but over time “there exists a parallel trend which tends to minimize this gap” and “scientific research is, for the time being, rather confined to the smoothing of this disparity” (p. 264) [56].

The OECD position was not far from the American one, and may even have been influenced by the latter. In 1968, the OECD published *Gaps in Technology*, which collected information on three related aspects of the problem [57]: 1) differences in the development of national scientific and technological capabilities; 2) differences in performance in technological innovation; 3) economic effects of 1 and 2. It is worth summarizing the results at length.

With regard to science and technology capabilities, the OECD looked at graduates, the migration of scientists and engineers, and R&D. Concerning the production of graduates, *Gaps* found that "the United States appears to put relatively much more emphasis on pure science than on technology [while] the European effort in technology surpasses the United States' effort in both relative and absolute terms" (p. 12). Turning to the migration of scientists and engineers, the OECD stated: "Europe has lost in recent years approximately 2000 scientists and engineers annually", but the report immediately added: "significant rates of emigration are, however, limited to a few countries only, and they are, moreover, concerned with one-way flows only" (p. 12). But it was R&D that was the main variable used here: "in 1964, the United States devoted 3.4% of GNP to R&D, the economically-advanced European OECD countries together 1.5%, the European Economic Community 1.3%, Canada 1.1% and Japan 1.4%" (p. 13). The largest disparity in R&D was found to be in industry: "no firm in any European country has an R&D programme of this magnitude" (more than $100 million per annum) (p. 13). In basic research, "the United States has a strong position in most fields of fundamental research, but above all in fields where heavy capital and maintenance expenditures, and a large number of highly qualified scientists (above Ph.D. level) are necessary…European fundamental research units are generally smaller." (p. 13). Government funding of R&D was also higher in America: "the United States devoted four and a half times as much public money to R&D as industrialized Western Europe", although it is highly concentrated in defense, space and nuclear energy (p. 13). "While it has not been the aim of the United States policy to support industries or products directly for commercial purposes, the indirect commercial effects have been considerable" (p. 14).

On the second item—innovation—, the conclusions were similar in tone: "Firms based in the United States have had the highest rate of original innovation over the past 15 to 20 years. Of the 140 innovations, they have originated approximately 60%. United States firms also have the largest share of world exports in research-intensive product groups (about 30%), and the largest monetary receipts for patents, licensing agreements, and technological know-how (between 50 and 60% of total OECD receipts)" (p. 15). "One conclusion that appears irrefutable: United States firms have turned into commercially successful products the results of fundamental research and invention originating in Europe. Few cases have been found of the reverse process" (p. 17).

With regard to the diffusion of innovation, the report found that "the United States have the highest level of diffusion of new products and processes, but many other Member countries have had higher rates of increase in the diffusion of new products and processes over the past 10 to 15 years. However, rates of increase in diffusion have been much higher in Japan…" (p. 17). But above all, for the OECD, "differences between Member countries in performance in originating innovations do not appear to have had any [negative] effects on Member countries' overall economic growth performance" (p. 18).

Finally, with regard to the economic impact of science and technology, the OECD looked at two indicators. Firstly, flows of technology: "The United States' receipts for patents, licenses, etc., account for 57% of total receipts in OECD countries" (p. 19). Secondly, trade statistics showed that "the United States tends to have a trading advantage over other Member countries in newer, more sophisticated products" but, again, "there is no indication that the USA advantage in those goods where scientific capability and innovation skills are important has had deleterious consequences for other countries" (p. 18).

Overall, in the view of the OECD, the causes of the gap were not R&D per se: "scientific and technological capacity is clearly a prerequisite but it is not a sufficient basis for success…The market—size and homogeneity, including that portion made possible by Government procurement—is in fact a very important factor conditioning the realization of scientific and technological potential…Nevertheless, a broader market would, in and of itself, not solve the problem." (p. 23), because other factors are equally important, among them: size of firms, role of government support, industrial rather than public support, economic climate, educational and social environment, and management.

4. The mystique of ranking

By the mid 1970s, the policy issues had completely changed. The OECD was no longer preoccupied with gaps, but concerned with allocating R&D resources in support of socio-economic goals [58,59], and with the overall "leveling off" of R&D. In 1975, the OECD published an analysis of a decade of work on measuring R&D [39]. The quality of the data has considerably improved, at least with regard to their details. Although the social sciences and humanities were still excluded from the R&D survey, there were more refined classification with regard to R&D by industry, scientific field, and socioeconomic objective. Statistics were also a lot more numerous (and sophisticated!) [60] than in the 1967 report.

The numbers showed that the United States continued to be the largest R&D performer in the OECD area, "spending more than all the other responding countries taken together" (p. 9). But the OECD comparisons were now conducted vis-à-vis five groups of countries, and not only versus the United States. The groupings were constructed on the basis of the performance of countries based on both GERD and GERD/GNP (pp. 14–15):

1. Group I: *Large R&D and Highly R&D Intensive*—France, Germany, Japan, United Kingdom, United States
2. Group II: *Medium R&D and Highly R&D Intensive*—Netherlands, Sweden, Switzerland
3. Group III: *Medium R&D and R&D Intensive*—Australia, Belgium, Canada, Italy

4. Group IV: *Small R&D and R&D Intensive*—Austria, Denmark, Finland, Ireland, Norway
5. Group V: *Small R&D and other*—Greece, Iceland, Portugal, Spain.

The report documented a 'leveling off' of R&D expenditures. The phenomenon was measured in two ways (pp. 19–21). Firstly, annual growth rates of GERD and R&D manpower were stable or declining in seven countries over the period 1963–1971. Secondly, the GERD/GNP was stable or declining for nine countries, among them the United States. Three conclusions were drawn from the statistics (p. 23). Firstly, "the principal change since the publication of the results of the first ISY has been the absolute and relative decline in the resources devoted to R&D by the United States and the United Kingdom and the re-emergence of Japan and Germany as major R&D powers". Secondly, differences between Member countries narrowed slightly: "in 1963, nearly 60% of all OECD R&D scientists and engineers worked in the United States, as against about 20% in the (enlarged) Common Market and 20% elsewhere (of which 15% were in Japan). By 1971, the corresponding shares were: United States, less than 55%; Common Market, virtually no change; other countries, 25% (of which 20% were in Japan)". Thirdly, "there was a "leveling off" in the amount of resources devoted to R&D in about half the countries in the survey".

This was only one of the main issues of the OECD report. The other was its "stress on the role of the business enterprise sector" (p. 25)—because it is the "prime performer of R&D" (p. 47)—and the respective role of (or balance between) public and private R&D (p. 85). The report noted a slight decrease in the share of government R&D funding, but a substantial increase in the percentage of GERD financed by business funds (p. 27). In most (15) countries, the business enterprise sector was the most important sector for performance of R&D, performing about two-thirds of the national efforts in Groups I and II, and over half in Group III (p. 47). Only Australia and Canada differed from this group, with about one-third of the R&D performed by industry. All in all, "over the period…countries seem to have drawn together…: the role of industry increased in nine countries", reported the OECD (p. 49).

The interest in the business sector at the Directorate for Science, Technology and Industry (DSTI) was a direct consequence of the *Gap* exercise. One of the conclusions of the debate, as we have seen, was that innovation was at the heart of discrepancies between the United States and Europe. The obvious solution for national governments was to support industries' efforts, and for the OECD to continue putting emphasis on industrial statistics. A specific analysis of industrial R&D trends published in OECD (1979) [61], and a *Science and Technology Indicators* series begun in 1984, would specifically contribute to this task.

Trends in Industrial R&D (1979) [61] continued the previous analyses on leveling off, especially in "the new economic context since the energy crisis of 1973" (p. 5). The study was originally undertaken by an OECD group of experts examining "science and technology in the new economic context"[21]. It concluded that "the new

[21] The main result of the group was published as: OECD (1980) [62].

economic context does not seem to have had a major impact" (p. 16), since no change was observed in the overall level of industrial R&D, but a slight increase of 8% occurred between 1967 and 1975 (p. 14). Privately funded industrial R&D grew by about 30% (p. 16), mainly before the crisis, but was offset by a decline in government support, above all in the United States. The report also noted a significant redistribution (and convergence) of industrial R&D in the OECD area as efforts in the United States and the United Kingdom have declined and those of Japan and Germany have increased (p. 17).

The core of the report, however, was devoted to analyzing trends in nine groups of manufacturing industries, each industry group being discussed in terms of its share of the three principal areas of performance: United States, EEC countries, and others—notably Japan. The study included the main 11 OECD countries only—classified into two groups: major and medium industrial R&D countries—because "they perform 97% of all industrial R&D in the OECD area" (p. 11), although a small final chapter (nine pages out of a total of 200 pages) discussed 'small' countries.

The series *Science and Technology Indicators* (STI) followed, and three editions were published in 1984, 1986, and 1989. The first edition dealt wholly with R&D, while the other two added some new indicators (output and impact). The exercises were perfect examples of ranking countries and assessing their efforts against the best performers. As M. Henry et al. discussed recently with regard to OECD education statistics, countries were drawn "into a single comparative field which pivots around certain normative assumptions about provision and performance" (p. 84) [63]. I examine in the next few pages how the series and its successor were a further step in the OECD' s philosophy of ranking countries.

The 1984 edition [32] started with an overall view of R&D in the OECD area, in line with the 1975 report. The main results were threefold: 1) slower growth in R&D expenditures in the 1970s as opposed to the 1960s, although higher than GNP growth, 2) the United States remained the main performer of R&D, but its share of total R&D declined by 6% in the 1970s, while that of Japan increased by 4% and that of the European Community remained unchanged (slight gain of only 1%); 3) the share of government R&D in public budgets diminished in almost all countries, as well as the share of the university sector.

Following the general overview of the OECD area, four groups of countries were constructed according to their GERD, each being discussed in a separate chapter. This constituted the core of the report (260 pages out of a total of more than 330 pages), and was preceded by a short discussion on grouping exercises. The report refused to use some countries as a yardstick or "norm" (p. 24):

> The United States is far from being a typical OECD country…Many authors simply take the resource indicator concerned for the United States and for one or two other major spenders as a "norm", as they are the technological leaders to whose R&D patterns the other countries should be aspiring in relative if not in absolute terms. However, here we shall take a different approach. For each R&D resource indicator we shall try and establish what the typical OECD country spends and then identify the exceptions. This "typical" OECD country is not

defined in precise [a priori and unique] statistical terms (arithmetic average, median, etc.) but is based on observations of tables for individual indicators (industrial R&D, defense R&D, energy R&D).

Grouping in *STI*—1984

High—United States, Japan, Germany, France, United Kingdom
Medium—Italy, Canada, Netherlands, Sweden, Switzerland, Australia, Belgium
Low—Austria, Norway, Denmark, Yugoslavia, Finland, New Zealand, Ireland
Others—Spain, Portugal, Turkey, Greece, Iceland.

Nevertheless, the OECD analyzed countries' performances according to groups labelled with normative names (high, medium and low GERD). While each group was treated separately, the overview chapter continued to compare countries and rank them, generally against the largest five, because "once we have identified and discussed what happened to R&D in these five countries [United States, Japan, Germany, United Kingdom, France] we have more or less explained what happened to R&D in the OECD area as a whole" (p. 20). Over and over again, the organization conducted its analysis with recurrent comparisons using expressions like "the largest spenders", those in "first place", or "at the upper end of the range".

The OECD's grouping was founded on the following rationale: "it is only meaningful to make absolute comparisons between countries which devote broadly the same amounts to R&D in that they face the same degree of constraint in allocating resources" (p. 22). For the OECD, however, there remained more important groups (high GERD) than others (low GERD) and, within each of them, there were winners (generally the bigger countries) and losers (the smaller ones).

With the second edition of *STI* in 1986, grouping of countries was reduced to just three categories—large, medium, and small countries—and this grouping was not used in the analysis, but only in graphs (e.g.: p. 22) and tables (pp. 86ss). The dimension used for the grouping was country size, although this was not defined explicitly.

Grouping in *STI*—1986

Large—United States, Japan, Germany, France, United Kingdom, Italy, Canada
Medium—Spain, Australia, Netherlands, Sweden, Belgium, Switzerland, Austria, Yugoslavia
Small—Denmark, Norway, Greece, Finland, Portugal, New Zealand, Ireland, Iceland.

With regard to R&D, the main message of the report was similar to the previous one: 1) R&D funding increased by 3.5% annually between 1969 and 1981, 2) the United States lost a few percentage points between 1969 and 1983 (from 55% of OECD GERD to 46%); Japan gained several percentage points (from 11% to 17%), but the European Community's position has not changed; 3) the business enterprise sector has taken over from the public sector as the main funder of R&D, with two-thirds of GERD—while the share of universities continued to decline. This last point (industry's share of GERD) became a target which several countries thereafter suggested in their policy documents.

In this second edition, a new type of ranking appeared: industries were classified into three groups with regard to their R&D intensity: high, medium or low. The first group corresponded to what the OECD called "high technology industries", that is, industries that spent over 4% of turnover on R&D[22]. This was one more ranking for which the performance of countries was evaluated in terms of share of high technology industries, growth, market share, and trade balance. Very soon, however, the high technology list was criticized for being based on a specifically American classification [64].

The third edition of *STI* (1989) did not change very much, continuing the previous trends. The same message as in the previous two editions, and the same grouping as in the last report, prevailed. One characteristic of the previous reports, however, gained increased emphasis: the analysis and tables were regularly presented according to what the OECD called geographical zones: OECD—for which the United States and Japan were separately identified, as well as the group of the seven largest countries—, EEC, Nordic countries, and others.

A fourth *STI* report was envisaged, but never completed [65]. In fact, after 1989, the statistical unit would never again publish official reports wholly devoted to the analysis of its R&D survey. Instead, it published regular statistical series (without analysis) on one hand, and contributed to the policy analyses conducted in the Directorate for Science, Technology and Industry (DSTI) on the other hand. The main contribution of the DSTI was the *Science and Technology Policy: Review and Outlook* series, and its successor—*Science, Technology and Industry Outlook*.

The first two editions of the series contained very few statistics. Policy trends and problems were treated mostly in a qualitative language, although the first edition (1985) included a very brief discussion of countries grouped according to GERD/GNP (p. 18), and the second (1988) a series of statistical tables, mainly on scientific publications, in an appendix. With the third edition (1992) and those following, however, an overview text reminiscent of the *STI* series was included as a separate chapter or section, with the same structure, indicators and breakdowns as before, but less discussions by groups of countries and rankings. In fact, what characterized the new series, above all from the 1996 edition on, were the following three characteristics: 1) more diversity in sources for statistics, 2) a more problem-oriented and policy-oriented focus, and 3) an emphasis on economic aspects of science and technology (Table 1).

This reorientation was mainly the result of the Technology/Economy Program (TEP) in the early 1990s [66]. Gone was the exclusive concentration on descriptive analysis of the data from the ISY results, that is, on trends in R&D growth, and on the distribution of efforts among sectors. Now it was the internationalization of research, the role of public support for industry and its impact on R&D, innovation,

[22] Aerospace, Computers, Electronics, Pharmaceuticals, Instruments, Electrical Machinery.

Table 1
Treatment of the R&D data in *STI* and *Science, Technology and Industry Outlook*

Science and technology indicators	Total pages	GERD
1984	407 pages	407 pages
1986	125 pages	63 pages
1989	137 pages	130 pages
Science, technology and industry outlook		
1985	101 pages	None
1988	123 pages	None
1992	273 pages	20 pages
1994	341 pages	63 pages
1996	344 pages	12 pages
1998	328 pages	24 pages
2000	258 pages	12 pages

competitiveness, economic productivity, and the knowledge-based economy that were the issues. To discuss science and technology in these terms demanded other kinds of data than R&D expenditures and personnel, or patents and trade in high-technology industries.

The cost paid for this reorientation of statistical analyses was that statistics became a black box. While the *STI* series, for example, was not afraid of discussing the limitations of the data—although methodological notes were not exhaustively included in the publication, but rather in specific documents to that end—the policy series completely eliminated such discussions [67]. The matter was of interest to statisticians only; policy-makers—and above all their policy analysts—wanted facts, whatever the quality of the data.

Nowhere was this more evident than in the scoreboards—the last innovation of the DSTI. In the mid-1990s, the DSTI restructured its publication [68,69]. Up to then, four reviews and/or outlooks were prepared. The Secretariat suggested merging the 'Industrial' and 'Science and Technology Policy' reviews into one, to be published every two years. In the alternating year, a scoreboard of indicators would be published.

The idea of the scoreboard followed the construction of the STAN (Structural Analysis) database and its affiliates in the early 1990s. One of the first reports to come out of the new databases was a scoreboard of 16 indicators covering R&D, investment, international trade, employment and structural change [70]. Thereafter, and starting in 1995, an *Industry and Technology Scoreboard of Indicators* was published every two years. It included a series of economic and S&T indicators, graphically illustrated, ranking countries on different dimensions with a very brief analytical text (between two and five paragraphs for each indicator) – but with very few methodological notes.

From the scoreboards, the DSTI also produced compendiums specifically dedicated to the ministerial meetings: one in 1995 [71], and another in 1999 [72]. These documents were “synthetic and attractive” statistical and analytical documents that “tell a story readily understandable by generalists and the press” [72]. It included a set of indicators, each presented on one page, with graphs and bullet points highlighting the main trends.

The 1999 issue of the compendium dealt with the knowledge-based economy (KBE) [103]. In the mid-1990s, the KBE became the buzzword of the OECD [73] and its DSTI—particularly in *STI Outlooks* [74], *Scoreboards* [75,76], and conferences[23]. According to the OECD, knowledge-based economies are “economies which are directly based on the production, distribution and use of knowledge and information” (p. 3) [80]. The emergence of the concept is the direct consequence of economists’ new interest “to incorporate more directly knowledge and technology in their theories and models” (new growth theory) [80].

Despite its centrality to the economy, however, knowledge is hard to quantify and to price, according to experts and the OECD [80]. Nevertheless, the compendium collected over thirty indicators intended to measure the performances of countries on the KBE (Table 2). For the OECD, however, the KBE was above all a rhetorical concept. Most if not all of the indicators in the compendium are types of indicators that the OECD had already collected for several years[24]. The document simply aligned a series of indicators and fact-sheets put under a new umbrella—the KBE. The OECD recognized that the indicators were “not adequate to describe the dynamic system of knowledge development and acquisition” (p. 6) [73]. But they were probably sufficient to call the attention of policy-makers, politicians and the ‘general public’ to matters of science and technology.

Building on the work on indicators for the KBE, the OECD is about to develop a new kind of ranking called benchmarking. Benchmarking “enables each country to compare itself with the best performer in a particular area and to situate itself above or below the OECD averages” [82]. Since 1997, thematic studies have applied the “best practice” approach to science and technology [83,84]. Now, OECD countries will be systematically compared according to different indicators, based on a refinement and extension of indicators developed for the 2001 *STI Scoreboard* on the KBE [82,85,86]. The philosophy of the exercise reads as follows: “This comparison will provide practical means for countries to formulate their own performance targets, e.g.: to attain a ranking among the top five OECD countries in terms of ICT [information and communication technology] intensity or to double venture capital supply as a share of GNP within the next five years” (p. 5) [86]. The OECD has rarely been so explicit about the aims of its statistical work.

[23] A workshop and a conference on a new generation of indicators for the KBE were organized in 1996 and 1998 (Blue Sky Project). See: [75,77–79].

[24] This is not peculiar to the OECD. Contrary to its claims, Dominique Foray did not totally succeed in distinguishing the traditional economy of R&D and innovation from the KBE, at least with regard to the policy issues of the KBE [81].

Table 2
Indicators on the knowledge-based economy [102]

1. Knowledge-based economy
a. Investments in capital and knowledge
b. Human resources (education)
c. GERD
d. Fundamental research
e. Business R&D
f. R&D in manufacturing industries
g. R&D in services
h. Innovation
i. Venture capital
2. Information and communication technologies (ICT)
a. ICT spending as a percentage of GNP
b. Use of computers
c. Internet and e-commerce
d. ICT sector
e. Innovation in ICT
3. S&T policies
a. Public R&D/GNP
b. Socio-economic objectives of R&D
c. Share of public R&D
d. R&D financial flows between sectors
e. Public support to R&D
f. Business R&D by size
g. Tax subsidies
4. Globalization
a. R&D abroad
b. Patent ownership
c. Technological alliances
d. Co-signatures and co-inventions
5. Output and impact
a. Scientific publications
b. Patents
c. Innovation
d. Productivity
e. Share of knowledge industries in added-value
f. High technology trade
g. Technological balance of payments

5. Conclusion

This paper has argued that productivity and technology gaps have been the principal historical factors that have influenced OECD work on science and technology policy and statistics. This has led to the current practice of ranking countries, and of assessing their performances against the United States. Whether the statistics helped shape policy agendas and priorities remains to be documented, but it certainly shaped political discourses, policy documents, and analytical studies.

Since they first emerged in the 1950s and 1960s, the productivity and technological gaps have never disappeared from the agendas of international organizations. What is peculiar in several recent OECD projects on science and technology is their focus on productivity. Contrary to the OEEC however, the OECD now intends to measure specifically the contribution of science and technology—mainly information and communication technologies (ICT)—to economic growth. This is an old project indeed. In the previous two decades, the DSTI had developed projects on structural adjustment and technology (1976–78) [87], and science, technology and competitiveness (1981–84) [88,89]. It also organized an important international seminar on technology and productivity (1989) [90]. More recently, the S&T statistical unit was associated with several OECD projects devoted specifically to productivity. Analyses have been conducted on productivity and job creation [91–93], and on the contributions of R&D, innovation and technologies to economic growth—the growth project (new economy) [93–95].

The OECD is no longer alone as an international organization alarmed by productivity disparities between countries. Since the early 1990s, the European Union has been increasingly involved in the field of science and technology statistics. It is the European Union, which currently pursues most faithfully the work on gaps between Europe and the United States in its annual reports on competitiveness (European Commission [96,97]). The failure to close the gap appears, according to the Commission, to be due to both the higher employment rate in the United States, and higher labor productivity as a consequence of investments in ICT.

It is probably inevitable that international comparisons and, above all, international statistics, lead to such discourses. Emulation between countries, mimicry and convergence probably have to be accepted as an indirect effect of statistical standardization. And indeed, the OECD had a major influence on the most recalcitrant country: the United States. Following the OECD study on technological gaps, the United States began nourishing some fears and apprehensions of its own. According to M. T. Boretsky, director of the Technological Gap Study Program (1967–69) at the Department of Commerce (DOC), in the early 1970s the United States was in danger of losing its pre-eminence in advanced technologies, particularly those that are important in world trade [98–101]. American exports of technology-intensive manufactured products were leveling-off, according to the DOC study. This was so mainly because of the narrowing of the gap with other OECD countries, and because of faster growth rates in these countries. Ironically, “if, in the 1960s, any country’s economically-relevant R&D performance could be described as having had the characteristics of a gap, the description should have been accorded the United States rather than to the major countries of Europe, or to Japan”, concluded Boretsky (p. 85) [100].

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