Are Statistics Really Useful?

Myths and Politics of Science and Technology Indicators

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Project on the History and Sociology of S&T Statistics

Working Paper No. 20

2002

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> If we take in our hand any volume of divinity or school metaphysics, for instance, let us ask: does it contain any abstract reasoning concerning quantity or numbers? No. Does it contain any experimental reasoning concerning matter of fact or existence? No. Commit it then to the flames, for it can contain nothing but sophistry and illusion (D. Hume (1748), *An Enquiry Concerning Human Understanding*).

> Statistics are among the most visible and most extensively-used outputs of the OECD. If the OECD were to close its doors tomorrow, the drying up of its statistics would probably make a more rapid and a bigger impact on the outside world than would the abandonment of any of its other activities (OECD (1994), *Statistics and Indicators for Innovation and Technology*, DSTI/STP/TIP (94) 2, p. 3).

In 1971, the OECD published its sole official science policy document of the decade: *Science, Growth and Society*. [1] The report departed from the historical OECD emphasis on economic considerations with regard to the objectives of science policy, and suggested aligning the latter with social objectives: [2]

> The science of economics, despite all the refinements it has undergone in this century, has not been able to give policy-makers the kinds of advice they need. (p. 33). During the 1960s, science policy in the OECD countries was considered as an independent variable of policy, only loosely related to the total social and political context. Just as economic growth came to be regarded as an end in itself, rather than as a means to attain certain social goals, so science policy became attached to the "research ratio" as a kind of touch-stone of scientific success independent of the content of R&D activity or its coupling to other policy objectives (p. 45).

The Brooks report, as it was called, had few consequences on OECD science policy orientations in the long term. It was rather an *erreur de parcours* in OECD history: economics would continue to drive national science policies and objectives in Member countries and feed the main OECD science and technology policy documents. Over the

[1] OECD (1971), *Science, Growth, and Society: A New Perspective*, Paris.
[2] For similar views, see also: C. Freeman *et al.* (1971), The Goals of R&D in the 1970s, *Science Studies*, 1: 357-406.

period 1960-2000, the aim of science policy has been, in line with the economists' literature of the time, to articulate science and technology to economic ends. [3]

Thinking in economic terms meant that empirical data and statistics would be the quintessence of OECD analyses and deliberations. [4] Chris Freeman, an economist at the National Institute of Economic and Social Research (London) from 1959 to 1965 working on several studies on research and innovation in industry, was one of the main persons behind this thinking. He was involved in most of the OECD science and technology analyses of the sixties, and it was he who produced the first edition of the Frascati manual in 1962 aimed at collecting standardized statistics on research and development (R&D). In 1966, he founded – and directed until 1982 – the Science Policy Research Unit (SPRU) at the university of Sussex, a research center dedicated to quantitative analyses of science and technology policies. He also continued to be involved in OECD policy deliberations until the 1990s. [5]

This paper concentrates on R&D statistics at the OECD. It aims to clarify what people understood when they talked about the usefulness of statistics for decision-making. This usefulness generally had to do with the second of four possible uses of statistic: theoretical, practical, ideological/symbolic and political. As regards OECD statistics, the paper argues that the last two were as important because, as R. R. Nelson argued, policy-making goes "considerably beyond questions whether to spend, and if so how and on what". [6]

The first part argues that it was economists' dream of making science policy more "scientific" that explains the development of science and technology statistics at the OECD

[3] Reconstruction of Europe (1950s), economic growth (1960s), technological gaps (1970s), and innovation (1980s).
[4] For historical considerations on the influence of the economy and economics on science and statistics, see: J. Kaye (1998), *Economics and Nature in the Fourteenth Century: Money, Market Exchange, and the Emergence of Scientific Thouight*, Cambridge: Cambridge University Press; M. Poovey (1998), *A History of the Modern Fact*, Chicago: University of Chicago Press.
[5] Certainly, there were people (particularly in the Directorate of Scientific Affaires (DSA) and its follower, the DSTI) promoting social preoccupations at the OECD (among them A. King and J.-J. Salomon, for example), as well as "non classical" economists (like C. Freeman), but the main paradigm and aim of the organization was economics.

in the 1960s. The period was, in fact, one where "rational" management tools were promoted in every government administration: planning, forecasting and prediction, and statistics. Statistics, more particularly, were supposed to make science policy less haphazard and more enlightened.

The next two parts confront economists' and state statisticians' rhetoric with reality. They show how discourses on the usefulness of OECD statistics were often exercises in rhetoric to legitimize statisticians' work or justify government's choices. Either statistics could not be developed to answer fundamental policy questions (second part), or the few existing R&D statistics were rarely put to practical use, except for ideological, symbolic and political purposes (third part).

Rationalizing S&T Policy

Positivism was an influential doctrine in certain philosophical milieus in the 19th and 20th centuries. The doctrine acclaimed the methodology of the natural sciences, namely quantitative and empirical research, in the conduct of all sciences. [7] Positivism was particularly popular in the social sciences: social scientists must align with the methodology of the natural sciences if they are to be successful in their endeavours. [8] "Mathematical measures are the most appropriate tools for human reason to comprehend the complexities of the real world", once wrote the UNESCO Working Group on Statistics on science and technology. [9] Karl Popper, [10] Frederik Hayek, [11] and Maynard Keynes [12] all criticized the doctrine, as applied to the social sciences, for being too reductionist. For Hayek, scientism was the "slavish imitation of the method and language of Science. (…) It

[6] R. R. Nelson (1977), *The Moon and the Ghetto*, New York: Norton, p. 35.
[7] L. Kolakowski (1968), *The Alienation of Reason: A History of Positivist Thought*, New York: Doubleday; T. Sorell (1991), *Scientism: Philosophy and the Infatuation with Science*, London: Routledge.
[8] See, for example: D. Ross (1991), *The Origins of American Social Science*, Cambridge: Cambridge University Press; J. Heilbron (1995), *The Rise of Social Theory*, Minneapolis: University of Minnesota Press.
[9] UNESCO (1972), *Considerations on the International Standardization of Science Statistics*, COM-72/CONF.15/4, p. 4.
[10] K. Popper (1957), *The Poverty of Historicism*, London: Routledge and Kegan Paul.
[11] F. von Hayek (1952), *The Counter-Revolution in Science: Studies on the Abuse of Science*, Indianapolis: Liberty Fund (1979).

involves a mechanical and uncritical application of habits of thought to fields different from those in which they have been formed" (p. 24). Scientism was, according to Hayek, at the heart of social engineering and planning: the "desire to apply engineering techniques to the solution of social problems" (p. 166), "effectively using the available resources to satisfy existing needs" (p. 176).

At the OECD, the doctrine was most evident in three of the organization's work "programs": institution building, forecasting, and the production of statistics.

Setting up Offices of Science Policy

The first task to which the OECD dedicated itself with regard to science and technology policy was persuading Member countries to draw up national science policies [13] and set up central units or co-coordinating offices "that can see the problem of both science and the nation from a perspective wider than that available to any individual scientist or organization". [14]

The Science Office envisaged by the Piganiol report was not a science ministry or an executive science agency. [15] The office should be an advisory body, without official line of authority in the government structure, and a supporting staff (p. 36). It should "concern itself with questions of the consistency, comprehensiveness, support, organization, evaluation, coordination, and long-term trends and implication of all the nation's activities in research, development, and scientific education, both in and out of Government, and on the domestic and the international scenes. (…) The functions of the Office should be to monitor these several activities, to aid in establishing priorities among them, and to foster the multitude of organizational and operational connections among different agencies and institutions out of which policy ultimately emerges" (p. 37).

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[12] J. M. Keynes (1938), Letter addressed to R. F. Harrod, in *The Collected Writings of J. M. Keynes*, vol. XIV, London: Macmillan, 1973, p. 300.
[13] OECD (1960), *Co-Operation in Scientific and Technical Research*, Paris, p. 24.
[14] OECD (1963), *Science and the Policies of Government*, Paris, p. 34.
[15] *Ibid*. p. 35.

The report continued: “the tasks of a Science and Policy Office will naturally divide into information gathering on the one hand, and advisory and co-ordinating activities on the other. The latter will require a sound factual basis” (p. 39). The following list of tasks was thus suggested (pp. 40-41):

Information to be collected:

1. Data, analyses, and evaluations of money and manpower investment in research and development.
2. Periodic state-of-the-art surveys in selected major scientific and technical fields.
3. Projections of future needs for scientific and technical personnel.
4. Data on the organization and management of institutions engaged in research, development and education.
5. Data about trends and activities in research, technology and education in other countries.
6. Studies of factors affecting the training, employment, motivation and mobility of scientists and engineers.
7. Data and case studies on the contributions of research and technology to economic development, social change, national defense, international co-operation, etc.

Coordinating activities:

1. Determination of, or advice on, the nation’s research and development priorities.
2. Recommendation on the size and distribution of the part of the national budget devoted to research and development, including the proportion that should be devoted *ad initio* to the support of basic research.
3. Co-ordination of the scientific plans and policies of government agencies, and advice to individual departments on preparation of their research and development budget submissions to the national treasury.
4. Consultation with government departments concerning ways of exploiting scientific opportunities in the formulation of policy.
5. Recommending measures to establish or strengthen research institutions and to stimulate increased research and development activity in non-governmental sectors of society.
6. Making information, advice, and possibly also some consulting services available on request to any sector of the society engaged in research and development activities.
7. Initiation and monitoring of scientific and development programs of national scope.
8. Co-ordination of national participation in international scientific activities.

It would not take long before Member countries acted. When the OECD organized the first ministerial conference on science in 1963, only four countries had a ministry of science. By the second conference in 1966, three-quarters of governments had one.

Forecasting Research

The Piganiol report put enormous emphasis on two functions of the Office of science policy: planning (by way of determining priorities, establishing the science budget, coordinating other agencies and monitoring programs) and statistics. In line with planning, two activities became buzzwords of OECD science policy thought in the 1960-70s: forecasting and technology assessment. [16] In fact, “most governments can support only a fraction of the R&D projects which are proposed to them. (…) Governments must, to some extent, determine priorities within science and technology”. [17] “It is in any case self-evident that the present rate of expansion cannot continue indefinitely (…). A choice must be made”, suggested C. Freeman and A. Young in an early OECD study. [18]

In order to allocate resources, “research planning is not only possible but inevitable”, reported J.-J. Salomon, head of the OECD Science Policy Division, in its review of the 1967 OECD seminar on the problems of science policy. [19] And he continued: “an entirely different process of thought and direction is required: planning entails forecasting”.

Some thought differently. To such questions as “is it possible for the economist to say what proportion of GNP should be devoted to R&D”, J. R. Gass, Deputy Director of the Directorate of Scientific Affairs (DSA), replied:

> There is no magic percentage figure which enables us to escape the nuts and bolts of relating R&D expenditures to economic and other objectives. (…) Such endeavours run into several major obstacles. Firstly, economic objectives are rarely explicitly defined. Secondly, the economic planners have not yet become accustomed to incorporating, or indeed making explicit, the technological assumptions underlying their economic forecasts. Thirdly, many of the decisions relating to R&D are unforeseeable not only by nature, but also because they are made by private entrepreneurs in domains where commercial secrecy is important”. [20]

[16] J.-J. Salomon (1970), *Science et Politique*, Paris: Seuil, pp. 157-228.
[17] OECD (1966), *Government and the Allocation of Resources to Science*, Paris, p. 11. Similar statements can be found in OECD (1965), *Ministers Talk About Science*, Paris.
[18] C. Young and A. Young, *The R&D Effort in Western Europe, North America and the Soviet Union*, OECD, Paris, 1965, p. 15.
[19] OECD (1968), *Problems of Science Policy*, Paris: 11.
[20] *Ibid.*, p. 52.

In a similar vein, H. Brooks from the US President's Science Advisory Committee maintained that: "Many of the current demands for better scientific planning are probably as naïve as the early demand for economic planning". [21] However, he did leave a place for forecasting, adding: "We have to develop a much more sophisticated understanding of how the existing system works before we can control it".

E. Jantsch and C. Freeman, both consultants at the OECD, were two representative individuals of the time with regard to the "scientification" movement in science policy. The former had recently produced a document for the OECD on technological forecasting that analyzed over hundred basic approaches and techniques. [22] At the 1967 OECD seminar, Jantsch suggested: "A recently perfected and potentially most valuable planning tool for science policy is technological forecasting". [23] Although Jantsch took great pains to distinguish forecasting from prediction, the latter being rather deterministic and focused on technical realizations, the message was clear: there is now a "necessity of anticipating advances" (p. 115). "The allocation of funds to fundamental research is one of the classical problems of public science policy. (…) Technological forecasting now provides effective tools for translating our future more clearly into structural terms right down to the level of fundamental science" (p. 118).

The desire for forecasting was reinforced considerably with the *Brooks Report* of the early 1970s, which delivered a sharp criticism of science policies of the 1960s because of their failure to foresee and forestall the present difficulties: the support of a broad range of free basic research has produced a growth of disciplines but not socially useful results, as it was argued. [24] "The imperative for the coming decade is, then, the management and orientation of technological progress", claimed the Brooks report (p. 36). "Each government should establish, at Ministerial level or in a manner independent of the Executive, a special structure that would be responsible for anticipating the likely effects, threatening or

[21] *Ibid.*, p. 111.
[22] OECD (1966), *Technological Forecasting in Perspective: A Framework for Technological Forecasting, its Techniques and Organization, a Description of Activities and Annotated Bibliography*, DAS/SPR/66.12
[23] OECD (1968), *op. cit*. p. 113.

beneficial, of technological initiatives and developments" (p. 106). Technological assessment, a new social technique developed in the sixties, particularly in the United States (and which led to the establishment of the Office of Technology Assessment in 1972), [25] would allow governments to "evaluate the social costs of existing civilian and military technologies in the form of pollution, social disruptions, infrastructure costs, etc., to anticipate the probable detrimental effects of new technologies, to devise methods of minimizing these costs, and to evaluate the possible benefits of new or alternative technologies in connection with existing or neglected social needs" (p. 82).

Over three decades, the OECD would promote the ideas of forecasting and planning as ways to establishing socioeconomic goals and priorities and coordinate efforts toward the attainment of those goals through seminars, studies and methodological documents (Table 1 and Appendix 1) [26] - the director of the DSA, Alexander King, would become the cofounder of the Club of Rome. To these tools, research evaluation would be added in the 1980s and more recently.

Collecting Statistics

C. Freeman was a partisan of operational research, system analysis and technological forecasting: "There is no reason why these methodologies, developed for military purposes but already used with success in such fields as communication and energy, could not be adapted to the needs of civilian industrial technology". [27] In 1971, he suggested a three-stage methodology for technology assessment that should start with "economic

[24] J. Ben-David (1977), The Central Planning of Science, in J. Ben-David (1991), *Scientific Growth*, Berkeley: University of California Press: 269.

[25] NAS (1969), *Technology: Processes of Assessment and Choice*, Washington; NAE (1969), *A Study of Technology Assessment*, Washington.

[26] During the 1990s, the activities of the OECD on these topics were less systematic: a seminar on technology foresight was held in 1994 (followed by a special issue of *STI Review* in 1996), and the proceedings of a conference (1997) on future technologies were published: OECD (1998), *21st Century Technologies: Promises and Perils of a Dynamic Future*, Paris. Another paper, intended for the 1998 issue of *Science, Technology and Industry Outlook*, was never published: OECD (1997), *Technology Foresight: Outlook and Predictions*, DSTI/IND/STP (97) 7.

mathematical methods for rendering explicit the value judgments which are implicit in our present institutional and legal system of controlling technology (…)”. [28] At the 1967 OECD seminar, however, Freeman talked about R&D statistics as **THE** tool for rational management of science policy. “Trying to follow a science policy, to choose objectives and to count the costs of alternatives objectives, without such statistics is equivalent to trying to follow a full employment policy in the economy without statistics of investment or employment. It is an almost impossible undertaking. The chances of getting rational decision-making are very low without such statistics”. [29] H. Roderich, head of the OECD Division for Research Co-operation in the 1960s, unambiguously shared this enthusiasm: “you have to think in quantitative terms, you have to take into account measurements, no matter how poor or how crude your estimates are”. [30]

Table 1.
Main OECD Projects
Concerning “Rational” Science Policies

- Technology Assessment (1964-89)
  - Technological Forecasting
  - Social Assessment of Technology [31]
    - New Urban Transportation Systems
    - Humanized Working Conditions
    - Telecommunication Technologies as an Instrument of Regional Planning
    - Impact of New Technologies on Employment
  - Societal Impacts of Technology

[27] OECD (1963), *Science, Economic Growth and Government Policy*, C. Freeman, R. Poignant and I. Svennilson, Paris, p. 73; see also C. Freeman (1971), *Technology Assessment and its Social Context*, Studium Generale, 24, pp. 1038-1050.
[28] Freeman *et al.* (1971), *op. cit.* p. 393.
[29] OECD (1968), *Problems of Science Policy*, Paris: 58.
[30] *Ibid*. p. 92.
[31] The program of work was under the supervision of an advisory group on control and management of technology from 1972 to 1976.

Systemic Methods in Science Policy and the Problem of Planning the Allocation of Resources (1970-75)
Research Evaluation (1980s)

In the early days of the OECD, thinking on science policy had been driven by economic considerations [32] and, for this reason, by empirical data. [33] This has a lasting influence on the organization. As early as 1963, C. Freeman *et al.*, in a document that synthesized the result of the program of studies of the DSA on "economy of research" and served as a background to the first ministerial conference held in 1963, made the following assessment: "most countries have more reliable statistics on their poultry and egg production than on their scientific effort and their output of discoveries and inventions". (…) The statistics available for analysis of technical change may be compared with those for national income before the Keynesian revolution". [34] A pity, since the Piganiol report stated: "Informed policy decisions (…) must be based on accurate information about the extent and forms of investment in research, technological development, and scientific education". (…) Provision for compilation of such data is an indispensable prerequisite to formulating an effective national policy for science". [35]

The story of the "scientification" of policies, as recalled by Freeman *et al.*, went like this: "Governments have been loath to recognize their responsibilities concerning the level and balance of the national R&D effort. Government policies have evolved somewhat haphazard, being influenced at times by the special interests of government departments, at

[32] Although one can often read sentences like the following in OECD reports: "The formulation of a national research policy must take into account non-economic objectives as well as economic ones; and the former may even sometimes take precedence, and will in any case have a major impact on the scale and direction of R&D". OECD (1963), *Science, Economic Growth and Government Policy*, Paris, p. 20. In fact, this "ambivalence" reflected a continuous tension at the DSA between quantitative (and economic) and qualitative (and social) points of view.
[33] See: B. Godin (2001), *The Number Makers: A Short History of Official Science and Technology Statistics*, Montreal: OST, pp. 23ss; B. Godin (2001), *Measuring Output: When Economics Drives Science and Technology Measurement*, Montreal: OST.
[34] OECD (1963), *Science, Economic Growth and Government Policy*, Paris, p. 21-22; the same citation (more or less) can be found on p. 5 of the first edition of the Frascati manual.
[35] OECD (1963), *Science and the Policies of Government*, Paris, p. 24.

times by lines of thought advocated in influential scientific circles". [36] Now, "governments in some countries have begun to set up a top-level science service or department which is called upon to 1) compile basic data on the research effort, 2) conduct enquiries and convene groups to evaluate scientific and technological trends, reveal gaps, and estimate the medium and long-term needs for research and development in the different sectors of economic activity (…)". [37]

The lesson was clear: numbers enlighten. "It is very difficult, even for a group of specialists, to have a clear view of all the problems in such a complex area and to decide upon priorities with absolute certainty. With the data and information available at present in most countries, the only possible attitude is a pragmatic one. The best procedure seems to be as follows: the first step is to make as thorough an analysis as possible of each economic sector with regard to its needs for R&D (…)". [38] At the national level, this meant governments needed, firstly, an annual science budget that "enables particular proposals for scientific activity to be examined in the context of total government spending". [39] Secondly, governments also needed to maintain a comprehensive inventory of the total and distribution of national scientific resources. [40] It was only on this basis that, thirdly, planning was a possible and necessary step for the development and optimum deployment of resources. [41]

The scheme Freeman *et al.* suggested was in fact the one the OECD adopted in the early 1960s, via its methodological manual on R&D surveys: [42]

> The first elementary step towards improving the rationality of this process [science policy], towards making these choices more conscious and more carefully considered, is the

[36] OECD (1963), *Science, Economic Growth and Government Policy*, Paris, p. 49.
[37] *Ibid*. pp. 51-52.
[38] *Ibid.*, p. 70.
[39] OECD (1966), *Government and the Allocation of Resources to Science*, Paris, p. 37.
[40] *Ibid*. p. 42.
[41] *Ibid*. p. 46.
[42] C. Freeman (1968), Science and Economy at the National Level, in OECD (1968), *Problems of Science Policy*, Paris p. 57.

> systematic collection of statistics on the deployment of scientific manpower, and on the expenditures on different branches of scientific activity. These statistics must be collected in a great variety of breakdowns. They must show the distribution of scientific effort between industries, between firms, between sectors of the economy, between government agencies, between different universities, between different sizes of research establishments, between different disciplines in science.

All in all, it seemed that the OECD had found the solution to the most difficult questions of science policy: how to allocate funds to science and technology. According to Freeman *et al.*, statistics would be the ideal yardstick. The reality will be very different, however. In fact, science policy is an art, an art that can surely be informed, but that is still an art. As R. R. Nelson pointed out: "The science of science policy is very soft". [43]

Controlling Research

Statistics can be put to four possible uses: theoretical, practical, ideological/symbolic, and political (Table 2). While collecting R&D statistics, governments were certainly not interested in knowledge *per se* - theoretical use -, although the OECD program on the economy of research in the early 1960s had this as one of its objectives. [44] Certainly also, understanding R&D was one of the prime results of R&D surveys. Summarizing twenty years of surveys, Y. Fabian, director of the OECD Science and Technology Indicator Unit (STIU), identified two main trends in R&D data. Firstly, the growth in R&D spending slowed down in the OECD area in the 1970s compared with the 1960s. A modest rate of growth would follow in the 1980s. Secondly, there was a swing from public to private support for R&D. University R&D leveled off in most countries, and industrial R&D was given particularly high priority. [45] One of the main uses of national and OECD statistics in recent history, then, had been to accompany analytical documents. [46]

[43] R. R. Nelson (1977), *The Moon and the Ghetto*, New York : Norton, p. 59.
[44] B. Godin (2001), *The Number Makers: A Short History of Science and Technology Statistics*, Montreal : OST.
[45] Y. Fabian (1984), The OECD International Science and Technology Indicators System, *Science and Public Policy*, February: 4-6.
[46] See, for example: OECD (1963), *Science, Economic Growth and Government Policy*, chapter 2; OECD (1980), *Technical Change and Economic Policy*, chapter 3; OECD (1991), *Technology in a Changing World*, pp. 50-64.

But it was the belief and wish of economists and state statisticians that statistics would also be practical. Whether the theoretical results served this end will be dealt with below. For the moment, I would like to discuss a related thesis, a very popular thesis in academic circles, particularly in the literature on the history of (social) statistics: governments produced statistics in order to control populations. In the case of science and technology, the thesis says that governments entered the field of science and technology measurement to control R&D expenses. "Substantial annual increases in government spending can no longer be taken for granted". [47] Choices had to be made.

Table 2.

Uses of S&T Statistics

Theoretical
- Understanding and learning about science and technology
- Comparing countries (benchmarking)
- Forecasting

Practical ("Controlling")
- Managing (planning and allocating resources, assessing priorities)
- Orienting research
- Monitoring
- Evaluating (accountability)

Ideological/Symbolic
- Displaying Performance
- Objectifying decisions
- Justifying choices

Political
- Awakening and alerting
- Mobilizing people
- Lobbying for funds
- Persuading politicians

The control thesis, with regard to science and technology statistics at least, certainly has to be qualified. First, the notion of control may include several meanings that are not always clear in the literature on social statistics. The first meaning, associated with Michel Foucault, refers to the *disciplining, policing and regulating* of individuals. [48] Social statistics were techniques used by governments to submit individuals to moral and social goals. This is a strong definition of control, but a definition which is also found in less radical form in the literature. In fact, a second definition refers to how classifications and measurements inadvertently shape individuals by suggesting new ways in which to behave and think about themselves or, at the very least, how categories create ways of *describing* human beings which, by looping effects, affect behaviour and actions. [49] I have discussed an example of such effects in a previous paper. [50] I submit that a third sense of control refers to the means by which statistics enable governments to *intervene* in the social sphere, not necessarily for the purpose of control, but to achieve a predetermined goal. [51] In the case of science and technology statistics, I would definitely opt for this last sense: the goal was funding and orienting research. Here, the term control is a misnomer.

Orienting Fundamental Research

In 1966, the OECD produced a series of documents for the second ministerial conference on science, among them one on fundamental research. [52] The report recalled that "in fundamental research (…) the very notion of planning seems to be a contradiction (…). In fact, it is often suggested that the policy of an enlightened government towards fundamental research can only be to provide ample financial resources and encourage the training of research workers (…). [However,] in these days of rising research expenditures by governments and of a too facile appreciation of its promise of practical applications,

[47] OECD (1966), Government and the Allocation of Resources to Science, *op. cit*. p. 50.
[48] Miller, P. and T. O'Leary (1987), Accounting and the Construction of the Governable Person, *Accounting Organizations and Society*, 12 (3): 235-265; Miller, P. and N. Rose (1990), Governing Economic Life, *Economy and Society*, 19 (1): 1-31; Rose, N. (1988), Calculable Minds and Manageable Individuals, *History of the Human Sciences*, 1 (2): 179-200.
[49] Goodman, N. (1978), *Ways of Worldmaking*, Indianapolis (Illinois): Hackett Publishing; Hacking, I. (1995), The Looping Effects of Human Kinds, in D. Sperber *et al.*, *Causal Cognition: A Multidisciplinary Debate*, Oxford: Clarendon Press: 351-383; A. Desrosières (1993),
[50] B. Godin (2000), *Measuring Science: Is There Basic Research without Statistics?*, Montreal: OST.
[51] This way of conceptualizing "rationality" is more in line with J. Habermas than M. Foucault. See: (1984), *The Theory of Communicative Action*, Volume I, Boston: Beacon Press.

[science for its own sake] is impossible to sustain" (p. 18). But the report continued: "it would be a great mistake, and in the end detrimental to both science and economic growth, for governments to base their policies of support for research only on lines of fundamental investigation which from the beginning appeared promising in terms of application" (p. 24). "By neglecting fundamental research, a country would be condemning its own industry to obsolescence" (p. 25).

The Ministers agreed generally with the diagnosis of the report – fundamental research should be regarded as a long-term investment – but were unwilling to accept fully its institutional recommendations, judged too timid. In fact, the report did not really consider changes in the structure of the universities, the funding mechanisms, or the academic "mentalities" as solutions to the problem of research as applied to socioeconomic objectives. The OECD was hence requested to continue its examination of the subject. Joseph Ben-David was therefore invited to examine the implications of the report. Using several indicators, Ben-David documented a gap – another one - in the development of fundamental research between Europe and the United States, and suggested that the origins of the gap went back to the beginning of the 20th Century: failure to develop adequate research organizations and effective entrepreneurship in the exploitation of science for practical purposes. [53] Briefly stated, European universities were not oriented enough towards social needs: academics still considered science essentially as a cultural good. To change the situation would thus, according to Ben-David, require long-term policies involving structural changes. [54]

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[52] OECD (1966), *Fundamental Research and the Policies of Government*, Paris. Member of the group of experts were: A. Maréchal, E. Amaldi, S. Bergstrom, F. Lynen, C. H. Waddington.

[53] OECD (1968), *Fundamental Research and the Universities: Some Comments on International Differences*, Paris, p. 45.

[54] "Except from the point of view of scientists themselves, research is no longer an end in itself", declared A. King in his foreword to the Ben-David report. Obviously, member countries did not unanimously share the idea at the time. Belgium thought that science policy was part of educational policy not economic, and The Netherlands denounced such a view as the prostitution of science (A. King Memoirs, unpublished, chapter 24, pp. 7 and 14). "The relationship between government and science is neither as simple nor as readily accepted as the relationship between government and most other social activities that make claims on public resources. In fact, government often show a marked diffidence in their dealing with science, largely because of the

Thereafter, what the OECD would understand by planning research was, among other things, how to allocate resources in order to get the right balance between fundamental and applied research, knowing, on the one hand, that academics were autonomous and "uncontrollable" [55] and, on the other hand, that more oriented research was much needed. According to Freeman *et al.*, fundamental research fell into two categories: free research that is driven by curiosity alone, and oriented research: "the government bodies responsible for science policies must see to it that the right balance is maintained". [56] A second document on the allocation of resources, produced for the ministerial conference, also held the same vision: "All countries should attempt to maintain some competence in a wide range of sectors in both fundamental research and applied research and development in order to be able to identify, absorb and adapt relevant foreign technologies". [57]

The vision was in fact a qualified response to the way the problem of planning had been framed by academics since M. Polanyi. [58] Until then, the problem was discussed in terms of the freedom of the scientist: "any social interference with the autonomous workings of science would slow scientific progress" - not because scientists have a right to freedom - but because freedom was the most efficient means for the efficiency of the science system. [59] Others held a more moderate view: fundamental research should deserve at least an unquestionable and adequate proportion of R&D expenditures, but none, as Brooks noted, gave much basis for quantitative criteria. [60]

In fact, how could such a balance be decided except with statistics? The OECD committee responsible for the report on fundamental research suggested that basic research should deserve 20 per cent of total research expenditures: "Support of basic research in the applied

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alleged uniqueness of R&D activities and the autonomy of the scientific community" (OECD (1966), *Government and the Allocation of Resources to Science*, Paris, p. 11-12.)

[55] "It is important to preserve the absolute priority of fundamental research and to uphold the freedom of universities": OEED (1960), *Co-Operation in Scientific and Technical Research*, Paris: 20. See also : OECD (1963), *Science and the Policies of Governments*, Paris: 24-25.

[56] OECD (1963), Science, Economic Growth and Government Policy, *op. cit*. p. 64.

[57] OECD (1966), *Government and the Allocation of Resources to Science*, Paris, p. 54. Members: of the group of experts were: H. Brooks, C. Freeman, L. Gunn, J. Saint-Geours, J. Spaey.

[58] M. Polanyi (1962), The Republic of Science, *Minerva*, 1: 54-73.

[59] H. Brooks (1968), Can Science Be Planned?, in OECD (1968), *Problems of Science Policy*, Paris, p. 100.

laboratory is therefore to be encouraged to the extent of allowing each applied research organization to spend up to, say, 20 per cent of their efforts on original investigation. Such an average should be considered as an institutional average. (…) This is relevant both to industrial and government laboratories". [61]

Where did such a ratio (which varied from 5% to 20% depending on authors and organizations) come from? Certainly, one can find similar numbers back to the 1940s in the US Steelman report, for example, which suggested quadrupling basic research expenditures to 20% of total R&D in 1957, [62] or from scientists at the US Naval Research Advisory Committee in the 1950s which proposed that the Navy invest between 5 and 10 percent of its R&D budget in basic research (and when that level was achieved, that it be doubled). [63] For several authors, however, the ratios were a historically contingent matter. For example, the notion that 5% of total R&D be devoted to basic research in enterprises came from the fact that a "twentieth is the highest still inapplicable rate of taxation on social investment in advanced technological enterprise". [64] For others, like J.-J. Salomon, such criteria were articles of faith. "In most countries, it is an unwritten usage that requires that appropriations to fundamental research shall be not less than 10% of the total R&D". [65] Salomon suggested that the origin of the norm was to be found in Condorcet's *Fragments sur l'Atlantide*, which made the provision of resources to what he called *la société des savants* subject to the condition that "one-tenth of the subscription, let us say, shall always be set aside to serve the general interests of this *société* in order to ensure that its utility extends to the whole system of human knowledge". The argument also appeared in 1974 in a three-volume OECD study on the research system: "There appears to be little more than folklore, custom and even a bit of magic to the belief (and practice) that a certain percentage of the

[60] *Ibid*.
[61] OECD (1966), *Fundamental Research and the Policies of Government*, Paris, p. 32-33.
[62] J. R. Steelman (1947), *Science and Public Policy*, Washington: USGPO, p. 28.
[63] See: H. M. Sapolsky (1979), Academic Science and the Military: The Years Since the Second World War, in N. Reingold (ed.), *The Sciences in the American Context: New Perspectives*, Washington: Smithsonian Institution Press, p. 389.
[64] P. Forman (1990), Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, *Historical Studies in the Physical and Biological Sciences*, 19: 198-199.

total research budgets should be devoted to fundamental science. Even the famous 10% figure for fundamental research funding has little to sustain it empirically". [66]

At about the same time as the OECD expert group's 20% suggestion, the US National Academy of Sciences (NAS) was more pessimistic on our capacity for estimating precisely the ratio of basic to applied research. It produced two reports for the Congress, one devoted to basic research and national goals, [67] the other on applied science and technological progress. [68] Both reports addressed the question of how much research the government ought to support, and what criteria can or should be used in arriving at a proper balance of support between basic research and applied research and development. The experts could not produce any direct answers, and the NAS either preferred to offer a diversity of viewpoints by presenting individual papers, as in the 1965 report, or took note, simply, of actual ratios between basic and applied research. [69]

In sum, either numbers could not be suggested (NAS), or, when they were, were not "rationally" demonstrated (OECD). As the Brooks report once concluded: "The search for the "optimum", whether in relation to the aggregate amount allocated to R&D activities or to methods of management and execution, is more an art than a science". [70] Relevant statistics were, however, supposed to be one of the purposes of the Frascati manual. Of the five objectives the manual should serve, C. Freeman mentioned "management control" of research. By this he meant that survey data would allow one to allocate resources "to attain the optimum development", evaluate the productivity of research centers, and determine the balance between types of research. [71]

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[65] J.-J. Salomon (2001), Social Sciences, Science Policy Studies, Science Policy-Making, in R. Arvanitis (ed.) *Science and Technology Policy: A section of the Encyclopedia for the Life Supporting Systems*, EOLSS and UNESCO Publishers, to be published, pp. 7-8.
[66] OECD (1974), *The Research System*, Vol. 3: p. 188.
[67] NAS (1965), *Basic Research and National Goals: A Report to the Committee on Science and Astronautics* (US House of Representatives), Washington.
[68] NAS (1967), *Applied Science and Technological Progress: A Report to the Committee on Science and Astronautics* (US House of Representatives), Washington.
[69] Both reports also mentioned, although briefly, the need for more statistics and indicators: NAS (1965), p. 22; NAS (1967), p. 8.
[70] OECD (1971), *op. cit*. p. 47.
[71] OECD (1963), Frascati Manual, *op. cit*. p. 10.

In the end, however, the OECD never really needed numbers on the balance issue. From the beginning, the (OEEC and) OECD had clearly decided to act in favour of applied and oriented research rather than fundamental research. [72] "It is essential to maintain the proper balance between fundamental and applied research. Having said this, it can then be stated that the greater emphasis should be on applied research which is not developed to the same extent in Europe as in the United States", said the first policy document of the OECD on science policy. [73] The "proper balance" argument and the few good words on fundamental research in OECD documents were never for fundamental research itself, but because fundamental research was thought to be at the origin of (all) applied research. [74]

The balance issue, nevertheless, had echoes in the Frascati manual. Firstly, the term "oriented research" was introduced in the 2nd edition, as a type of research activity that deserves attention (but without any recommendation as to its measurement): between basic and applied research, there was now place for a type of fundamental research aligned towards the resolution of specific problems. To date, however, very few countries collect numbers on oriented research (United Kingdom, Australia). [75] Secondly, and following the example of the European Commission, the OECD introduced, in the 3rd edition of the Frascati manual, a classification of government R&D by socioeconomic objective. The classification would, in principle, allow one to link the allocation of R&D resources to national and social needs. The too-aggregated level of the statistics, however, prevented the classification from being truly useful for that purpose. [76]

[72] The early Working Parties of the OEEC (Scientific and Technical Information; Productivity and Applied Research) as well as the EPA were mainly concerned with applied research: productivity centers, cooperative applied research groups, networks of technical information services, management of research. The OECD early Scientific Research Committee (1961) comes, moreover, from the OEEC Applied Research Committee (in 1966, it was divided into two new committees: Science Policy and Research Cooperation).
[73] OECD (1960), *Co-Operation in Scientific and Technical Research*, Paris, p. 26.
[74] The argument was quite different in the United States (NSF and NAS), from the 1950s to today, where increased funding of fundamental research was directly targeted.
[75] B. Godin (2000), *Measuring Science: Is There Basic Research without Statistics?*, Montreal :OST.
[76] B. Godin (2001), *Innovation and Tradition: The Historical Contingency of R&D Statistical Classifications*, Montreal :OST.

Managing Industrial R&D

Before turning to the political uses of statistics, let us look briefly at another case of the assumed practical usefulness of R&D statistics. Could national surveys of R&D be more useful for enterprises in their quest to "control" industrial R&D laboratories? "There seems to be no way for measuring quantitatively the performance of a research laboratory. [But] a comparison of figures for one laboratory with figures for some other laboratory (…) may lead the laboratory administrator to ask questions about his own laboratory", [77] wrote R. N. Anthony, author of the first influential survey on industrial R&D in the United States, a survey supported by the Associates of the Harvard Business School. [78]

Besides the survey, Anthony used the statistics he produced for the Department of Defense (Office of Naval Research) to publish a book entitled *Management Controls in Industrial Research Organizations*. [79] The term control in the title could lead us to believe, at first glance, that the book would discuss methods developed to control research activities and scientists in industrial R&D laboratories. Behind the term, however, what one finds is the reference to the need for firms to manage their research laboratories, a relatively new creature not yet well understood. [80] "To some people, the word control has an unpleasant, or even a sinister, connotation: indeed, some of the synonyms given in Webster's dictionary – to dominate, to subject, to overpower – support such an interpretation. As used here, control has no such meaning", wrote Anthony. [81] The book dealt rather with administrative aspects of industrial research: technical programs, service and support activities, money, facilities, organization and personnel, basic policy decisions, short-range planning, operation decisions and actions, checking up on what was done.

[77] R. N. Anthony (1952), *Management Controls in Industrial Research Organizations*, Cambridge (Mass.): Harvard University Printing Office, p. 288.
[78] D. C. Dearborn, R. W. Kneznek and R. N. Anthony (1953), *Spending for Industrial Research, 1951-1952*, Division of Research, Graduate School of Business Administration, Harvard University.
[79] R. N. Anthony (1952), *op. cit*.
[80] C. E. K. Mees and J. A. Leermakers (1950), *The Organization of Industrial Scientific Research*, New York: McGraw-Hill; C. C. Furgas (1948), *Research in Industry: Its Organization and Management*, Lancaster: Lancaster Press. For a good summary of the literature, see: A. H. Rubenstein (1957), Looking Around, *Harvard Business Review*, 35 (3): 133-146.

Certainly, firms needed ways to plan research activities, increase the effectiveness of their investments, and "control" expenditures, but also ways to stimulate new activities in the light of bureaucratic conservatism of certain divisions. [82] However, "very little control is exercised after the decision has been made to proceed with work in a certain area and of a certain order of magnitude", as Anthony showed with his interviews of over 200 laboratory directors. [83] The first NSF survey of industrial R&D also documented the fact that formulas were rarely used except as a rough guide by managers to decide on the size of budgets: R&D expenditures are determined mainly by judgmental appraisals. [84] R. R. Nelson, finally, pointed out that few companies relied on formulas to allocate budgets to research divisions or specific formal plans for selecting projects: "despite talks of close controls, budgetary and otherwise, much industrial research is conducted under very loose control". [85] "Tremendous uncertainties involved in making any major technological breakthrough preclude either the routinization of invention or the precise prediction of invention". [86] "Let the division manage their own affairs with a minimum of surveillance, so long as they maintained good numbers", that is an adequate return on investments. [87]

Certainly also, the issue of the freedom (as opposed to the control) of the industrial scientist – as compared to the academic researcher – was an important one at the time. A similar case to that discussed above with fundamental research was encountered here. According to Anthony, "research workers must have freedom, and management must manage. (…) The central problem is to find the proper balance between these two opposing principles. [88] At the time, relative freedom was thought to be essential for research, even in industry, if only

[81] R. N. Anthony (1952), *op. cit*. p. 3.
[82] R. Seybold (1930), *Controlling the Cost of Research, Design and Development*, Production Series, New York: American Management Association, p. 8.
[83] R. N. Anthony (1952), *op. cit*. p. 27.
[84] NSF (1956), *Science and Engineering in American Industry: Final Report on a 1953-1954 Survey*, NSF 56-16, Washington, pp. 46-47.
[85] R. Nelson (1959), The Economics of Invention: A Survey of the Literature, *The Journal of Business*, 32 (2), p. 101; see also: A. H. Rubenstein (1957), Setting Criteria for R&D, *Harvard Business Review*, January-February: 95-104.
[86] R. Nelson, *ibid.,* p. 115.
[87] D. Brown (1927), *Centralized Control with Decentralized Responsibility*, New York: American Managers Association. Cited in T. M. Porter (1992), Quantification and the Accounting Ideal in Science, *Social Studies of Science*, 22: 643.
[88] Anthony (1952), *op. cit*. p. 15.

to recruit the best scientists: "it is neither possible neither desirable to supervise research activities as closely as, say, production activities are supervised. (…) It is the essence of fundamental research that no one can know in advance what the results are likely to be, or even whether there will be any results. (…) An attempt to exercise too tight a control over [research] will defeat the purpose of control". [89]

If industrialists really wanted to "control" their scientists, they did not need national R&D surveys at all. [90] There were other means to that end. What firms needed were "scientific" tools to assess the value of their R&D projects and decide where to invest, "to detect and stop unsuccessful work as promptly as possible". [91] Hence, the rise of the literature on planning industrial research and "rational" techniques such as cost/benefit analyses.

A Lobby in Action

When discussing the usefulness of statistics for practical ends, [92] official statisticians and users of statistics in fact often confused statistics in general with OECD and national science and technology survey data. If you look at the uses of statistics mentioned by member countries in a recent OECD enquiry, there is ample evidence of statistics' usefulness, according to experts, but rarely were the data from national or OECD science and technology surveys mentioned. [93] The reasons generally centered around three

[89] R. N. Anthony (1952), *op. cit*. p. 27.
[90] Some firms were even totally opposed to R&D surveys: "A few people, in commenting on the idea of the questionnaire, questioned the wisdom of undertaking the project at all because, they felt, an unwise use of the figures contained in this report could have a dangerous effect on the atmosphere, and perhaps even on the output, of certain laboratories": R. N. Anthony (1952), *op. cit.*: 450.
[91] R. N. Anthony (1952), *op. cit*., p. 28.
[92] Current taxonomies all center on practical objectives. See: OECD (1980), *Science and Technology Indicators: A Background for the Discussion*, DSTI/SPR/80.29; OECD (1990), *Current Problems Relating to Science, Technology and Industry Indicators*, DSTI/STIID; J. van Steen (1995), *Science and Technology Indicators: Communication as Condition for Diffusion*, OECD; B. van der Meulen (1998), *The Use of S&T Indicators in Policy: Analysing the OECD Questionnaire*, DSTI/EAS/STP/NESTI/RD (98) 6.
[93] OECD (1998), *The Use of S&T Indicators in Policy: Analyzing the OECD Questionnaire*, DSTI/EAS/STP/NESTI/RD (98) 6, p. 21.

limitations (pp. 22-23): the data are generally too aggregated and not detailed enough for policy purposes, [94] non-comparable (between countries), [95] or out of date (time lags). [96]

I suggest that national and OECD data are first-level (macro) statistics, that is, contextual indicators, and are usually used in this sense in government reports: to paint a picture of the international context in order to compare (or monitor) one's country to other countries, or (rhetorically) align policies to those of the best performer, generally the United States. Unlike other statistics, science and technology data are not embedded in mandatory or institutional rules (policies, programs, legislation) as several economic and social statistics are. The Consumer Price Index (CPI), for example, serves to index salaries as well as to define monetary policies; unemployment rates are constructed in order to define who would get allowances; demographic statistics are used for political representation and distribution. No such "regulations" exist behind science and technology statistics. National science and technology surveys are certainly helpful *a priori*, but rarely mandatory for policy decisions.

In fact, national science and technology policies have generally been developed before national statistics became available, or simply without recourse to statistics at all. [97] Such was the case for innovation policies. Innovation became a priority of government policy in the early 1970s, but we had to wait until the 1990s for innovation to be properly and systematically measured. [98] In the meantime, governments (and academics) used R&D as a proxy to measure innovation. Similarly, policies of the eighties with regard to new technologies developed on very shaky empirical ground: only recently did statistics become, still quite imperfectly, available. [99] We could say the same for early R&D policies:

[94] B. Godin (2001), *Innovation and Tradition: The Historical Contingency of R&D Statistical Classifications*, Montreal: OST.
[95] B. Godin (2001), *Metadata: How Footnotes Make Numbers Obsolete*, Montreal: OST.
[96] B. Godin (2001), *NESTI and the Role of Users in OECD R&D Statistics*, Montreal: OST.
[97] For a similar argument for economics in general, see: D. N. McCloskey (1985), *The Rhetoric of Economics*, Madison: University of Wisconsin Press.
[98] B. Godin (2002), *The Rise of Innovation Surveys: Measuring a Fuzzy Concept*, Montreal: OST.
[99] Godin (2001), Innovation and Tradition: The Historical Contingency of R&D Statistical Classifications, *op. cit*.

the first policy analyses, those of the OECD, for example, were developed with rather poorly comparable statistics, as Freeman himself documented. [100]

In fact, the understanding of science and technology issues, as a goal of statistics, had already been provided by academics' studies and statistical work. [101] Official science and technology surveys rather served other purposes, not really different from 19th Century statistics: "in all instances, the specification of the data to be collected and the matrices to be adopted, whether by private individuals and associations or government agencies, was elaborated with a view to providing numerical proof of usually fairly well-formulated pre-existing hypotheses (…)". [102]

Some would draw drastic conclusions from this state of affairs: data on research and development "are of limited usefulness in policy decisions and offer no guidance with respect to balance among fields, effects of R&D, or the accomplishments and value of R&D", [103] or: "the data currently available for many OECD countries do not permit evaluation of whether the real amount of resources available is growing or declining, let alone whether it is sufficient". [104] In the same spirit, but in a more nuanced way, an OECD study of the seventies suggested: "It is one thing to come to a decision that a certain field is much more important than another. It is yet another question to say that the field is, let us assume, nine times as important as the next one inasmuch as it would cost nine times as much to sustain research in that field" (…). Quantitative indicators can only be one of many sets of inputs into the entire science policy formulation process, and perhaps, in the final analysis, not even the most important ones". [105] "Ministers and their very senior staff are rarely direct consumers of indicators because their decisions are based on qualitative political considerations. (…) Private decision-makers have their own key internal indicators

[100] OECD (1963), Science, Economic Growth and Government Policy, Paris, *op. cit*. p. 21-22; C. Freeman and A. Young (1965), The R&D Effort in Western Europe, North America and the Soviet Union, *op. cit*.
[101] Among whom are those working as consultants for the OECD, like C. Freeman.
[102] S. Woolf (1989), Statistics in the Modern State, *Comparative Studies in Society and History*, 31: 590.
[103] K. Arnow (1959), Financial Data on R&D: Their Uses and Limitations, in NSF, *Methodological Aspects of Statistics on R&D, Costs and Manpower*, NSF 59-36, Washington, p. 47.
[104] OECD (1994), *Statistics and Indicators for Innovation and Technology: Annex I*, DSTI/STP/TIP (94) 2/ANN 1, p. 12.
[105] OECD (1974*), The Research System*, Vol. 3: 190-191.

in terms of monetary accounting systems. (…) Others seek indicators in order to justify their projects and the needs for more resources”. [106]

Another possible conclusion to draw is that data are certainly useful, but in two other senses. Firstly, the discourses on the usefulness of OECD indicators are part of the rhetoric of statisticians to legitimize their own work. In the same spirit as R. Gass’ comment (p. 6 above), the OECD itself admitted: [107]

> Faced with the possibility of leveling-off, some scientists have reacted by calling for total spending on scientific activities to be allotted a fixed percentage of the GNP, or to be related to some base total which is not susceptible to sharp fluctuations. (…) In practice, <u>no government follows so elaborate formula</u> (…).

In fact, it was always part of statisticians’ rhetoric to overvalue their statistics: “An extended and high-quality set of quantitative indicators is <u>necessary</u> to the design and evaluation of science and technology policy”. [108] Indicators “are <u>needed</u> by governments, to evaluate their programs and researchers, they are needed by firms, who want to assess the contribution of R&D to their global achievement”. [109] According to some, such statisticians’ statements were self-promoted for the sole need of statisticians, with little value to science officials. [110] In the 1980s, for example, statisticians rather stressed the “importance of [OECD analytical] reports, not only because of the trends they revealed, but because their preparation highlighted problems with the quality and comparability of the data”. [111] The bias would conduct the reorientation of R&D statistics towards policy problems in the nineties: [112] statistics had to enlighten policies, not lag behind them.

[106] OECD (1994), *Statistics and Indicators for Innovation and Technology: Annex I*, DSTI/STP/TIP (94) 2/ANN 1, p. 4-5.
[107] OECD (1966), Government and the Allocation of Resources to Science, *op. cit*. p. 50.
[108] D. Guellec (2001), Introduction, *STI Review*, Special Issue on S&T Indicators, 27, p. 7.
[109] *Ibid*. p. 11.
[110] B. Godin, *The Number Makers: A Short History of Science and Technology Measurement*, Montreal: OST.
[111] OECD (1987), *Summary of the Meeting of NESTI*, SPT (87) 8, p. 5.
[112] B. Godin (2000), *The Number Makers: A Short History of Science and Technology Statistics*, Montreal: OST.

Secondly, governments use statistics, certainly, but often for symbolic and ideological aims. It is worth citing T. M. Porter here on the history of social statistics: [113]

> One cannot say that bureaucracies in democratic societies tend by their very nature to absolve themselves of all responsibility by blindly applying mechanical decision procedures. The converse, however, is not so far from the truth: formalized quantitative techniques tend to be used mainly when there is occasion to disguise accountability, or at least to depersonalize the exercise of authority. Career civil servants usually know too much about the problems they confront to be content with the inevitable abstractions and simplifying assumptions that go into a formal economic analysis. What they want from such studies is justification for a course of action (p. 45). The objectivity of quantitative policy studies has more to do with their fairness and impartiality than with their truth (p. 29). It matters not whether forecasts prophesy well or poorly, for their true function does not depend on their accuracy (…): the prestige of forecasts owes more to their disinterestedness than to their trustworthiness (p. 40).

In brief, accuracy did not really matter: "inconsistency in data collected over time is better than precise data that does not have a history", felt many participants to a recent NSF workshop. [114] Thus, despite their limitations, [115] statistics never prevented policy-makers from using them for ideological, symbolic, and political purposes. The case of the main science and technology indicator, namely GERD [116] as a percentage of GDP, is most appropriate to document the phenomenon. The GERD/GDP ratio is an indicator first conceived in the thirties, [117] and conventionalized in the first edition of the Frascati manual. [118]

In the history of science and technology policy, the indicator was largely used by governments for normative purposes: "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". [119] A country not investing

[113] T. M. Porter (1992), Objectivity as Standardization: The Rhetoric of Impersonality in Measurement, Statistics, and Cost-Benefit Analysis, *Annals of Scholarship*, 9: 19-59.
[114] M. E. Davey and R. E. Rowberg (2000), *Challenges in Collecting and Reporting Federal R&D Data*, Washington: Congressional Research Service, p. 19.
[115] B. Godin (2001), *Metadata: How Footnotes Make for Doubtful Numbers*, Montreal: OST.
[116] Gross Expenditures on R&D (GERD).
[117] B. Godin (2000), *Measuring Science: Is There Basic Research without Statistics*, Montreal: OST.
[118] pp. 34-36.
[119] OECD (1963), *Science and the Policies of Government*, Paris, p. 15. For an early statistical analysis comparing countries in these terms, see: S. Dedijer (1962), Measuring the Growth of Science, *Science*, 138 (3542): 781-788.

the "normal" or average percentage of GERD/GDP always set itself the highest 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". [120]

What criterion was used as a yardstick? Since the early fifties, the United States became the model or touchstone for other countries, at least with regard to science and technology. Several OECD studies documented the superiority of the United States in productivity, [121] R&D investment, [122] science (fundamental research), [123] technology, [124] and education. [125] The United States thus provided a clear goal toward which to work, as Ben-David claimed. Therefore, the American GERD/GDP 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: [126] national governments systematically introduced the target in their policy objectives, and the OECD regularly compared countries within each of its *Reviews of National Science Policy* [127] and, within its *Science and Technology Indicators* [128] or *Science and Technology Policy Outlook* [129] series, constructed groups of countries according to their level of GERD/GDP; the United Nations and UNESCO developed specific GERD/GDP objectives for developing countries [130] as well as objectives of funding from developed countries to developing ones. [131]

[120] OECD (1966), *Government and the Allocation of Resources to Science*, Paris, p. 50.
[121] The OEEC European Productivity Agency (EPA) was specifically set up to this end in 1953.
[122] Freeman and Young (1965), *op. cit*.
[123] OECD (1968), Fundamental Research and the Universities: Some Comments on International Differences, *op. cit*.
[124] OECD (1968), *Gaps in Technology: General Report*, Paris.
[125] OECD (1963), *Resources of Scientific and Technical Personnel in the OECD Area*, Paris.
[126] B. Godin (2002), *The Textual Rhetoric of Numbers: How Did the OECD Construct R&D Statistics*, Montreal: OST.
[127] Started in 1964, the series would cover every OECD Member country.
[128] See particularly the first edition: OECD (1984), *Science and Technology Indicators*, Paris, pp. 24-25.
[129] See, for example: OECD (1985), *Science and Technology Policy Outlook*, Paris: pp. 20-21
[130] See, for example: United Nations (1960), *Declaracion de Caracas*, New York; United Nations (1971), *World Plan of Action for the Application of Science and Technology to Development*, New York: 55-61.

The practice was not without dangers however, as the OECD itself once admitted. Firstly, "international comparisons might lead to a situation where, for prestige reasons, countries spend more on R&D than they need or can afford". [132] Secondly, the indicator said nothing about the relationship between the two variables: is the GDP of a country higher because it performs more R&D, or are R&D expenditures greater because of a higher GDP? [133]

> 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 interlinked and that is the most we can say. [134]

Finally, the indicator and the comparisons based upon it do not take diversity into account. [135] Despite these warnings, national governments continued to use the indicator to argue for higher and higher ratios of GERD/GDP, specifically, those of the United States. [136] According to a recent OECD mini-survey, the indicator is still the most preferred by member countries, well ahead of any output indicator. [137] 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". [138]

The practice of ranking countries soon extended to other dimensions of R&D. [139] A similar effect of mimicry (countries aiming toward a similar goal) occurred, for example, when countries began detailing the GERD by sector. It appeared that the major part of the GERD came from industry - over 60% on average. [140] This central role of industry would become

[131] United Nations (1971), *Science and Technology for Development*, New York.
[132] OECD (1966), *Government and the Allocation of Resources to Science*, Paris, p. 50.
[133] A. Holbrook (1991), The Influence of Scale Effects on International Comparisons of R&D Expenditures, *Science and Public Policy*, 18 (4): 259-262.
[134] R. H. Ewell (1955), Role of Research in Economic Growth, *Chemical and Engineering News*, 33 (29), p. 2981. For similar warnings, see also: J.-J. Salomon (1967), Le retard technologique de l'Europe, *Esprit*, December, pp. 912-917.
[135] K. Smith (2002), Comparing Economic Performance in the Presence of Diversity, *Science and Public Policy*, 28 (4), pp. 267-276.
[136] For an example, see: R. Voyer (1999), Thirty Years of Canadian Science Policy: From 1.5 to 1.5, *Science and Public Policy*, 26 (4): 277-282.
[137] OECD (1998), *How to Improve the MSTI: First Suggestions From Users*, DSTI/EAS/STP/NESTI/RD (98) 9.
[138] OECD (1974), *The Research System*, Volume 3: 174.
[139] B. Godin (2002), The Textual Rhetoric of Numbers*, op. cit*.
[140] OECD (1975), *Patterns of Resources Devoted to R&D in the OECD Area, 1963-1971*, Paris.

a supplementary target of several policy discourses. The OECD also imagined a new indicator based on the GERD/GDP philosophy of ranking things: high-technology intensities. The indicator was constructed by dividing the R&D expenditures of an industry by the value of its production and comparing the value thus obtained to the industrial average. Three groups of industries were thus identified: high, medium and low-tech. [141] This was a hierarchy some statisticians contested. [142]

The GERD/GDP ratio was only one example of statistics being used for political ends. [143] Others would soon follow. Canada constructed a whole statistical region (National Capital Region, or NCR) in its R&D statistics to counter the discourses of *separatists* (as federalists called Quebec *independentists*) who argued that the Federal government was investing much more in Ontario than in Quebec. By subtracting federal R&D expenditures in the NCR from Ontario's share (where the region is mainly located), Statistics Canada diminished the gap between Quebec and Ontario. [144] The United Kingdom introduced a new measurement in its R&D statistics in order to please politicians who were more and more receptive to the relevance of research. A category of research was integrated between basic and applied: strategic research. At OECD meetings, the UK statisticians tried to persuade other countries to adopt and standardize the practice, but without real success. [145] Finally, the NSF developed a whole series of statistics with regard to the support of basic research for instrumental ends, namely to influence Congressmen about the necessity to redress the balance between basic and applied research. Similarly, statistics on the shortages of scientists and engineers, and gaps versus the USSR were offered in order to convince politicians to increase funding for academic research. [146]

[141] B. Godin (2001), *Measuring Output: When Economics Drive Science and Technology Measurements*, Montreal: OST.
[142] *Ibid*.
[143] Y. Ezrahi (1978), Political Context of Science Indicators, in Y. Elkana *et al.*, *Towards a Metric of Science*, New York: Wiley and sons: 285-327.
[144] B. Godin (2000), La mesure de la science et la construction statistique d'un territoire: la Région de la Capitale National (RCN), *Revue canadienne de science politique*, 33 (2): 333-358.
[145] B. Godin (2000), *Measuring Science: Is There Basic Research without Statistics?*, Montreal: OST.
[146] *Ibid*. See also: B. Godin (2002), *Highly Qualified Personnel: Should We Really Believe in Shortages?*, Montreal : OST.

How was it possible that statistical agencies, reputed for their objectivity, moved into politics? This has nothing to do with the way statistical agencies managed their position and their relations with government departments and policy divisions concerned with science policy, although the following question was a perennial one in the organization of statistics: should the statistical work be performed in an autonomous agency, or should it be connected to the policies and conducted in a government department? For some, autonomy was a gauge of objectivity. [147] For others, statistics were useless if not aligned to users' needs. [148]

Table 3.
Agencies Reporting R&D Data to OECD [149]

(1995)

National Statistical Offices (Producers)	S&T Ministries and Agencies (Users)
Australia	Belgium
Austria	Denmark
Canada	France
Finland	Germany
Italy	Greece
Japan	Iceland
Netherlands	Ireland
Spain	Korea
Sweden	New Zealand
Switzerland	Norway
Turkey	Portugal
United Kingdom	United States

[147] National Research Council (1992), *Principles and Practices for a Federal Statistical Agency*, Washington; United Nations Statistical Commission (1994), *Fundamental Principles of Official Statistics*, Official Records of the Economic and Social Council, 1994, Supplement no. 9.
[148] J. L. Norwood (1975), Should Those Who Produce Statistics Analyze Them? How Far Should Analysis Go? An American View, *Bulletin of the International Statistical Institute*, 46: 420-432.
[149] OECD (1995), *Discussion of Science and Technology Statistics at the 4th Ad Hoc Meeting of National Statistical Offices of OECD Member Countries*, DSTI/EAS/STP/NESTI (95) 34.

The organization of science and technology statistics in Western countries has oscillated between two patterns in recent history (Table 3). In one, as in Canada, statistics were produced by an autonomous agency. In other cases, as in the OECD, statistics was part of a policy division. In still other cases, as in the United States, science and technology statistics had a mixed status: neither an autonomous statistical agency nor one located within a department, but the outgrowth of an arm's-length agency.

Charles Falk, director of the NSF Division of Science Resources Studies (SRS) from 1970 to 1985, identified four factors that should affect the organizational location of science and technology statistics: credibility, ability to identify important current policy issues, ready and early access to statistical data, capacity to attract the right kind of staff. [150] Of these, the first – credibility – was, for him, the most important: the organization should be "relatively immune to political and special interest pressures", he wrote. For Falk, credibility depended on the organization's reputation. At the same time however, he added that organizations should not be purely statistical organizations, because they would be too far removed from policy discussions, nor purely analytical study groups too remote and too unfamiliar with data sources: "Hopefully, some central organizations can be found which contain both elements and the science and technology indicators unit's location within this organization should make possible close interaction with both types of groups". Falk's implicit and ideal model was, of course, the NSF, and his recommendations were thus not desinterested.

The history of statistics (at the NSF, among others) proves, however, that these desiderata are illusions. Autonomy does not necessarily mean neutrality. [151] Despite its reputation and its location, an organization can produce legitimate statistics and use them for political purposes, to such a level that some maintained recently that, to avoid conflicts of interest, the NSF's SRS Division should be transformed into an autonomous statistical agency. It

[150] C. Falk (1980), *Factors to Be Considered in Starting Science and Technology Indicators Activities*, Paper presented at the OECD Science and Technology Conference, 15-19 September 1980, STIC/80.14, Paris. C. Falk (1984), Guidelines for Science and Technology Indicators Projects, *Science and Public Policy*, February: 37-39.
[151] T. L. Haskell (1998), *Objectivity is Not Neutrality: Explanatory Scheme in History*, Baltimore: Johns Hopkins University Press.

would, they add, at least avoid poor scientific analyses like those devoted to predicting shortages of scientists and engineers in the late eighties. [152]

Conclusion

The view of statistics and indicators as information for decision-making derives its power and legitimacy from economic theory: the belief that people will act rationally if they have perfect information on which to base their decisions. It was not rare, however, to find skeptical remarks concerning this belief in the literature. In one of the first assessments of the NSF's *Science Indicators* (*SI*), H. Averch stated: "*SI*-76 does not now contribute explicitly toward the identification of major policy issues, provide predictions of potential ills and goods from science and technology, or relate the impact of science and technology to social and economic variables". [153] "I cannot deduce from the information in *SI*-76 what the level of incentives should be or the efficacy and effectiveness of various proposed options". [154] For Averch, "policy options and effects do not flow from indicators (…)." [155]

Other commentators on the uses of education statistics made similar remarks. Authors generally recognized that statistics and indicators do play some role. Firstly, "the OECD has been successful in reshaping the statistical systems of its member countries (…)".[156] Secondly, the OECD statistics indirectly shaped policy agendas and priorities by ranking countries, for example: countries are drawn "into a single comparative field which pivots around certain normative assumptions about provision and performance". [157] "Inevitably, the establishment of a single playing field sets the stage for constructing league tables, whatever the somewhat disingenuous claims to the contrary. Visually, tables or figures of comparative performance against an OECD or a country mean carry normative overtones

[152] National Research Council (2000), *Measuring the Science and Engineering Enterprise: Priorities for the Division of Science Resources Studies*, Washington, p. 105; National Research Council (2000), *Forecasting Demand and Supply of Doctoral Scientists and Engineers*, Washington, p. 55-56.
[153] H. Averch (1980), Science Indicators and Policy Analysis, *Scientometrics*, 2 (5-6), p. 340.
[154] *Ibid*. p. 343.
[155] *Ibid*. p. 345.
[156] M. Henry, B. Lingard, F. Rizvi, S. Taylor (2001), *The OECD, Globalization and Education Policy*, Kidlington (Oxford): IAU Press and Elsevier, p. 84.
[157] *Ibid*. p. 95.

(…). To be below or on a par with the OECD average invites simplistic or politically motivated comments”. [158]

But indicators “fall far short of providing data to government officials for [what they are said to do, i.e.] making social investment decisions”. [159] “Whether the data collection requirements have also influenced member countries to rearrange their policy priorities, however indirectly, can at present only be speculated upon”. [160] What can indicators do, then? For Averch, they can help “to shape lines of argument and policy reasoning”. [161] [Indicators] can serve as checks (…), they are only part of what is needed (…).” [162] For others, indicators cannot be used to set goals and priorities or to evaluate programs, but “what they can do is to describe and state problems more clearly, signal new problems more quickly, and obtain clues about promising new endeavors”. [163]

This whole question was the subject of a recent debate between T. M. Porter and E. Levy. According to Levy, Porter portrayed quantification as a replacement for judgment in his book *Trust in Numbers*: [164] “Quantification overcomes lack of trust in human judgment, and as such it overcomes weaknesses in scientific communities and in public life by replacing human judgment with numbers”. [165] For Levy, statistics serve rather as guidance (p. 730): it is “less a replacement of judgment than the medium and framework in which analysis takes place and judgment is exercised” (p. 735). The use of statistics is not (generally) mechanical. They “require the massive application of judgment on a continuous basis” (p. 735). They have “vastly improved the role of human judgment in decision-making” (p. 736).

[158] *Ibid*. p. 96.
[159] J. Spring (1998), *Education and the Rise of the Global Economy*, Mahwah (New Jersey): L. Erlbaum Ass., p. 173.
[160] Henry *et al.* (2001), *op. cit*. p. 95.
[161] H. Averch, *op. cit.* p. 344.
[162] *Ibid*. p. 345.
[163] T. Wyatt (1994), Education Indicators: A Review of the Literature, in OECD, *Making Education Count: Developing and Using International Indicators*, Paris, p. 109.
[164] T. M. Porter (1995), *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*, Princeton: Princeton University Press.
[165] E. Levy (2001), Quantification, Mandated Science and Judgment, *Studies in the History and Philosophy of Science*, 32 (4), p. 724.

Porter recognized that *Trust in Numbers* emphasized "too singlemindedly the drive to turn calculation into an automatic source of objectivity", [166] but these cases exist: "the value of numbers as information, raw material on which judgment can be exercised, must be distinguished from reliance on routines of calculation in an effort to make decisions purely automatic" (p. 741).

With regard to surveys of science and technology, particularly the official R&D survey, these were obviously directed towards some form of instrumental action. Governments (American and Canadian, at least) wanted to mobilize researchers for war. [167] Some departments, among them the US Bureau of Budget, wanted to limit expenses on basic research. [168] Still others thought that statistics could contribute to planning science activities. [169] But rarely did government have success. Firstly, the tools, whether registers or surveys, were not detailed enough for this purpose. This was probably the main limitation of science and technology statistics for policy purposes. According to the OECD itself, "this macro-economic analysis does not have sufficient explanatory value, notably when relating technology and economic growth". [170] Secondly, statistical units had, or soon claimed, their own autonomy: statistics assumed purposes and meanings quite different from those assigned to them in the beginning.

At the OECD, there were two approaches to science and technology policy. One was represented by economists and statisticians like C. Freeman who wrote that "in order to make R&D data more useful as a basis for science policy, […] it is necessary to measure a variety of related scientific and technical activities". [A] quantitative approach is necessary

[166] T. M. Porter (2001), On the Virtues and Disadvantage of Quantification for Democratic Life, *Studies in the History and Philosophy of Science*, 32 (4), p. 740.
[167] B. Godin (2001), *The Number Makers: A Short History of Science and Technology Statistics*, Montreal: OST.
[168] *Ibid*.
[169] On the history of US planning agencies that conducted R&D surveys in the 1930s-40s, see: A. H. Dupree (1957), *Science in the Federal Government: A History of Policies and Activities to 1940*, New York: Harper and Row: 350-361.
[170] OECD (1994), *Statistics and Indicators for Innovation and Technology: Annex I*, DSTI/STP/TIP (94) 2/ANN 1, p. 11.

for resolving some of the issues involved in the complex chain leading from research to innovation". [171] The other approach was more qualitative. It was represented by J.J. Salomon who viewed, for example, the technological gap between the United States and Europe as follows: « il est fait d'un ensemble de retards, d'inadaptations et de lacunes dont les sources sont si diverses – historique, économique, politique, sociologique, culturelle – qu'il faut renoncer à les identifier en termes quantitatifs ». [172]

This tension at the DSA (and DSTI) thus reflected in a paradoxical situation where the main R&D indicator (GERD/GDP) was not really useful for policy purposes but more for rhetorical ends, while the main policy problem (allocation of resources) could never get quantitative criteria.

[171] C. Freeman (1967), *op. cit*. p. 466.
[172] J.J. Sorel (1967), Le retard technologique de l'Europe, *op.cit*. p. 917.

Appendix 1.
List of OECD Documents and Events
on Technological Forecasting and Technology Assessment

Documents

Technological Forecasting in Perspective (E. Jantsch), 1967 *

Society and the Assessment of Technology (F. Hetman), 1973 *

Methodological Guidelines for Technology Assessment Studies, 1974 [173]

Social Assessment of Technology, 1976 [174]

Facing the Future: Mastering the Probable and Managing the Unpredictable, 1979. *

Assessment of the Societal Impacts of Technology, 1981 [175]

21st Century Technologies: Promises and Perils of a Dynamic Future, 1998. *

Seminars, Symposiums and Conferences

Seminar on Technology Assessment (1972)

Symposium on Technology Assessment (1989)

* Official publication.

[173] DAS/SPR/73.83, DAS/SPR/74.1-7, DAS/SPR/74.22.
[174] SPT (76) 21.
[175] SPT (81) 21.

Appendix 2.
List of OECD Documents
on Science Policy Planning

Documents

Analytical Methods in Government Science Policy: An Evaluation (DAS/SPR/70.53)
Allocation of R&D Resources: A Systemic Approach (SPT (73) 20)
Prospective Analysis and Strategic Planning (SPT (75) 18)
Planning and Anticipatory Capacity in Government (SPT (80) 14)
Medium and Long-Term R&D Expenditures Planning in OECD Countries (SPT (83) 8)

Seminars

Seminar on Methods of Structural Analysis (1973)