The New Economy:
What the Concept Owes to the OECD

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The New Economy:
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Spending money on research in order that society and the economy benefit has always been the driving force behind public investment in science and technology. Even during the so-called "policy for science" period (1950s-1960s), governments never funded research for its own sake. The goals were varied and many, and ultimately utilitarian – political, economic, social.

In the literature, most if not all measured impacts of science and technology concentrate on the economic dimension. In the 1950s, economists began integrating science and technology into their models, and focused on the impact of R&D on economic growth and productivity. Cost/benefit analyses were conducted and econometric models developed that tried to measure what the economy owed to science and technology. The limitations of the studies were many, as this paper will document, but never so large, from the economist's point of view, as to question the validity of the results.

In the 1990s, these studies coalesced into new growth theories and the concept of New Economy. The new economy referred to data that indicated the appearance of new economies in the United States and in a number of smaller OECD countries not very "vibrant" in terms of entrepreneurship. What characterized new economies was the acceleration of trend growth and productivity. Technologies, particularly information and communication technologies (ICT), were believed to be at the hearth of the phenomenon, and several researchers, both from universities and governments, developed programs of work to study the phenomenon.

Why and how did governments and statistical offices develop an interest in measuring productivity and the new economy? I suggest looking to the OECD to answer that question. In fact, for over forty years, the OECD has been a think tank for its member countries, and a special type of think tank. Most think tanks are advocacy think tanks:

groups defending partisan or ideological ideas. [1] The OECD is a rather research-oriented think tank: one of its missions is to promote a greater understanding of (economic) issues among national policy makers through seminars, workshops and studies. Looking at the way the OECD entered the field of study on science, technology and economic growth would thus inform us about national practices, since it was national governments which defined the OECD's working agenda, and which applied its findings and recommendations.

This paper is divided into three parts. The first is a very brief presentation of early academic studies on the economic impact of R&D. The second part traces the main events and decisions that led to the OECD's Directorate for Science, Technology and Industry (DSTI) into measuring the contribution of science and technology to productivity and economic growth. The third and final part examines the rhetorical construction recently developed at the DSTI to convince people that there was something new happening in the economy (the New Economy), and the main factor responsible for this situation was technology.

Integrating Science and Technology into the Econometric Equation

In 1955, R.H. Ewell, from the NSF, conducted one of the first quantitative analysis of R&D *showing* (sic from the editor of the magazine) a definite correlation between research and productivity. [2] According to Ewell, "R&D conducted during the preceding 25-year period contributed to $40 to $80 billion of the GNP in 1953" by way of new products and lowering the cost of production of old ones (p. 2984). These gains implied that "the GNP would have been only $285 to $325 billion in 1953 if no research had been conducted since 1928 (…), or looked at cumulatively, there would have been a cumulative loss of national product of $400 to $800 billion during the period 1928-53 in the absence of research." (p. 2984).

[1] D. E. Abelson (2002), *Do Think Tanks Matter? Assessing the Impact of Public Policy Institutes*, Montreal: McGill-Queens.
[2] R. H. Ewell (1955), Role of Research in Economic Growth, *Chemical and Engineering News*, 18 July, pp. 2980-2985.

Ewell also calculated the return on research investment: R&D expenditures of $1.5 billion produced $40-$80 billion benefits, namely: 2,000% to 5,400%, or 100% to 200% annually over a 25 year period, a relatively high rate of return compared to other areas of investment (p. 2985). "In fact, it indicates that from an investment standpoint we probably should be putting more of the national income, or of the national effort, into research than we are now doing" (p. 2985). "This would mean that the $4 billion research in 1955 should result in a cumulative increment to the national product of $100 to $200 billion in 25 years" (p. 2985). All in all, concluded Ewell, "research may be the most important single factor in economic growth in the United States" (p. 2980).

The methodology of the study was very sketchy. Ewell used fragmentary data dating back to 1920 (and before, i.e. 1776) to project R&D expenditures of $6.9 billion in 1965 based on past trends, and assess a requirement of 75,000 research scientists and engineers (p. 2982). His estimates on the impact of research on productivity were highly speculative, based on rough over-all estimates, educated guesses and a margin of error of a factor of two (p. 2983). [3] But the limitations, according to the author, did "not really affect the conclusions" (p. 2980).

Ewell's early efforts at linking science and productivity would soon be followed by others. The task has occupied economists since the mid-1950s, when they began integrating science and technology into theoretical models. These efforts began at the US Department of Agriculture [4] – one of the first Departments to set up a Bureau of Economic Research [5] – and the US National Bureau of Economic Research (NBER). [6]

[3] Based on cursory analyses of the new products and technological changes in 40 industries since 1928 and on discussions with a number of industrial research leaders.
[4] For a brief summary of the studies coming out of the Department, see Z. Griliches (1998), *R&D and Productivity: The Econometric Evidence*, Chicago: University of Chicago Press, pp. 1-3.
[5] G.M. Lyons (1969), *The Uneasy Partnership: Social Sciences and the Federal Government in the 20th Century*, New York: Sage.
[6] J. Kendrick (1961), *Productivity Trends in the United States*, NBER, Princeton: Princeton University Press.

Until the 1950s, economic growth was explained as a function of capital and labour – the Cobb-Douglas function. [7] Science and technology came to be added in the following two ways. Firstly, R. M. Solow formalized early works on growth accounting (decomposing GDP into capital and labor) [8] in 1957, and equated the residual in his equation with technical change – although it included everything that was neither capital nor labor – as "a shorthand expression for any kind of shift in the production function". [9] Integrating science and technology was thus not a deliberate initiative, but it soon became a fruitful one. Solow estimated that nearly 90% of growth was due to the residual. In the following years, researchers began adding variables into the equation in order to better isolate science and technology [10], or adjusting the input and capital factors for capturing quality changes in output. [11] Since these first calculations, the literature on the topic has grown considerably. [12] Typically, a 1% increase in the R&D capital stock is found to lead to a rise in output of between 1% and 5%.

Solow's approach has been the dominant methodology for studies on productivity, and more recent studies still suggest a large growth residual, generally accounting for one-third of productivity. There was another approach, however, for integrating science and technology into studies of economic growth: calculating rates of return of R&D by way of costs/benefits analyses or econometrics. [13] These studies concluded that the large

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[7] R. R. Solow (1956), A Contribution to the Economic Theory of Economic Growth, *Quarterly Journal of Economics*, 70 (1), pp. 65-94.

[8] J. Schmookler (1952), The Changing Efficiency of the American Economy, 1869-1938, *Review of Economics and Statistics*, 34 (3), pp. 214-231; M. Abramovitz (1956), Resource and Output Trends in the United States Since 1870, *American Economic Review*, May, pp. 5-23.

[9] R. M. Solow (1957), Technical Change and the Aggregate Production Function, *Review of Economics and Statistics*, 39, August, pp. 312-320.

[10] E. F. Denison (1962), *The Sources of Economic Growth in the United States and the Alternatives Before Us*, Committee for Economic Development, New York; E. F. Denison (1967), *Why Growth Rates Differ*, Washington: Brookings Institution.

[11] D. W. Jorgenson and Z. Griliches (1967), The Explanation of Productivity Change, *Review of Economic Studies*, 34 (3), pp. 249-283.

[12] For an overview, see: G. Cameron (1998), *Innovation and Growth: A Survey of the Empirical Evidence*, Nuffield College, Oxford.

[13] Z. Griliches (1958), Research Costs and Social Return: Hybrid Corn and Related Innovations, *Journal of Political Economy*, 66 (5), pp. 419-431; E. Mansfield (1965), Rates of Return from Industrial R&D, *American Economic Review*, 55 (2), pp. 310-32; J. R. Minasian (1969), R&D, Production Functions, and Rates of Return, *American Economic Review*, 59 (2), pp. 80-85; E. Mansfield et al. (1977), Social and Private Rates of Return From Industrial Innovations, *Quarterly Journal of Economics*, May, pp. 221-240.

majority of R&D projects produced social returns that exceeded the private financial returns, generally by a factor of two (between 20% and 50% on average).

The second type of economic model into which science and technology began to be integrated in the 1960s was international trade. [14] Until then, the current model of international trade, known as Heckscher-Ohlin-Samuelson, centered on resource endowments as the main factor explaining international trade patterns. In the late 1960s, however, authors began introducing additional factors, among them technology (generally measured by R&D), to explain why some countries led in terms of trade and others lagged. [15] This interest in technology to explain international trade appeared in response to current foreign trade patterns. The new studies suggested that countries were not equal in terms of publicly available science and technology. Some became leaders because they innovated and diffused technologies before others (accumulation). [16]

The two models – economic growth and international trade – are often intimately related today. Studies on convergence of countries or technological gaps (catch-up) are an illustration of such links. [17] In the rest of this paper, however, I will concentrate on economic growth.

[14] For an overview, see: P. Krugman (1995), Technological Change in International Trade, in P. Stoneman (ed.), *Handbook of the Economics of Innovation and Technological Change*, Oxford: Blackwell, pp. 342-365.

[15] M. V. Posner (1961), International Trade and Technical Change, *Oxford Economic Papers*, 13, pp. 323-341; R. Vernon (1966), International Investment and International Trade in the Product Cycle, *Quarterly Journal of Economics*, 80, pp. 190-207; D. B. Keesing (1967), The Impact of R&D on United States Trade, *Journal of Political Economy*, 25 (1), pp. 38-48; W. Gruber, D. Mehta, R. Vernon (1967), The R&D Factor in International Trade and International Investment of United States Industries, *Journal of Political Economy*, 25 (1), pp. 20-37; R. Vernon (ed.) (1970), *The Technology Factor in International Trade*, NBER, New York: Columbia University Press.

[16] J. Fagerberg (1994), Technology, and International Differences in Growth Rates, *Journal of Economic Literature*, 32, pp. 1147-1175.

[17] M. Abramovitz (1986), Catching Up, Forging Ahead, and Falling Behind, *Journal of Economic History*, XLVI (2), pp. 385-406; W. J. Baumol (1986), Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show, *American Economic Review*, 76 (5), pp. 1072-1085; J. Fagerberg, B. Varspagen and N. von Tunzelmann (1994), *The Dynamics of Technology, Trade and Growth*, Aldershot (Hants): Edward Elgar; W. J. Beaumol, R. R. Nelson and E. N. Wolff (ed.) (1994), *Convergence of Productivity: Cross-National Studies and Historical Evidence*, Oxford: Oxford University Press; M. Abramovitz and P.A. David (1996), Convergence and Deferred Catch-Up: Productivity Leadership and the Waning of American

Studying Productivity at the OECD

Very early on, the mathematics behind economists' models was qualified as "not strong enough to permit very accurate estimates (…). At best, the available estimates are rough guidelines" wrote E. Mansfield in a review article published in 1972. [18] Twenty-five years later, Z. Griliches concluded that "the quantitative basis for these convictions [links between investments in science and economic growth] is rather thin", and pleaded for realism. [19] Despite forty years of development, the field is still plagued by important methodological limitations that prevent anyone "proving without doubt" the impact of science and technology on productivity. As the OECD constantly reminded its readers: everyone is convinced of the contribution of science and technology to the economy (imagine a world without technologies); but statistically, the demonstration remains limited. Why, then, had the OECD and its member countries entered the field?

In 1962, the OECD Committee on Scientific Research (CSR) of the Directorate for Scientific Affairs (DSA) decided "to give more emphasis in the future to the economic aspects of scientific research and technology". [20] The committee suggested that governments link science and technology to economic growth and productivity, and assess the contribution of the former to the latter. Again, in 1976, the second *ad hoc* review group on science and technology statistics suggested that studies on the links between R&D and productivity be established at the DSTI. [21]

People had to wait until the 1990s, however, to see work on science, technology and productivity at the DSTI. The lag between the demands of the 1960s and the work of the 1990s can be explained by at least two factors. First, the reluctance of mainstream (classical) economists to bring technology and innovation into theories and econometric

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Exceptionalism, in R. Laudan, T. Taylor and G. Wright (ed.), *The Mosaic of Economic Growth*, Stanford: Stanford University Press: 21-62.

[18] E. Mansfield (1972), Contribution of R&D to Economic Growth in the United States, *Science*, 175 (4021), p. 478.

[19] Z. Griliches (1998), R&D and Productivity: Econometric Results and Measurement Issues, in R&D and Productivity: The Econometric Evidence, *op. cit*. pp. 52-89.

[20] OECD (1962), *Minutes of the 4th Session*, Committee for Scientific Research, SR/M (62) 2, p. 17.

[21] OECD (1978), *Report of the Second Ad Hoc Review Group on R&D Statistics*, SPT (78) 6 pp. 25-27.

models. Second, the difficulties that lie behind linking science and technology directly to productivity.

Nevertheless, very early on the OECD responded to the challenges posed by the new economic theories and models of the 1950-60s. With regard to economic growth, in 1963 the OECD conventionalized an indicator combining science/technology and economic growth – GERD/GDP – and harmonized its concepts with the System of National Accounts (SNA). All OECD studies conducted on R&D in the 1970s and 1980s analyzed the indicator and compared member countries according to it. [22] Concerning theories of international trade, the OECD conducted several studies on competitiveness in the 1980s, and developed indicators on technological balance of payments (TBP) and trade in high technology.

The real work began, however, in the 1990s. The fact that the OECD and its member countries entered the field of science, technology and economic growth followed the reorientation of its program on science and technology statistics towards more economic issues. Certainly, the economic impact (output!) of science and technology has always been a priority for the DSA and for the DSTI's statistical unit, and evolutionary economists as consultants, among them R. Nelson and C. Freeman, pushed for integrating science and technology into economic policy for several years. [23] Beginning in the 1990s, OECD classical economists finally began developing an interest in science and technology. Policy has shifted from a focus on macro-economic policies to a focus on micro-economic such as firm-level innovation. New growth theories were then in vogue, and succeeded in focusing OECD mainstream economists on science and technology as a source of economic growth. [24] According to many, however, there is nothing new under

[22] Besides this innovation, the OECD produced its first and very brief analysis comparing industrial R&D with economic variables in the mid 1970s. See: OECD (1976), *Comparing R&D Data with Economic and Manpower Series*, DSTI/SPR/76.45.
[23] See, for example, OECD (1980), *Technical Change and Economic Policy*, Paris; OECD (1991), *Technology and Productivity: the Challenges for Economic Policy*, Paris.
[24] G. M. Grossman and E. Helpman (1991), *Innovation and Growth in the Global Economy*, Harvard: MIT Press; P. Aghion and P. Howitt (1992), A Model of Growth through Creative Destruction, *Econometrica*, 60 (2), pp. 323-351; P. M. Romer (1990), Endogenous Technological Change, *Journal of Political Economy*, October (98), pp. 71-102.

the sun here. New growth theories are only a mathematical – or stylized – formalization of what we have known for decades, and their practitioners have "limited acquaintance (…) with the previous empirical literature". [25] Be that as it may, the OECD economists followed the new academic fashion.

With the diverging rates of economic growth across countries in the 1970s and 1980s, the impact of technology on growth and productivity became a cause of concern for many. The DSTI developed projects on structural adjustment and technology, [26] science and technology in the new economic context, [27] and science, technology and competitiveness. [28] But it was during the Technology and Economy Program (TEP) and after that work on productivity expanded. [29] The Economic and Statistical Analysis Division (EASD) of the DSTI came to be associated with several OECD projects devoted specifically to productivity: analyses were conducted on productivity and job creation for the OECD Job Study project, [30] and on the contribution of R&D, innovation and technologies to economic growth for the OECD horizontal Growth Project [31] (Table 1).

This followed the transformation of the DSTI statistical unit into a division in 1986. A coordinated project was launched in 1988 (Structural Analysis Program) on indicators of scientific, technological and industrial competitiveness and performance, with three broad goals: [32]

- To establish comprehensive, disaggregated, internationally comparable databases linking R&D, input-output, industrial and import/export data at the individual industry level.

[25] Z. Griliches (1998), Introduction, in R&D and Productivity: The Econometric Evidence, *op. cit.* p. 7. R. R. Nelson (1994), What Has Been the Matter with Neoclassical Growth Theory, in G. Silverberg and L. Soete (eds.), *The Economics of Growth and Technical Change*, Aldershot: Edward Elgar; R. Nelson (1997), *How New is New Growth Theory*, Challenge, September/October, pp. 29-58.
[26] OECD (1978), *Technology and the Structural Adaptation of Industry*, DSTI/SPR/78.25 and 78.26.
[27] OECD (1980), Technical Change and Economic Policy, *op. cit*.
[28] OECD (1984), *Technology and International Competitiveness*, DSTI/SPR/84.46.
[29] OECD (1992), *Technology and the Economy: the Key Relationships*, Paris.
[30] OECD (1996), *Technology, Productivity and Job Creation*, Paris; OECD (1996), *Technology and Industrial Performance*, Paris.
[31] OECD (2001), *The New Economy: Beyond the Hype*, Paris.

- To construct a wide range of industry and aggregate-level indicators of the evolution of technological and economic performance.
- To undertake empirical studies of the role of technology in globalization, international competitiveness, productivity growth and structural change.

Table 1.
DSTI Projects on Science, Technology and the Economy

1. New Economic Context (1976-80)
2. Technology and Structural Change (1975-79)
3. Science, Technology and Competitiveness (1980-84)
4. Innovation and Economic Climate (1981-85)
5. Trade in High-Technology (1984-85)
6. Contribution of Science and Technology to Economic Growth (1987-88)
7. Technology/Economy Programme (TEP) (1988-91)
8. Technology, Productivity and Jobs (1994-99)
9. Growth Project (1999-2001)

The main output of the project was a new database, STAN (Structural Analysis), implemented in 1992. [33] STAN was intended to cover the full data spectrum from basic research to trade indicators. It was designed specifically to underpin analyses of the connection between technology, structural adjustment and economic performance. STAN was "intended to be an analytical tool on which much of the quantitative analysis and modeling carried out in the DSTI will be founded (…) and provide a scoreboard of indicators in order to monitor and evaluate the evolution of industrial structures and economic competitiveness and performance in the light of scientific and technological

[32] OECD (1994), *Statistics and Indicators for Innovation and Technology*, DSTI/STP/TIP (94) 2, p. 8.

developments". [34] As a consequence, *Science, Technology and Industry Outlook*, a biennial review combining elements from the *Industrial Review*, the *S&T Policy Outlook* and the earlier *S&T Indicators* reports, was started in 1996. [35] Also, a scoreboard of indicators became regularly available from 1995 as *Industry and Technology: Scoreboard of Indicators*.

The work on technology and economy really started with the TEP program, at least at the DSTI. Among the eight issues identified during the TEP exercise was "technology and economic growth". To study the issue, the DSTI organized an important international conference on technology and productivity in 1989 where M. Abramovitz, Z. Griliches, J. W. Kendrick and R. R. Nelson, among others, participated. [36] The purpose of the conference was to "identify various factors that influence the development, adoption and diffusion of technology and, ultimately, the rate of productivity growth", [37] and particularly to shed light on the productivity (or Solow) paradox: although there was evidence of acceleration of industry's technological efforts in most member countries, this had not yet been reflected in an upturn in productivity.

The conference discussed growth trends since World War II (and the convergence of OECD economies than ensued), the causes of the slowdown that followed in the seventies and after, and the difficulty of measuring the contribution of science and technology to productivity and economic growth. The output of the conference, at least with regard to the prospects for studies on science, technology and productivity, was not very optimistic. The chairman of the conference concluded: [38]

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[33] OECD (1988), *Progress Report on STAN*, DSTI/IP/88.19; OECD (1994), *STAN Databases and Associated Analytical Wor*k, DSTI/EAS/STP/NESTI (94) 7.

[34] OECD (1987), *Review of the Committee's Work Since 1980*, DSTI/SPR/87.42, p. 18; OECD (1988), *Summary of the Meeting of NESTI*, SPT (88) 2, p. 10.

[35] OECD (1994), *Developing STI Reviews/Outlooks: A Proposal*, DSTI/IND/STP/ICCP (94) 4.

[36] OECD (1991), Technology and Productivity: The Challenge for Economic Policy, *op. cit*.

[37] A. Lindbeck (1991), Lessons From the Conference, in OECD, Technology and Productivity: The Challenge for Economic Policy, *op. cit*. p. 13.

[38] *Ibid*. p. 15.

> A deepening of the research on these complex issues probably requires some redirection of the analysis of productivity growth (…). It is clear that it is important to improve the methods of making *direct* measurements of technological change, rather than trying to interpret residuals (…). We are far away from a situation when policy implications can be derived in a satisfactory way from research in this area.

In a similar tone, R. R. Nelson concluded his communication as follows: "Attempts by governments to influence growth rates are likely to be shallow until the connections among the variables are better understood. And, indeed, I am impressed by the shallowness of most of the prescriptions for faster growth. It is easy enough to recommend that rates of physical investment be increased, or that industrial R&D be expanded, or that time horizons of executives be extended, or that labor and management be more cooperative and less adversarial. But if the prescription stops here, it is hard to see what one actually is to do". [39]

Despite (or because of) these warnings, the DSTI entered the field of studies on productivity with the same methodology then in vogue in academic circles. Its first contribution appeared in 1992, in a chapter of the TEP final report that concluded on very low correlations between (embodied as well disembodied) R&D and productivity. [40] "The proposition that investment in R&D and technological progress are essential for future growth has not yet been conclusively empirically demonstrated. Nevertheless, economists generally agree that R&D and technical progress do indeed play a crucial role in economic growth". [41]

TEP was only a prelude to the DSTI efforts on science, technology and productivity. The G7 ministerial conference held in 1994 in Detroit, based on the results of studies conducted at the request of the previous ministerial meeting (1992) on the causes of

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[39] R. R. Nelson (1991), A Conference Overview: Retrospect and Prospect, in OECD, Technology and Productivity: The Challenge for Economic Policy, *op. cit*. p. 584.
[40] OECD (1992), Technology and Economic Growth, in OECD, Technology and the Economy: the Key Relationships, *op. cit.* chapter 8.
[41] OECD (1992), Technology and Economic Growth, in OECD, Technology and the Economy: the Key Relationships, *op. cit.* p. 184.

unemployment (known as the Jobs study project), [42] arrived at the consensus that technological change is *perhaps* the leading force for job creation and economic growth. But everyone agreed that there was a lack of internationally comparable information to properly document the case. The head of the Private Office of the Secretary-General summarized the issue as follows: [43] "Further work on the relationship between technology, productivity and employment [is] needed for the following reasons: at the beginning of the [Jobs] study, there existed less relevant work in DSTI that in directorates such as DEELSA and ECO; studying the link between technology and employment was conceptually more difficult, given its indirect nature and the corresponding lack of statistics; this link could thus be argued rather than proved". The G7 conference therefore asked the OECD Secretariat to examine the relationship between productivity, job creation and technology, especially information and communication technologies (ICT). In a letter to the Secretary-General, the US Secretary of the Treasury suggested five topics that became the five activities of the OECD Secretariat on the horizontal project *Technology, Productivity and Job Creation*: [44]

- relationship between technological change, productivity, job creation and job loss,
- best practice in technology policy,
- demand for highly-skilled labor,
- information technology and changes in industries,
- development of information infrastructure.

This was the background in which the DSTI participated in Phase II of the Jobs study: the *Technology, Productivity and Job Creation* project. According to OECD member countries, *Technology, Productivity and Job Creation* was the "most important work undertaken on this difficult subject of technology and jobs to date". [45] With regard to the

[42] OECD (1994), *The OECD Jobs Study: Facts, Analysis, Strategies*, Paris; OECD (1994), *The OECD Jobs Study: Evidence and Explanations*, Paris; OECD (1995), *The OECD Jobs Study: Implementing the Strategy*, Paris.
[43] OECD (1994), *Summary Record of the Joint Ad Hoc Expert Meeting on Technology, Productivity and Job Creation*, DSTI/IND/STP/ICCP/M (94) 1, p. 8.
[44] OECD (1994), *Future Work on Technology, Productivity and Job Creation: Addendum*, DSTI/IND/STP/ICCP (94) 3/ADD1.
[45] OECD (1996), *Summary Record of the 6th Meeting*, DSTI/IND/STP/ICCP/M (96) 2, p. 7.

relationships between technology and productivity (Activity I), the DSTI conducted two kinds of analyses: [46] 1) at the industry level: looking at the impact of R&D and, above all, (embodied) technology diffusion and acquisition on productivity; [47] 2) at the firm level: analyzing the heterogeneity of firms' experience and characteristics within industries and its capacity to explain productivity. [48] The results were published respectively in 1996 [49] and 1998. [50] The main message was that both R&D and embodied technology had an impact on productivity, but that the latter was far more important, particularly with regard to ICT in services. However, "it is very difficult to prove beyond doubt that technology has been a major factor in productivity gains (…). [But] the slowdown would have been worse without new technology". [51]

The New Economy

The ministerial demand for more data and analyses continued. As a follow-up to the *Technology, Productivity and Jobs Creation* project, the OECD Council of Ministers asked the Secretariat in May 1999 to study the causes of growth disparities across and within OECD countries. In the 1950s and 1960s, most OECD countries grew rapidly as they recovered from the war and applied American technology and know-how. This catch-up period came to a halt in the 1970s. [52] In the United States, however, the last

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[46] OECD (1994), *Future Work on Technology, Productivity and Job Creation: Road Map*, DSTI/IND/STP/ICCP (94) 3, pp. 6-7.

[47] OECD (1994), *Technology Diffusion Flows in 10 OECD Countries: Interim Report,* DSTI/IND/STP/ICCP (94) 8.

[48] OECD (1997), *Technology and Productivity: A Three-Country Study Using Micro-Level Databases*, DSTI/EAS/IND/SWP (97) 7. This very preliminary work was pursued as a follow-up to the Growth project discussed below. See: OECD (2002), *Proposed Work on ICT and Business Performance*, DSTI/ICCP (2002) 2; OECD (2003), *ICT and Economic Growth: Evidence from OECD Countries, Industries, and Firms*, Paris.

[49] N. Sakurai, E. Ioannidis and G. Papaconstantinou (1996), *The Impact of R&D and Technology Diffusion on Productivity Growth: Evidence for 10 OECD Countries in the 1970s and 1980s*, OECD/GD (96) 27; OECD (1996), Technology, Productivity and Growth, in OECD, *Technology, Productivity and Job Creation*, Paris, chapter 2; OECD (1996), Technology and Productivity, in OECD, *Technology and Industrial Performanc*e, Paris, chapter 3.

[50] OECD (1998), The Dynamics of Industrial Performance: What Drives Productivity Growth? in OECD, *Science, Technology and Industry Outlook*, Paris, chapter 4.

[51] OECD (1996), Technology, Productivity and Growth, in OECD, Technology, Productivity and Job Creation, *op. cit*. pp. 48-49.

[52] R. R. Nelson and G. Wright (1992), The Rise and Fall of American Technological Leadership: The Postwar Era in Historical Perspective, *Journal of Economic Literature*, 30, pp. 1931-1964; M. Abramovitz

decade has seen an acceleration of growth in GDP per capita, but some of the other major economies have lagged. This divergence between countries has caused renewed interest in the main factors driving economic growth and the policies than might influence it. It also gave rise to claims about the emergence of a New Economy. [53]

The fundamental question asked by the OECD Council was whether in recent years growth trends have changed in various OECD countries and, if so, what factors can explain this. [54] In response, the OECD launched a two-year multidisciplinary study involving three Directorates [55] and several committees. The first phase was dedicated to fact-finding, and the second to analyzing policies that support growth. [56] The results were presented in two steps to the Council of Ministers: June 2000 [57] and May 2001. [58] A special edition of the *Science, Technology and Industry Outlook* series followed, [59] as well as a background study. [60]

The *Growth project*, as it was called, was inspired by the strong economic performance of the United States. The OECD "confirmed" that there was a New Economy, although uneven across countries. Cross-country disparities (or gaps) in economic growth have increased in the OECD in the 1990s: only about one-fifth of OECD countries experienced a rise in trend growth, among them the United States. [61] The causes behind growth

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(1994), The Origins of the Postwar Catch-Up and Convergence Boom, in J. Fagerberg, B. Varspagen and N. von Tunzelmann (1994), The Dynamics of Technology, Trade and Growth, *op. cit*. A. Maddison (1987), Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment, *Journal of Economic Literature*, 25 (2), June, pp. 649-698. A. Maddison (1991), *Dynamic Forces in Economic Development: A Long Run Comparative View*, Oxford: Oxford University Press.

[53] *The Economist* (2000), A Survey of the New Economy, September 23rd; *Business Week* (1997), The New Economy: What It Really Means, November 17-23, pp. 38-40.

[54] OECD (1999), *Growth Project*, DSTI/IND/STP/ICCP (99) 1.

[55] Directorate for Science, Technology and Industry (DSTI), Directorate for Education, Employment, Labour and Social Affairs (DEELSA), Economics Department (ECO).

[56] OECD (2000), The OECD *Growth Project: Proposed Work for the Second Year in the DSTI*, DSTI/IND/STP/ICCP (2000) 4.

[57] OECD(2000), *Is There a New Economy? First Report on the OECD Growth Project*, Paris; OECD (2000), *A New Economy? The Changing Role of Innovation and Information Technology in Growth*, Paris.

[58] OECD (2001), The New Economy: Beyond the Hype, *op. cit*.

[59] OECD (2001), *Drivers of Growth: Information Technology, Innovation and Entrepreneurship*, Paris.

[60] OECD (20030, *The Sources of Economic Growth n OECD Countries*, Paris.

[61] OECD (1999), *Economic Growth in the OECD Area: Are the Disparities Growing?*, DSTI/EAS/IND/SWP (99) 3; OECD (2000), *Economic Growth in the OECD Area: Recent Trends at the*

performances were multiple and difficult to single out, according to the OECD, but innovation and technological change, particularly ICT were "shown" to be the main drivers of economic growth: "something new is happening in the structure of OECD economies (…). It is this transformation that *might* account for the high growth recorded in several countries. Crucially, ICT *seems* to have facilitated productivity enhancing changes in the firm, in both new and traditional industries (…)". [62]

How was the discourse constructed and the demonstration arrived at? In a sense, the US question to the OECD Secretariat, a question pushed and pulled by central banks, [63] was not a new one. As we mentioned above, it has been over 40 years since academics studied the issue. The model used to this end was growth accounting. The economy was represented by a production function linking output (production) to inputs (labor, capital), plus a residual – called multifactor productivity (MFP) today. Since R. Solow's article in 1957, [64] the residual is interpreted as technical change: "Whatever portion of the measured growth of output could not be explained (…) [is] attributed to technological change". [65]

In the econometric literature, the contribution of technology to productivity is measured by correlating the residual to indicators of science and technology (R&D, patents): "*All* productivity growth is related to *all* expenditures on R&D and an attempt is made to estimate statistically the part of productivity growth that can be attributed to R&D". [66] This procedure is considered to be very limited by the experts themselves:

Aggregate and Sectoral Level, DSTI/IND/STP/ICCP (2000) 2; OECD (2000), *Innovation and Economic Performance*, DSTI/STP (2000) 2.

[62] OECD (2001), The New Economy: Beyond the Hype, *op. cit.* p. 4.

[63] For example, see the contributions of the US Federal Reserve economists (S.D. Oliner and K.J. Stiroh): S. D. Oliner and D. E. Sichel (1994), Computers and Output Growth Revisited: How Big is the Puzzle?, *Brookings Papers on Economic Activity*, 2, pp. 273-334; S. D. Oliner and D. E. Sichel, The Resurgence of Growth in the Late 1990s: Is Information Technology the Story, *Journal of Economic Perspectives*, 14 (4), pp. 3-22; D. W. Jorgenson and K. J. Stiroh (2000), US Economic Growth in the New Millennium, *Brookings Papers on Economic Activity*, 1, pp. 125-211.

[64] R. M. Solow (1957), Technical Change and the Aggregate Production Function, *op. cit*.

[65] E. Mansfield (1972), Contribution of R&D to Economic Growth in the United States, *op. cit*. p. 477.

> The theoretical model underlying most research by economists on productivity growth over time, and across countries, is superficial and to some degree even misleading. [67] Despite all the efforts to make the residual go away it still is very much with us. And despite all the efforts to give substance to its interpretation as technological advance, or advance of knowledge, that interpretation is far from persuasive (…). The residual accounts for a hodge-podge of factors (…) difficult to sort out. [68]

Indeed, the limitations of studies on technology and productivity are numerous, among them: the factors in the growth equation are not independent of each other and cannot be simply added up; the residual covers many sources of growth besides technological advance; R&D takes time and may not affect productivity until several years have elapsed; only economic impacts are measured, and only those that are measurable with the System of National Accounts (SNA). Finally, correlation is not causality, an old lesson frequently overlooked.

The OECD knew these limitations very well: "Innovation and technological change are commonly considered as being the most important drivers of economic growth. However, it is difficult to capture their contribution in empirical analysis". [69] In 2001, in collaboration with the OECD Statistics Directorate, the DSTI therefore published "the first comprehensive" productivity manual aimed at "statisticians, researchers and analysts involved in constructing industry-level productivity indicators". Written by P. Schreyer, from the Statistics Directorate, the manual stated: [70]

> When labour and capital are carefully measured, taking into account their heterogeneity and quality change, the effects of embodied technical change and of improved human capital should be fully reflected in the measured contribution of each factor of production (…). More often than not [however], data and resource constraints do not permit a careful differentiation and full coverage of all labour and capital inputs. As a consequence, some of the embodiment effects of technological change and some or all of the changes in skill composition of labour input are picked up by the MFP residual (…). [But] MFP is not necessarily technology [it also includes the impact of other factors], nor does technological change exclusively translate into changes in MFP.

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[66] Z. Griliches (1998), Issues in Assessing the Contribution of R&D to Productivity Growth, in R&D and Productivity: The Econometric Evidence, *op. cit*. p. 17.
[67] R. R. Nelson (1981), Research on Productivity Growth and Productivity Differences: Dead Ends and New Departures, *op. cit*. p. 1029.
[68] *Ibid*. p. 1035.
[69] OECD (2000), A New Economy? The Changing Role of Innovation and Information Technology in Growth, *op. cit*. p. 27.
[70] OECD (2001), *Measuring Productivity: Measurement of Aggregate and Industry-Level Productivity Growth* (Productivity Manual), Paris, p. 115-117.

The limitations have not prevented the DSTI from getting involved in productivity studies. Three elements characterized the way the DSTI "demonstrated" the link between science, technology and productivity: 1) synthesizing academic works; 2) internationalizing the statistics; 3) developing a visual rhetoric.

Synthesizing Academic Works

Academics usually convince others that they have done a good job by citing previous work to support their arguments. [71] The OECD reports were no exception. The main argument of the reports on the New Economy was usually reviewing the academic work on the issue. This step was central, since the OECD always conducted a limited number of studies itself. Academic studies have always been the main source of OECD ideas.

The 2000 report on the *Growth Project* reviewed two kinds of work. First, studies conducted on economic aspects of science and technology. [72] Trends in business R&D over the 1990s were discussed, as well as patents, high-tech trade, changes in research activities like new forms of financing (venture capital) and increased collaboration. Although interesting in themselves, these indicators had nothing to do with productivity measurement *per se*. They have been used for a long time in other contexts, and are now widely grouped under the "knowledge-based economy" concept. In fact, these indicators were eliminated from the final OECD Growth report (2001) – only to be reinserted later into a DSTI specific publication on the subject (Table 2).

The second kind of work reviewed concerned specifically the contribution of ICT to productivity. [73] Studies conducted at the aggregate, industry and firm level were discussed. Most if not all of the data were of American origin and, for this reason, were a major limitation in documenting the phenomenon for other countries. Nevertheless, the

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[71] B. Latour (1987), *Science in Action*, Cambridge (Mass), Harvard University Press, Chapter 1.
[72] OECD (2000), A New Economy? The Changing Role of Innovation and Information Technology in Growth, *op. cit*, pp. 27-47.
[73] *Ibid*. pp. 50-71; OECD (2001), The New Economy: Beyond the Hype, *op. cit*. pp. 16-26.

US growth pattern was sufficient to convince the OECD that something important was happening and waited only to be measured for other countries.

Table 2.
Content of the DSTI Growth Reports

Growth Reports	**STI Outlook Series**		
	2000	2001	Special Edition 2001
Productivity and			
- Science and technology	X	deleted	reinserted
- ICT	X	X	X
- Entrepreneurship			added
- Policies	X	X	X

Internationalizing the Statistics

Besides using academic work to support its case, the OECD conducted its own studies. The added value of OECD works on statistics has always been its comparative and international basis. Nowhere else but in the *Growth Project* was this expertise present. The OECD extended the American preoccupation on the New Economy and ICT to other countries.

Notwithstanding the limitations of academic studies, the DSTI conducted the same kind of work with the same concepts and methodology, that is, calculating the contribution of R&D and ICT to MFP. This was the methodology that had already inspired the DSTI's contribution to the *Technology, Productivity and Jobs* project. Equally, during the *Growth Project*, two kinds of such work were conducted. The first concentrated on the impact of R&D on productivity in 16 OECD countries. [74] An econometric model was developed that measured the impact of business R&D, public R&D and foreign R&D on productivity. With a few caveats, the author concluded: "Overall, the study points to the importance of technology for economic growth". Despite the positive correlations, however, the group of National Experts on Science and Technology Indicators (NESTI) qualified the study as "having numerous shortcomings and being rather mechanical". [75]

The second kind of study conducted with the MFP methodology dealt with the impact of ICT on several OECD countries. [76] At the aggregate (country) level – where the OECD could innovate – measurements showed only a weak correlation between the importance of the ICT sector and MFP growth: having an ICT *producing* sector is not a prerequisite for growth, concluded the studies. The diffusion of ICT to *other industries* was therefore looked at, for it was hypothesized that it was this that played a leading role. However, there was insufficient evidence, again, to attribute productivity improvements in these industries directly to their use of ICT. "Ten years or so from now, it should be easier to assess, for instance, the impacts on growth deriving from ICT, other new technologies and changes in firm organization". [77] But at the time, it was impossible.

Developing a Visual Rhetoric

The meagre empirical results did not prevent the OECD from publishing its report on the New Economy, adding a very long section on policies that should be promoted by governments in order to participate to the New Economy. [78] MFP was only weakly correlated with growth, yet the report ignored much of its own data and proceeded to trot

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[74] D. Guellec (2000), *R&D and Productivity Growth: A Panel Data Analysis of 16 OECD Countries*, DSTI/EAS/STP/NESTI (2000) 40.
[75] OECD (2001), *Summary Record of the NESTI Meeting, 14-15 May 2001*, DSTI/EAS/STP/NESTI/M (2001) 1, p. 7.
[76] P. Schreyer (2000), *The Contribution of ICT to Output Growth: A Study of the G7 Countries*, DSTI/DOC (2000) 2; D. Pilat and F. C. Lee (2001), *Productivity Growth in ICT-Producing and ICT-Using Industries: A Source of Growth Differentials in the OECD?*, DSTI/DOC (2001) 4; A. Colecchia (2001), *The Impact of ICT on Output Growth: Issues and Preliminary Findings*, DSTI/EAS/IND/SWP (2001) 11; A. Colecchia and P. Schreyer (2001), *ICT Investment and Economic Growth in the 1990s: Is the United States a Unique Case - A Comparative Study of 9 OECD Countries*, DSTI/DOC (2001) 7.
[77] OECD (2001), Drivers of Growth: Information Technology, Innovation and Entrepreneurship, *op. cit*. p. 119.
[78] OECD (2001), The New Economy: Beyond the Hype, *op. cit*. pp. 27-68.

out the same old policy prescriptions that are open to the some of the same criticisms that Nelson made (see p. 12 above).

One should add, however, that the reports were very qualified with regard to the data. They constantly reminded the reader of the limitations of current studies. This was really different from what the DSTI has generally done with its own data: policy papers are usually short on caveats concerning data and sources. Here, however, the problems of measurement were amply discussed: the difficulty of measuring productivity correctly (output; services; quality changes); the limitations of using R&D as an indicator of science and technology; the lag before technologies (ICT) become really productive and have an impact on the statistics. The OECD message was also qualified in another sense. The OECD constantly reminded the reader that the links between science, technology and productivity have not been demonstrated. Equally, its own conclusions on these links were very timid, using words like "might" or "seem" (see p. 16-17 above) or concluding counterfactually (see pp. 13 and 15 above).

In light of the limitations of the data and methodology, then, how could one make a convincing case for the New Economy? By balancing the limitations with a specific rhetorical device: a plethora of figures and graphs. The final *Growth Report* (2001) contains a total of 74 pages, on which one can find 35 graphs and figures, that is: a graph or figure for every two pages. The purpose here was twofold. First, graphs and figures were used in lieu of tables – only two statistical tables appeared in the report – because it made the document more attractive. Such was the lesson suggested by W.C. Mitchell as early as 1919: "Secure a quantitative statement of the critical elements in an official's problem, draw it up in concise form, illuminate the tables with a chart or two, bind the memorandum in an attractive cover tied with a neat bow-knot (…). The data must be simple enough to be sent by telegraph and compiled overnight". [79] Such a rhetorical strategy is important considering the readership of the OECD: ministers, policy-makers, journalists. Second, a large series of graphs and figures could persuade the reader of the

[79] W.C. Mitchell (1919), Statistics and Government, *Journal of the American Statistical Association*, 125, March, pp. 223-235.

seriousness of the study. Although no statistics could be used to prove without doubt the emergence of the New Economy, graphs and figures nevertheless served the purpose (save the image!) of empiricism.

Conclusion

At the end of this story, one is thus left with a very modest role for economic statistics, a role with diminishing returns. After nearly fifty years of studies, one still looks in vain for hard data on the links between science, technology and productivity. The parameters for measurement "appear to be chosen not for their relevance but, either because data are already available or, because they are in line with dominant theoretical concepts". [80] While it finally became possible to get mainstream economists engaged in analyzing technology and innovation, they came to be engaged on a dubious hypothesis and the methods thy used did not help the understanding of the complex phenomenon involved.

Productivity issues have had a long history at the OECD. The mystique of growth started after World War II, and owed its existence in Europe mainly to the American aid (Marshall Plan). The OEEC – the predecessor of the OECD – and the European Productivity Agency (EPA) devoted considerable efforts to convincing member countries to improve their productivity in the 1950s. [81] Today, alongside the OECD, it is the European Commission that most faithfully pursues work on productivity gaps between Europe and the United States in its annual reports on competitiveness. [82] The failure to close the gap appears, according to the Commission, to be what characterizes the New Economy in the United States: higher employment rates, and higher labor productivity as a consequence of investments in information and communication technologies (ICT).

[80] G. Bell, F. Chesnais and H. Wienert (1991), Highlights of the Proceedings, in OECD, Technology and Productivity: The Challenge for Economic Policy, *op. cit.* p. 7.
[81] B. Godin (2002), Technological Gaps: an Important Episode in the Construction of S&T Statistics, *Technology in Society*, 24 (4), pp. 387-413.
[82] European Commission (2000), *European Competitiveness Report 2000*, Luxembourg; European Commission (2001), *European Competitiveness Report 2001*, Luxembourg.

At the DSTI, measurement of science, technology and productivity waited until the 1990s to appear. Methodological difficulties, but also skepticism, limited the efforts for some time. In 1980, for example, the DSTI policy division published a document entitled *Technical Change and Economic Policy* (1980) which explicitly rejected the classical economists' work on measuring the contribution of science and technology to productivity: [83]

> To attempt to attribute so much experienced economic growth to technical advance, so much to capital formation, and so much to increased educational attainments of the work force, is like trying to distribute the credit for the flavour of a cake between the butter, the eggs and the sugar. All are essential and complementary ingredients.

Over time, economists won. The strategy developed at the DSTI to integrate productivity into its statistics and reports was threefold. First, digest all available academic work in order to imitate their methodology. Second, internationalize the (academic and national) statistics to make a convincing case for its member countries. Third, organize the discourse into a policy-oriented framework, using buzzwords. In the present case, it was new growth theories and the New Economy that were the buzzwords. But over the OECD history the latter also shared their popularity with others: high technology, national system of innovation, globalization, knowledge-based economy, and information economy.

[83] OECD (1980), Technical Change and Economic Policy, *op. cit*. p. 65. The same example appeared in R. R. Nelson (1981), Research on Productivity Growth and Productivity Differences: Dead Ends and New Departures, *op. cit*. p. 1054.