

## **SCIENCE AND TECHNOLOGY DEVELOPMENT INFORMATION AND KNOWLEDGE**

**I. Nicolai**

*C3ED-Université de Versailles, Saint Quentin en Yvelines, France*

**Keywords:** Knowledge, tacit, codification, information, coordination, sustainable development, innovation, knowledge-based economy, social appropriation, deliberative process, organization

### **Contents**

1. Introduction
  2. NICT and the Knowledge-based Economy
    - 2.1 Towards a Knowledge Economy
    - 2.2 A Sustainable Knowledge-based Economy
  3. Information and Coordination
    - 3.1 A Market for Knowledge
    - 3.2 A Social Appropriation of the Sustainable Knowledge Economy
  4. Conclusions
- Glossary  
Bibliography  
Biographical Sketch

### **Summary**

Recent technological changes modify the process by which knowledge or information spreads through the economy. Economic, social and environmental opportunities need to be exploited while giving rise to some profound changes and important challenges. Codification and diffusion of knowledge is a path dependent process allowing a new mode of delivering technological learning by increasing interaction between the producers and users of knowledge. A knowledge-intensive business services industry seems to emerge as the key industry of the new knowledge-based economy with important effects on the rest of the economic system. At a microeconomic level, a market for knowledge emerges that might be reorganized. At a macroeconomic level, the organization of the society must be treated as a variable that might be addressed on all political levels.

### **1. Introduction**

The world's advanced industrial economies have been experiencing fundamental structural change over the last two decades of the twentieth century. Events, such as oil price shocks and major recessions, have contributed greatly to this phenomena, as have institutional changes, such as the increasing liberalization of world trade and capital markets, the rapid diffusion of technology and the major shift in the locus of economic activity from goods to services.

Development has been understood, since the Second World War, to involve economic growth, increases in per capita income, and attainment of a standard of living equivalent to that of the industrialized countries. It is much more widely recognized today that knowledge and human capital are crucial to all aspects of the development process. In this article, development, and scientific and technological progress are taken to mean the processes that lead to “an evolution of shared perceptions of what humanity is and should be and of devising the means of advancing both individually and collectively towards putting those values in practice.”

Various authors have emphasized the shift to knowledge-based growth, characterized by falling costs and rising efficiency in the transmission, retrieval and analysis of information. The most distinguishing feature of this knowledge-based economy is the pervasive presence of knowledge as both an input and an output throughout the economy. In this new economy, the ability to create wealth is increasingly dependent on the effective management of knowledge, that is, the organizational capability to create, acquire, accumulate and exploit information and knowledge. Rapid integration of Information and Communication Technologies (NICT) into professional and private lives, are transforming our society into an Information Society built on technology, knowledge, and intelligence. As its basis, it facilitates fast, cheap, equitable, resource-efficient access to information and information services, accumulated knowledge, learning opportunities, and co-operation support tools for its citizens.

Recent developments in the fields of communications and information technology are indeed revolutionary in nature. Information and knowledge are expanding in quantity and accessibility. In many fields, future decision-makers will be presented with unprecedented new tools for development. In such fields as agriculture, health, education, human resources and environmental management, or business development, the consequences really could be revolutionary.

As information becomes accessible, without any significant spatial or temporal constraints to anyone, it will increasingly become a basic economic resource and a structuring factor for our society. Given the world's population size, existing technologies, current expectations, and established political framework, the embodiment of NICT in a global Information Society could make a significant contribution to the development of sustainability.

According to OECD, while the transition to a knowledge-based economy holds the prospect of improved economic performance, it also brings adjustment challenges with implication for firms, individuals and governments (see, for example, demonstrations put in the White Book of the European Commission, the *Bangemann Report*).

In the context of industrial policy for example, today's global economy is increasingly shaped by market forces rather than government intervention. A new industrial policy paradigm is emerging: the focus is shifting from subsidizing market failures to facilitating innovation and the creation of knowledge. The empirical evidence has demonstrated Canadian industrial structure evolving towards a knowledge-based economy characterized by increasing using of knowledge, technology and skills.

The key issues of concern to policy makers and international organizations are the extent to which this major transformation has benefited all aspects of society and the ways and means of achieving a truly global information structure. Although the costs of using NICT to build national information infrastructures, which can contribute to innovative knowledge societies are high, the costs of not doing so are likely to be much higher. Promoting the Information Society as a stand-alone solution will probably not succeed in achieving sustainable development: under market frameworks that are not adequately in tune with social and environmental externalities, any dematerialization achieved could be overcompensated by an increase in consumption-related activities (rebound effect). Three fields of interest have interaction areas in common: information society, knowledge-based economy and sustainable development.

Decision-makers are invited to consider the implications of alternative knowledge societies and to take action to devise strategies to ensure that the benefits of NICT are broadly available and that the risks of social and economic exclusion are avoided or minimized.

Ensuring conditions of access to information infrastructures is only one, albeit important, part of the challenge of building innovative knowledge societies. Knowledge principally resides in people rather than in NICT. The learning process represents the first step of scientific and technical capacity building that is consistent with development goals. The benefits are closely associated with establishing equitable policy and regulatory frameworks and with ensuring that understanding, sharing and partnership-building are central components of national NICT strategies. Alliances and partnerships among stakeholders in developing countries and with organizations in the industrialized countries today need to recognize the importance of building social and technological capabilities among users. In such an assessment, the Information Society and Sustainable Development will be compatible concepts, if NICT and related infrastructural issues are embedded in new political and socioeconomic frameworks. It is worth noting, that such interactions are not static, but are likely to be very dynamic and to vary with the further development of technology, social and organizational structures.

This article is thus articulated around the following demonstration: the integration of knowledge from diverse sources, especially from environmental fields, could affect the policy-making process in two ways. Section 1 will describe the decomposition process of a knowledge-based economy. Section 2 will propose a deliberative procedure to ensure the implementation of successful NICT strategies.

-  
-  
-

**TO ACCESS ALL THE 19 PAGES OF THIS CHAPTER,**  
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

## Bibliography

Abramovitz M. (1989). *Thinking about Growth and Other Essays on Economic Growth and Welfare*. Cambridge University Press: Cambridge (U.K), Pages xviii, 377. [A wide discussion concerning growth and welfare.]

Abramowitz M. and David P. (1996). Technological change and the rise of intangible investments: the US economy's growth path in the 20th century. *Employment and Growth in the Knowledge-based Economy*. Paris, France: OECD Publishers. [An in-depth overview of intangible investments in the US Economy in relation to technological change.]

Antonelli C. (1988). The emergence of the network firm. *New Information Technology and Change, The Italian Case* (ed. C. Antonelli). Dordrecht, The Netherlands: Kluwer Academic Publishers. [An outline of the features of the network firm and the new information technology in Italy.]

Antonelli C. (1999). The evolution of the industrial organization of the production of knowledge. *Cambridge Journal of Economics* **23**, 243–260. [An overview on the evolution of the industrial organization concerning the production of knowledge.]

Arrow, K.J. (1996). *Economic Welfare and the Allocation of Resources for Invention*. Elgar Reference Collection. International Library of Critical Writings in Economics, vol. 70. Cheltenham, U.K. and Lyme, N.H.: E. Elgar Publishers. Distributed by American International Distribution Corporation, Williston, Vt., 227-243. Previous Publication: 1962 [A wide discussion on the allocation of resources to invention activity.]

Arrow K. J. (1990). *Stanford University Symposium on the Information Explosion*. Stanford, CA: Stanford University Press. [A report about the Symposium on the information explosion.]

Bezanson F.R. and Sagasti K.A. (1998). *Knowledge Societies: Information Technology for Sustainable Development* (eds. R. Mansell and U. Wehn), Oxford, UK: United Nations Commission on Science and Technology for Development, Oxford University Press. [An illustration of the features of the knowledge societies and information technology for Sustainable Development.]

Calenbuhr V. (1999). *Recent Industry Trends in Relation to Technology Policy Development, Technology Foresight and Sustainable Development* (Proceedings of the Budapest Workshop, Budapest, Hungary, 1998. Paris, France: OECD Publishers, pp. 104-115. [An overview of industry trends in relation to technology policy evolution.]

Cohendet P. and Kern F. (1999). Knowledge coordination, competence creation and integrated networks in globalized firms. *Cambridge Journal of Economics* **23**(2), 225–241. [A discussion regarding knowledge development and creation in globalized firms.]

Cowan R. and Foray D. (1997). *The Changing Economics of Technological Learning*, Working Paper 9539. IIASA. [An outline of economic change of technological learning.]

Cowan R. and Foray D. (1997). The economics of codification and the diffusion of knowledge. *Industrial and Corporate Change* **6**(3), 595–622. [A description of the economics of the diffusion of knowledge.]

Dasgupta P. and David P. (1994). Toward a new economics of science. *Research Policy* **23**, 487–521. [A framework for understanding the new economics of science.]

David P. A. and Foray D. (1995). Accessing and expanding the science and technology knowledge base. *STI Review* **16**, 14–68. [A description of the ways to access and expand knowledge base in science and technology.]

David P. A. and Steinmuller W. E. (1991). The impact of information technology upon economic science. *Prometheus* **9**, 36–61. [An assessment of the impact of information technology on economic science.]

David P.A. (1987). Some New Standards for the Economics of Standardization in the Information Age, *Economic Policy and Technological Performance*. P. Dasgupta and P. Stoneman (eds). Centre for Economic Policy Research series. Cambridge, New York and Sydney: Cambridge University Press, pp. 206-239. [A proposal of new standards for assessing information.]

Dosi G. (1996). The contribution of economic theory in the understanding of a knowledge-based economy. *Employment and Growth in the Knowledge-based Economy* (eds. D. Foray and B.A. Lundvall), Paris, France: OECD Publishers. [An overview of the contribution of economic theory in understanding the knowledge economy.]

Ducatel K., Burgelman J. C., Howells J., Bohlin E., and Ottitsch M. (1999). Information and communication technologies and the information society panel, Report from the Joint Research Centre, European Commission. *IPTS Futures Report Series* **3**, 65 pp. [A report about information and communication technologies of the European Commission Research Centre.]

Eliasson G. (1990). *The Knowledge-Based Information Economy*. Stockholm, Industrial Institute for Economic and Social Research, distributed by Almqvist and Wiksell International, 182 pp. [A description and discussion on the knowledge base economy.]

Ergas H. (1991). *The New Face of Technological Change and Some of its Consequences*, mimeo. [Features of technological change and its effects are reported.]

Eustace C. and Mortensen J. (1998). *ICT Investment in the Intangible Economy*, Research Report, Brussels, Belgium: European Commission. [An overview of investment in an intangible economy.]

Feldman M. and Lichtenberg F. (1996). Consequences and determinants of the geographic distribution of R&D: Cross country evidence from the European Community's R&D Information Survey. *Acts of International Conference on Economics and Econometrics of Innovation*, Strasbourg, France, 1996. [A profile of the consequences and determinants of the geographic distribution of R&D in the EU.]

Foray D. and Lundvall B. A. (1996). The knowledge-based economy: from the economies of knowledge to the learning economy. *Employment and Growth in the Knowledge-based Economy*. Paris, France: OECD Publishers. [A critical discussion on the differences between knowledge and learning economy.]

Foray D. (1995). The economics of intellectual property rights and systems of innovation: The persistence of national practices versus the new global model of innovation, *Technical change and the world economy: Convergence and divergence in technology strategies*. J. Hagedoorn (ed.). Aldershot, U.K.: E. Elgar distributed in the U.S. by Ashgate, Brookfield, Vt., 109-133. [A profile of economics of intellectual property rights and systems of innovation.]

Gavigan J. P., Ottitsch M., and Mahroum S. (1999). Knowledge and learning, towards a learning Europe, Joint Research Centre, European Commission. *IPTS Futures Report Series* **14**, 83 pp. [A wide discussion about the differences between knowledge and learning in Europe.]

Gera S. and Mang K. (1998). The Knowledge-Based Economy: Shifts in Industrial Output. *Canadian Public Policy* **24**(2), 149-184. [The shifts in industrial output in the knowledge based economy are reported and discussed.]

Giarini O. and Stahel W. R. (1993). *The limits to certainty*. Second revised edition Preface by I. Prigogine. Foreword by A. King. International Studies in the Service Economy. 4. Norwell, Mass. and Dordrecht: *Kluwer Academic Publishers*, Pages xxiii, 270. [A contribution of risks and certainty.]

Greiner C., Radermacher F. J., and Rose T. (1995). *Contributions of the Information Society to Sustainable Development*. A Report of the Working Circle: a DG XIII Initiated Group on Sustainability and Information Society. Brussels, Belgium: FAW. [The contribution of information to sustainable development is discussed.]

Klein B. H. (1988). Luck, necessity and dynamic flexibility. *Evolutionary economics: Applications of Schumpeter's ideas*. H. Hanusch (ed.). Cambridge, New York and Melbourne: Cambridge University Press, pp. 95-127. [An analysis of flexibility in relation to the different constraints of economic systems.]

Lamberton D. M. (1997). *The New Research Frontiers of Communications Policy*. Amsterdam, The Netherlands: North Holland. [Communication policy is considered in relation to the new research frontiers.]

Lamberton D. M. (1998). Information economics research: points of departure. *Information Economics and Policy* 10, 325–330. [The points of departure of information economics research are focused on.]

Laroche M., Mérette M. and Ruggeri G. C. (1999). Human capital in a knowledge-based economy. *Canadian Public Policy, Analyse de Politiques* 25(1), 87–100. [An analysis of human capital in a knowledge-based economy.]

Loasby B. J. (1994). Organisational capabilities and interfirm relations. *Metroeconomica* 45(3), October, 248-265. [A conceptual framework for a critical understanding of markets.]

Lundvall B. A. (1998). The learning economy: challenges to economic theory and policy, *Institutions and economic change: New perspectives on markets, firms and technology*. K. Nielsen and B. Johnson (eds.). European Association for Evolutionary Political Economy series. Cheltenham, U.K. and Northampton, Mass.: E. Elgar Publishers distributed by American International Distribution Corporation, Williston, Vt., 33-54. [The impact of the learning economy on the relations between firms and markets.]

Lundvall B. A. and Johnson B. (1994). The learning economy. *Journal of Industry Studies* 1(2), 23-42. [A profile of the learning economy.]

Malaska P. (1995). *Dynamic Conceptualization of the Interplay of the three Key Issues* (EC-Workshop, Brussels, Belgium, 1995). [A conceptual analysis of the three key issues.]

Mansell R. and Wehn U. (1998). *Knowledge Societies: Information Technology for Sustainable Development*. Oxford, UK: United Nations Commission on Science and Technology for Development, Oxford University Press, Pages vii, 323. [The features of information technology and the impacts on sustainable development are assessed.]

Nonaka I. and Takeuchi H. (1995). A theory of the firm's knowledge-creation dynamics, *The dynamic firm: The role of technology, strategy, organization, and regions*. (eds. A.D Chandler Jr., P. Hagstrom and O. Solvell). Oxford and New York: Oxford University Press, pp. 214-24. [An overview of the features of companies creating-knowledge.]

Nonaka I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science* 5, 4–37. [A discussion and analysis of the theory and creation of knowledge.]

Novarese M. (2000). Exploiting the potential of new information and communication technology for environmental benefit, Joint Research Centre, European Commission. *IPTS Report Series 41*. [The potential of information technology for improving the environment is analyzed and discussed.]

OECD (Organization for Economic Co-operation and Development) (1996). *Employment and Growth in the Knowledge-based Economy* (eds. D. Foray and B. A. Lundvall). Paris, France: OECD. [Types of employment in knowledge-based economy are analyzed and discussed.]

OECD (Organization for Economic Co-operation and Development) (1999). *Promoting Innovation and Growth Services*. Paris, France: Working Group on Innovation and Technology Policy, OECD. [Ways of promoting innovation in a service economy are reported and discussed.]

Okhawa K. and Rosovsky H. (1972). *Japanese Economic Growth*. Stanford, CA: Stanford University Press.

Polanyi M. (1967). *The Tacit Dimension*. London, UK: Routledge. [An outline of features of Japan Growth.]

Preissl B. (1995). Strategic use of communication technology—diffusion process in networks and environments. *Information Economics and Policy 7*, 75–99. [Communication technology as a strategic tool is considered.]

Simon H. A. (1991). Organizations and markets. *Journal of Economic Perspectives 5*(2), 25–42. [The relationship between organizations and markets are outlined.]

Soete L. (1996). Globalization, employment and the knowledge-based economy. *Employment and Growth in the Knowledge-based Economy* (eds. D. Foray and B.A. Lundvall). Paris, France: OECD Publishers. [The relationship between globalization, employment and knowledge-based economy are considered and analyzed.]

Stahel W. R. (1998). From products to services: selling performance instead of goods. *IPTS Report 27*. [A critical analysis of changes involved while pressing from products to services.]

Steinmuller E. (1995). *Neglected Dimensions of the Productivity Paradox: Users, Complementarities and Infrastructure* (Proceedings of Toronto Conference, Toronto, ON, Canada, 1995) Paris, France: OECD. [Some neglected dimensions of the productivity paradox are analyzed.]

UNCSTD (United Nations Commission on Science and Technology for Development) (1998). Working Group on IT and Development, United Nations Commission on Science and Technology for Development. [A report on the relationship between information and development.]

Van Mejl H. (1996). *Measuring Intersectoral Spillovers from IT and Non-IT Sectors* (International Conference on Economics and Econometrics of Innovation, Strasbourg, France, 1996). [Ways for measuring the intersectoral spillovers from information and non-information technology.]

Weber K. M., Zappacosta M. and Scapolo F. (1999). The competitiveness map: avenues for growth. European Commission, Joint Research Centre. *IPTS Report Series 12*. [The main avenues for growth for competitiveness are outlined.]

Windrum P. and Tomlinson M. (1999). Knowledge intensive services and international competitiveness: a four country comparison. *Technology Analysis and Strategic Management 11*(3), 391-408. [Knowledge services in the light of competitiveness are considered and discussed.]

## **Biographical Sketch**

**Isabelle Nicolai** is a Lecturer of economics of technological innovation at the University of Versailles Saint Quentin en Yvelines, Paris, France and member of the C3ED, UMR-IRD. Her fields of research are innovation analysis and structural changes. With regard to the adopted technologies and their microeconomic performances, she evaluates the way to implement them in a sustainable way. She proposed different special indicators to classify various green strategical behaviors allowing anticipation and improvement of methodological procedures of market governance. These studies were drawn in durable goods (automobiles), materials (phosphates) and new economy industries. Analyses have been published in International Journals such as the *International Journal of Technology Management*, *Revue d'Economie Industrielle* and *Ecological Economics*.

Isabelle has edited a book on *Sustainability and Firms, Technological Change and the Changing Regulatory Environment*, (1998) S. Faucheux, J. Gowdy and I. Nicolai (eds), Edward Elgar, Cheltenham, U.K. and Brookfield, U.S. She has also been involved in different contracts granted by the European Commission and French Ministries. She is a Member of the European Society of Ecological Economics.

UNESCO – EOLSS  
SAMPLE CHAPTERS