

Innovative People

**MOBILITY OF SKILLED PERSONNEL
IN NATIONAL INNOVATION SYSTEMS**

SCIENCE AND INNOVATION



OECD Proceedings

Innovative People

MOBILITY OF SKILLED PERSONNEL
IN NATIONAL INNOVATION SYSTEMS



ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14th December 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

© OECD 2001

Permission to reproduce a portion of this work for non-commercial purposes or classroom use should be obtained through the Centre français d'exploitation du droit de copie (CFC), 20, rue des Grands-Augustins, 75006 Paris, France, tel. (33-1) 44 07 47 70, fax (33-1) 46 34 67 19, for every country except the United States. In the United States permission should be obtained through the Copyright Clearance Center, Customer Service, (508)750-8400, 222 Rosewood Drive, Danvers, MA 01923 USA, or CCC Online: www.copyright.com. All other applications for permission to reproduce or translate all or part of this book should be made to OECD Publications, 2, rue André-Pascal, 75775 Paris Cedex 16, France.

TABLE OF CONTENTS

<i>Chapter 1.</i>	Human Resources, Mobility and the Systems Approach to Innovation <i>Keith Smith</i>	7
-------------------	--	---

Part I. Theoretical and Statistical Issues

<i>Chapter 2.</i>	Indicators for Human Resources and Mobility <i>Anders Ekeland</i>	17
<i>Chapter 3.</i>	Employment Growth, Social Capability and Human Mobility <i>Mark Tomlinson</i>	33
<i>Chapter 4.</i>	Job Mobility Implications of the HRST Definition: Illustrated by Empirical Numbers from Register Data <i>Ebbe Krogh Graversen and Kenny Friis-Jensen</i>	45
<i>Chapter 5.</i>	Firm Demography: Mapping Firm Dynamics Using Human Resource Data <i>Christian Svanfeldt and Jonny Ullström</i>	59

Part II. Comparative Mobility in the Nordic Region

<i>Chapter 6.</i>	Knowledge Transfer through Labour Mobility in the Nordic Countries: Structure and Dynamics <i>Svein Olav Nås, Anders Ekeland, Christian Svanfeldt and Mikael Åkerblom</i>	71
<i>Chapter 7.</i>	Job-to-Job Mobility Rates in the Nordic Countries, 1988-98 <i>Ebbe Krogh Graversen, Anders Ekeland, Svein Olav Nås, Mikael Åkerblom, Markku Virtaharju, Adrian Ratkic and Christian Svanfeldt</i>	91
<i>Chapter 8.</i>	Human Capital Mobility into and out of Research Sectors in the Nordic Countries <i>Ebbe Krogh Graversen</i>	115

Part III. High-skilled Resources and Mobility in Europe

<i>Chapter 9.</i>	Using the Community Labour Force Survey to Develop Mobility Rates on Human Resources in Science and Technology <i>Ibrahim Laafia and Alex Stimpson</i>	129
<i>Chapter 10.</i>	First Exploration of the Belgian HRST Data: A Study Based on Register Data <i>Tom Vandenbrande</i>	145

<i>Chapter 11. Labour Market Entry and Mobility of Young French PhDs</i> <i>Daniel Martinelli</i>	159
<i>Chapter 12. Mobility of Human Resources in Hungary: An Analysis and a Proposal for Regular Collection of Statistics</i> <i>Erzsébet Viszt, Zsuzsa Plank and Balázs Borsi</i>	175
<i>Chapter 13. Czech Labour Mobility, 1993-2000</i> <i>Jaromír Gottwald and Milan Šimek</i>	189
<i>Chapter 14. The Supply and Demand of High-technology Skills in the United Kingdom</i> <i>Mark Tomlinson</i>	203

Part IV. International Mobility

<i>Chapter 15. Foreign Scientific Researchers in Selected OECD EU Countries: Data Sources and Analysis</i> <i>Sami Mahroum</i>	219
<i>Chapter 16. International Mobility of PhDs</i> <i>Sveva Arveduto</i>	229
<i>Chapter 17. Research and Policy Issues in High-skilled International Migration: A Perspective with Data from the United States</i> <i>Mark Regets</i>	243
<i>Chapter 18. Migration between the Nordic Countries: What Do Register Data Tell Us about the Knowledge Flow?</i> <i>Ebbe Krogh Graversen, Mette Lemming, Mikael Åkerblom and Markku Virtaharhu</i>	261
<i>Chapter 19. The Role of International Mobility in the Czech Labour Market</i> <i>Jaromír Gottwald and Milan Šimek</i>	287

<i>Chapter 20. Human Resources: The State of Knowledge and Policy Challenges</i> <i>Anders Ekeland and Keith Smith</i>	299
---	-----

Chapter 1

HUMAN RESOURCES, MOBILITY AND THE SYSTEMS APPROACH TO INNOVATION

by

Keith Smith

Institute for New Technologies (INTECH), United Nations University, Maastricht

Introduction

The papers collected in this volume are part of the OECD National Innovation Systems project, which seeks to explore the possibilities for the quantification of systems approaches to innovation. Systems approaches see innovation as a complex collective phenomenon, characterised by interactions between economic agents in the shaping context of infrastructures and institutions. One persistent area of interest in systems approaches has been the institutions and organisations responsible for education at all levels: it has been strongly argued that the interactions between these institutions and industry, in both their educational and knowledge creation functions, have been fundamental in shaping innovation capabilities and economic performance (see David and Foray, 1995, for an influential statement). The chapters in this volume certainly do not treat all of the research and educational issues that are of interest within the systems approach, although they are focused on a key building block for any system-based or economy-wide attempt to analyse education, skills and attainments. This building block is the indicator and analysis issues that arise in seeking to map the structure of human resources, and the mobility of capabilities via labour markets and other forms of personnel exchange.

Education, innovation and development

Why should we focus on education and mobility in the context of innovation and development? About 20 years ago, Richard Easterlin presented perhaps the most systematic argument on the links between basic education and economic growth. In defining and thinking about the nature of economic growth, Easterlin went well beyond the idea that growth is simply an extension or intensification of production, and followed Landes in viewing it in terms of the creation and use of knowledge:

“The heart of the whole process of industrialisation and economic development is intellectual: it consists in the acquisition and application of a corpus of knowledge concerning technique, that is, ways of doing things.” (Landes, 1980, p. 111, cited in Easterlin, 1981, p. 2)

Beyond seeing technology and knowledge as determinants of growth, Easterlin saw knowledge creation as itself requiring explanation, and went on to make a strong causal argument to the effect that education (and particularly mass basic education) was a necessary condition for development.

This emphasis on human capabilities has been followed and developed in modern research on innovation. Basic to all innovation analysis is the idea that innovation and the development of new technologies occur through the activities of skilled personnel: researchers, engineers and managers. Innovation is a social process, involving not only new techniques (such as new items of equipment), but also new forms of knowledge, skills and competences. Competence is embodied in the collective experience and activities of the people who produce and implement a new technology; it relates not only to research results, but also to matters of organisation, problem-solving, marketing, and so on.

However, new technologies do not have their main economic effects solely through the innovation process – that is, through the commercialisation of a new technology – but rather through the diffusion, or spread, of the technology. This aspect of the economics of technology has often been neglected in technology policy, which has concentrated on technology supply rather than technology use. It is nevertheless of extreme importance in translating new technologies into economic outcomes. Just as innovation is a social process, so is diffusion: it relies on channels of communication, through which knowledge, skills and competences can spread. One of the most important of these channels is the physical movement of skilled personnel.

In their very influential study of flows of technological knowledge, Levin *et al.* (1987) examined a range of potential channels of information flow: licences, patent disclosures, reverse engineering, and so on. Movement of personnel – specifically, the hiring of R&D employees away from innovating firms – was a key element, and was closely linked with other forms of information flow involving inter-personal communication (technical meetings, informal conversations, etc.).

Mobility and the spread of industrialisation: historical perspectives

The role of personnel mobility is, in fact, widely emphasised within the historical literature on the spread of industrialisation. In particular, the distinction between tacit and codified knowledge, which has played a central role in modern innovation studies, has long been familiar to historians.

Although there is continuing debate about the precise role of scientific understanding in the Industrial Revolution, there is broad agreement that early industrial technologies depended heavily on human skills, particularly the skills of operators. This was most clearly the case with such technologies as iron-making or early chemicals production, where the timing of production processes was a critical element. It was also the case with mechanical technologies such as cotton spinning, where the construction and operation of machinery was the principal problem. The operative skills required were a persistent obstacle to the acquisition of industrial technology.

A good example of this is the early United States. David Jeremy (1981) has pointed to several cases where America quickly acquired British machinery in the early 1780s (even though the export of such machinery was illegal), but was unable to operate it. In Philadelphia (at that time the US capital), a complete spinning machine was acquired in 1783, but after four years no-one had been able to erect it, let alone operate it. Three other textile machines were successfully acquired and erected in New England in the late 1780s, but they too could not be operated (Jeremy, 1981, p. 76). This problem of human skills was understood at the highest levels of the new American Government, and the Secretary of the Treasury, Alexander Hamilton, and his assistant, Tench Coxe, organised a range of activities aimed at bringing British workers and engineers to America. Jeremy showed that:

“At least five recruiters of skilled labour working for American projects were active in England in the late 1780s and early 1790s. Most effective was Thomas Digges ... over a twelve months period in 1791-1792, he claimed to have sent to America eighteen or twenty artisans and machine makers. ... the barriers to Arkwright-technology transfer between Britain and America were largely overcome by the activities of recruiting agents, the readiness of workers to ignore the law in pursuit of better prospects in America, and the fact that the new technologies were embodied in the artisan.” (Landes, 1980, p. 111, cited in Easterlin, 1981, pp. 78-82)

Jeremy studied the spread of four major technologies to America, namely cotton spinning, powered cotton weaving, textile printing and woollen technologies. His primary conclusion following these studies was that “most obviously, the artisan emerges as the pre-eminent technology carrier in this period” (Landes, 1980, p. 111, cited in Easterlin, 1981, p. 254), and the primary source of such artisans was Britain.

Similar themes have been widely echoed in studies of European industrialisation. Peter Mathias explored the diffusion of technologies from Britain to continental Europe from the early 18th century, and showed that the movement of workers was central to the diffusion of the techniques of early industrial processes. Bruland (1989) showed that British textile machinery firms organised skilled labour supply for their customers in Western Europe, and that this involved considerable geographical mobility by skilled British workers. More recently, Harris (1998) showed that a considerable amount of technological diffusion in the 19th century occurred as a result of what would now be called industrial espionage, and that personnel mobility was a core component of such diffusion.

There is no reason to think that these processes have diminished in importance. It is widely agreed that a key role of American universities has been to act as gatekeepers for the selection and encouragement of high-skilled immigration, and that such immigration has been central to company creation and the overall dynamics of such regions as Silicon Valley. There is therefore no reason to disagree with William Parker’s (1971) remark that “...apart from some striking cases of imitation, the diffusion of technology in the modern world has been largely limited by techniques not unfamiliar to St Paul or Mohammed: the movement of persons and the transmittal of written documents” (Parker, 1971, p. 137).

Some contemporary issues

The long-standing issues concerning education, human resources and mobility are related to fundamental policy problems facing us today. The relevant policy arenas include labour market policy, educational resources and methods of provision, research policy, and policies towards immigration and international mobility. The real issue is that of how we should approach the analysis of problems in these arenas.

A long-standing approach to human resources has been the human capital theory pioneered by Gary Becker. Here, “human capital” refers to the person-embodied knowledge, skills and capabilities of people. The term “capital” is relevant because the theory views the development of such knowledge and skills as an investment process which produces both individual benefits (in the shape of higher incomes) and economic outcomes (in the form of higher productivity). The investment model is followed rather rigorously, and the demand for education is seen in terms of a return-on-investment approach in which the costs of education are related to the marginal benefits in terms of enhanced incomes. This is, of course, an approach reflecting the methodological individualism of neo-classical theory, and it lends itself to various forms of econometric testing of, for example, rates of return to educational investment.

The systems approaches that underlie the studies collected here take an altogether different perspective. They go beyond the level of the individual facing an education decision, into the operation of the system of institutions and organisations that together comprise the knowledge creation and distribution process. Here, the primary issues include the wider significance of education in terms of broader economic and technological trends. For example, Abramovitz and David argue that:

“Perhaps the single most salient characteristic of recent economic growth has been the secularly rising reliance on codified knowledge as a basis for the organisation and conduct of economic activities, including among the latter the purposive extension of the economically relevant knowledge base. While tacit knowledge continues to play a critical role...codification has been both the motive force and the favoured form taken by the expansion of the knowledge base. Although this particular trend can be traced far into the past, only within our own century has it progressed to the stage of fundamentally altering the form and structure of economic growth.” (Abramovitz and David, 1996, p. 35)

These kinds of claims involve ideas that go well beyond the individual level of the human capital literature. As with other ideas within the systems approaches, the arguments of Abramovitz and David involve links between educational attainment, mobility and diffusion, and the nature of technological change. In this, the various forms of systems approaches have probably been guilty of generating more questions than answers (although this should be seen as a sign of intellectual life and vitality). Moving towards a more quantitative and empirical form of exploring these ideas takes us into difficult questions of data and analysis. Approaching this level of analysis is the task that is taken up in the following pages.

A reader's guide to this volume

This proceedings report is the first major collection of papers related to the mobility of human resources. The work of the Focus Group on human mobility began in 1997, in Phase II of the OECD's work on national innovation systems. In the beginning, only the Nordic countries participated in the Focus Group, due to the availability of register data in these countries. In Phase III, it was decided to enlarge the Focus Group, and non-Nordic countries are not in the majority. This expansion underlines the growing interest in human mobility issues.

The proceedings in the current volume are based on a number of workshops and meetings held during 1999-2000. The report is divided into four main sections:

- Theoretical and statistical issues.
- Comparative mobility in the Nordic region.
- High-skilled resources and mobility in Europe.
- International mobility.

Theoretical and statistical issues

The chapters on theoretical and statistical issues discuss the conceptual and measurement problems that are closely connected to the efforts of the Focus Group to use mobility rates as indicators for the distribution and role of human resources in the economy. The “Canberra Manual” is relatively recent, having been first published in 1995, and is currently being revised. These chapters

will contribute to that revision process. In Chapter 2, *Ekeland* presents a discussion of the “Canberra Manual” – the OECD Manual for the Measurement of Human Resources – and the related issues of the International Standard Classification of Education (ISCED) and the International Standard Classification of Occupations (ISCO). This chapter includes a discussion of how well the Canberra definitions serve their purpose when they are implemented using Danish register data.

Tomlinson makes an attempt to explore the relationship between mobility and economic growth in Chapter 3. Although this connection is not easy to analyse empirically, this author makes an interesting and important conclusion that the mobility of high-skilled human resources should be seen in isolation from the mobility of workers with lower skills. In fact, they seem to play different roles relative to up- and downturns in the economy.

In Chapter 4, *Graversen and Friis-Jensen* explore the consequences of using different definitions of the concept of human resources in science and technology (HRST), and point to the measurement problems inherent in this area of study.

The important issue of “firm demography” is discussed by *Svanfeldt and Ullström* in Chapter 5. They clearly illustrate how fundamental this topic is in research on human resource mobility. The issue of firm demography highlights the difficulty of answering the question of what constitutes a firm – defining a “new” firm is not as easy as many of us would like to believe.

Comparative mobility in the Nordic region

The section on comparative mobility in the Nordic region contains material from Phase II of the OECD NIS project, which has not previously been published. Chapter 6 (*Nås et al.*) makes a non-technical summary of the outcome from the previous phase, which was limited to a cross-sectional study in the Nordic countries. This study looks at mobility between two years only, but using rather detailed sectoral breakdowns. The material from Phase III looks at mobility rates over the business cycle, *i.e.* ten years, using various educational, sectoral and age breakdowns (*Graversen et al.* in Chapter 7). *Graversen*, in Chapter 8, examines mobility between the research sector and the rest of the economy in Denmark. This chapter relates to work in progress in a Nordic context; more detailed analysis will soon become available.

High-skilled resources and mobility in Europe

There is, of course, no basic difference between mobility in the Nordic region and mobility in other countries. The rationale for a separate section devoted to the Nordic countries is the availability in the Nordic countries of public registers as a standard component of their national statistical systems.

Most of the studies featured here use data from Labour Force Surveys. Chapter 9, by *Laafia and Stimpson*, uses merged data from the national Labour Force Surveys to calculate mobility rates for the European Union (including associate members and candidate countries). By contrast, the Belgian contribution (*Vandenbrande*, Chapter 10) is based on register data, and is an attempt to make a comparable study to the work in Phase II (see Chapter 6, *Nås et al.*). Chapter 11 by *Martinelli* is based on a large regular survey of French PhDs and shows another side of mobility research: how newly graduated PhDs in different fields of study face different problems and have different developments in income levels, etc. The Hungarian, Czech and UK contributions (Chapter 12, 13, and 14 by *Viszt et al.*, *Gottwald and Šimek*, and *Tomlinson*, respectively) are examples of mobility studies that mainly use the respective national Labour Force Surveys, although they also draw on other data sources.

International mobility

Although basically different facets of the same phenomenon, domestic and international mobility vary in many aspects. Some of the differences are due to data sources, but basically the disparities are due to marked variations between national labour markets and the international market for highly skilled personnel. Since there is a fundamental lack of the data which would be required for an in-depth study of the issue of “brain drain”, the chapters in this section are attempts to exploit as much information as possible from the existing, very diverse and fragmentary, data that are available. In Chapter 15, *Mahroum* analyses the behaviour of scientific researchers in selected European countries, using mainly data available for the United Kingdom.

The Italian contribution by *Avveduto* (Chapter 16) is based on a special survey of PhDs that travelled abroad as part of their PhD.

The United States has, of course, a special role in any discussion of international flows of highly skilled personnel. In Chapter 17, *Regets* uses extensive data from the National Science Foundation to analyse this. In his analysis, *Regets* highlights a number of important issues that are of crucial relevance to policy makers.

In the Nordic countries, register data could potentially provide a very accurate picture of international mobility, although, regrettably, adequate data are for the time-being not being collected on a regular basis. Since the Nordic region has been an integrated labour market for some decades, it is possible to try to analyse inter-Nordic mobility in full detail. Register data do not allow a full-scale analysis, but *Graversen et al.* make a first attempt at such an exercise in Chapter 18.

Finally, there is a contribution from an economy in transition, the Czech Republic. The Czech case described by *Gottwald and Šimek* in Chapter 19 clearly points to the existence of two very different types of labour migration: one from the “East”, which mainly concerned low-skilled workers looking for employment or better paid jobs; the second group includes experts from the “West”.

In Chapter 20, *Ekeland and Smith* conclude with a brief summary of the main findings of this work, and discuss these in the light of the national innovation systems approach. While the formation and mobility of human capital remain a key component of innovation systems, they make the point that further studies would necessitate much improved data availability, and that countries should make a concerted effort to develop harmonised registry data that can be used for analytical purposes.

REFERENCES

- Abramovitz, M. and P. David (1996), "Technological Change and the Rise of Intangible Investments: The US Economy's Growth Path in the Twentieth Century", in OECD, *Employment and Growth in the Knowledge-based Economy*, OECD, Paris.
- Bruland, K. (1989), *British Technology and European Industrialization. The Norwegian Textile Industry in the Mid-19th Century*, CUP, Cambridge.
- David, P.A. and D. Foray (1995), "Accessing and Expanding the Science and Technology Knowledge Base", *STI Review*, Issue No. 16, OECD, Paris.
- Easterlin, R. (1981) "Why Isn't the Whole World Developed?", *Journal of Economic History*, Vol. XLI, No. 1, pp. 1-19.
- Harris, John R. (1998), *Industrial Espionage and Technology Transfer. Britain and France in the Eighteenth Century*, Ashgate, Aldershot.
- Jeremy, D. (1981), *Transatlantic Industrial Revolution: the Diffusion of Textile Technologies Between Britain and America, 1790-1830s*, Blackwell, Oxford.
- Landes, D. (1980) "The Creation of Knowledge and Technique: Today's Task and Yesterday's Experience", *Daedalus* 109, p. 111.
- Levin, R.C., A.V. Klevorick, R.R. Nelson, and S.G. Winter (1987), "Appropriating the Returns From Industrial Research and Development", *Brooking Papers on Economic Activity*, No. 3, pp. 783-831.
- Parker, W. (1971), "Economic Development in Historical Perspective", in N. Rosenberg (ed.), *Economics of Technological Change*, Penguin, London.