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OECD WORKSHOP ON THE ECONOMICS OF THE INFORMATION SOCIETY

WORKSHOP N°4

HELSINKI (PORVOO), 6-7 JUNE 1996

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris

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PREAMBLE

The OECD Workshops on the Economics of the Information Society are aimed at developing economic data, research and analysis in the area of "Global Information Infrastructure -- Global Information Society". They are conducted under the aegis and direction of the ICCP Committee as the precursor for policy discussions within the Committee. The Workshops concentrate on providing leading edge research on the economics of the coming "information society", have a quantitative and empirical stress and identify and refine the analytical and statistical tools for dealing with these issues.

The fourth in the series of Workshops was held at **Porvoo**, near **Helsinki, 6-7 June 1996** on the theme of "Human Resources". The Workshop was co-organised from the Finnish side by the Research Institute of the Finnish Economy (ETLA), the Ministry of Finance, the Technology Development Centre (TEKES), and the Helsinki School of Economics, together with the European Commission and the OECD. Overall co-ordination of the workshop was carried out by ETLA.

The Helsinki workshop was devoted to discussion of the wide range of issues concerning "the human resources in the information society". In future, the role played by human resources in the economic process might be significantly different from the situation today. Diffusion of information and communications technologies and extensive use of networks have a significant impact on the organizational structures of firms and governments and their functions. The portfolio of human resources and skills required by enterprises may change accordingly. The influence of those changes will not be confined to individual industrial sectors or functions, but will extend to the entire underlying fabric of industrial structure. The role and measures of government in managing these fundamental changes need to be identified.

On the occasion of this Workshop, leading experts from major economic research centers, academic bodies, consultancies, industry groups, think tanks, as well as government officials, presented their views and ideas for discussion. It provided the opportunity for interaction and debate on the economic impacts and policy implications of human resource related issues from various aspects. A stimulus for further research and highlighted priorities for future investigation were provided. This report outlines the highlights of the contributions and discussions at the Workshop, and provides a list of participants. The OECD acknowledges with thanks the support and enthusiasm of all those involved.

POLICY IMPLICATIONS

The discussion on human resources issues in the information society covered broader economic issues and policy implications ranging from the analysis of firm level impact of ICTs to the macroeconomic implications of building knowledge bases.

Here the seven areas of key points related to the policy implications and research agendas are extracted from the rapporteurs summary.

1. Occupational Shifts and Structural Changes -- Macro-analysis issues

- Greater understanding is needed of public policies that can help to ensure that an appropriate physical and social infrastructure is in place to complement the activities of the private sector.

- Review may be necessary for the consequences of investment in the education sector and a shift to a service-based economy in solving the structuring problems faced by the OECD countries such as income dispersion and unemployment.

- In such aspects, attention needs to be given to the analysis of changes in the structure of employment in the light of changes in the importance of different fields of specialization and miss-matches between the needs of industry and the training provided by the formal education sector.

2. Intangible Assets and the Knowledge Base

- It is necessary to recognize the importance of path dependent development and learning and the fact that the choices or selections of firms which lead to mistakes and to new corrective measures are at least as important for firm survival and competitiveness as the firms' sense of direction and the efficiency with which it co-ordinates its activities. Very small differences in knowledge assets can result in large differences in outcomes for firms.

3. Complex Technological and Social Systems -- Micro-analysis issues

- More emphasis on firm level data and studies of organizational changes and the role of ICT in skill development are necessary to disseminate best practices, and which are to be complemented by macro statistical work focusing on initial country studies.

- As an important research topic, it is necessary to develop a better understanding of the balance between the generic and specific skills needed to maintain creativity and sustainable competitive advantage through time and across geographical space when advanced ICT systems are introduced.

- Also, analyses are needed to identify the impact of the diffusion of advanced ICT on mobility of workers and on the distribution of employment modes such as self-employed, full time and part time, and consideration should also be given to the impact upon the taxation bases as a result.

4. Relationships between Types of Knowledge and Learning

- Rivalry between the Skilled and the Unskilled and Technological Change: Government policies aimed at stimulating productivity should be directed towards skilled worker sectors and towards accelerating access to information networks as a means of reducing the costs of education.

- The growth of ICT based knowledge distribution systems will need to be assessed to determine the impact on national education systems and the appropriate policy measures: Further research is needed on the possibilities and the limitations of distance learning using the ICTs.

- Formal Education, Retraining and Lifelong Learning: Governments will need to harness the dematerialisation of the economy and new policies will be needed to ensure that learning provides people with positive expectations about their participation in the future information society.

5. Workabilities of Markets in the Information society

- It is suggested that issues exist concerning the workability of markets in the information society and the outcomes of the strategic behavior of network operators, knowledge intensive information producers and firms using information service.

- Further work is needed on the outcomes of workability of markets across a range of knowledge-intensive industries and the impact of regulation and market liberalization as an initiative to innovate and compete.

- In conducting the analysis, more efforts upon the demand side must be considered as well as upon the supply side to identify the role of competitive markets in the transformation towards a global information society.

6. Formal Accounting and Measuring for the Information Society

- The collection of internationally comparable data should be given a high priority and highlighted the need for international collaboration for mapping and measuring transformation towards the information society.

- Modifications in existing international accounting systems and statistical classifications and a a new repertoire of statistical tools rather than incremental changes in existing classification systems may be needed to ensure that they take account of the outputs of the information society.

7. Policies for technological learning

- Further research needs are suggested for policy makers to pursue the optimal R&D policies.

- In such an aspect, research suggests that there are advantages in Horizontal Technology Policies which are applied to a wider range of research activities as compared to Vertical Technology Policies which are applied to the R&D activities in the specific technology area in the formulation of R&D policies.

PROGRAMME

OECD WORKSHOP ON THE ECONOMICS OF THE INFORMATION SOCIETY

Workshop No. 4, Porvoo, Finland
6-7 June 1996

Organising Institutions: ETLA-The Research Institute of the Finnish Economy, Helsinki
Helsinki School of Economics
Ministry of Finance, Helsinki
Technology Development Centre (TEKES), Helsinki
European Commission
Organisation for Economic Co-operation and Development (OECD)

Venue: Haikko Manor, Porvoo

Background

The OECD Workshops on the Economics of the Information Society are aimed at developing economic data, research and analysis in the area of "Global Information Infrastructure -- Global Information Society". They are conducted under the aegis and direction of the ICCP Committee as the precursor for policy discussions within the Committee.

The Workshops concentrate on providing leading edge research on the economics of the coming "information society", have a quantitative and empirical stress and identify and refine the analytical and statistical tools for dealing with these issues.

The Helsinki Workshop, the fourth in the series of workshops after Toronto (Canada), Istanbul (Turkey) and Tokyo (Japan), is intended to contribute to an understanding of Information Society issues and impacts from the economic perspective. It is linked with the OECD and G-7 activities on Information Infrastructures/Society, and the European Commission's activities on the European Information Society. The Workshop was co-organised from the Finnish side by the Research Institute of the Finnish Economy (ETLA), the Ministry of Finance, the Technology Development Centre (TEKES), and the Helsinki School of Economics, together with the European Commission and the OECD. Overall co-ordination of the workshop was carried out by ETLA.

Objective of the Helsinki Workshop

The Helsinki Workshop will mark the start of the "second round" for the treatment of the main themes of the workshop series, focusing on specific issues and aspects and eliciting answers. It will also break new ground.

The development of the perspective on human resources is one of the most important tasks in considering prospects for the global information society. In future, the role played by human resources in the economic process might be significantly different from the situation today. Diffusion of information and communications technologies and extensive use of networks have a significant impact on the organisational structures of firms and governments and their functions. The portfolio of human resources and skills required by enterprises may change accordingly. The influence of those changes will not be confined to individual industrial sectors or functions, but will extend to the entire underlying fabric of industrial structure. What is the role of government in managing these fundamental changes? What measures might governments take?

Hence, this two day Helsinki workshop, within its wider consideration of the economic issues raised by the emerging global information economy and global information society, together with the associated transitional processes and implications for economic growth and policy action, will also stress the prospects for the development, adjustment and deployment of human resources and skills.

Overall structure of the Workshop

Session 1: What is the role played by human capital in the information economy?

Session 2: How will industry be transformed as global information society emerges? Particularly, how will new forms of industrial organisation, e.g. R&D joint ventures and networking firms, affect restructuring of the economy?

Session 3: How can we measure and empirically investigate the economic transformation toward the global information economy?

Session 4: What are the implications for policies in the management of transition?

Session 5: Summary and discussion for the future research agenda.

Proceedings of Each Session

Each session (except the final session) will start with presentations by invited speakers (each approx. 20 minutes), followed by comments and questions from the discussants (each approx. 10 minutes). Towards the end of each session, the floor will be open to questions and comments from the participants. A final session will conclude the workshop by the rapporteur's summary report and remarks by the chairs of the previous sessions.

Thursday, 6 June 1996

08:30 Registration

09:00 Welcome and opening remarks

Jouhi Backman, Minister for Administrative Affairs, Government of Finland
Risaburo Nezu (Directorate for Science, Technology and Industry, OECD)
Alain Dumort (DGXXII-EC)

Pentti Vartia (ETLA

Ambassador Pasi Rutanen: *"Outcome of the recent OECD ministerial meeting in relation with knowledge-based societies and GIS"*

10:00-13:00 Session 1: Role of human capital in the information economy

In the research- and knowledge-intensive information economy, "human resources" more than ever represent a key factor of production. Both from the demand and supply side of the labour market, structural changes are taking place. This session will attempt to define the new role of human capital in the coming information economy from various aspects and present recent studies and empirical work.

Chair: Ilmari Pietarinen (Ministry of Finance, Finland)

Speakers: Edward Wolff (N.Y. Univ.): *"The Growth of Information Workers in the US Economy, 1950-1993: The Role of Technological Change, Computerisation, and Structural Change"* .

Gunnar Eliasson (Royal Institute of Technology, Stockholm): *"Human Capital and Firm Organisation".*

George Papaconstantinou and Alessandra Colecchia (Directorate for Science, Technology and Industry, OECD): *"The Evolution of Skills in OECD Economies and the Role of Technology"*

Xavier Vence (Univ. of Santiago): *"The Role of Human Resources for Regional Development in the Information Era: The Case of Peripheral Regions"*

Discussants:

Reija Lilja (ETLA)

Eve Caroli (CEPREMAP)

Helena Savolainen (Telecom Finland)

Discussion :

- Is the role of human resources growing in the economy? State-of-the-art of research on the human capital, technical progress and information as production factor.

- The key elements of 'human resources' in research, production, diffusion and absorption of the information economy. How we can evaluate the human resources?

- The mechanisms to redistribute human resources in the information economy. The impact of 'information flow' upon mobility or capacity for adjustment of human resources.

13:00-14:00 Lunch

14:00-18:00 Session 2: Emerging transformation of industry in the global information society

As use of ICTs (information and communication technologies) becomes more intensive, firms are transforming their activities. New activities are now either blurring the existing industrial classifications, or establishing new relationships among industries. The fabric of industrial activities will be undergoing major changes. This session will gather prevailing views on the impact of ICTs on industrial performance and on changing industrial structure as well as on job creation. The session will particularly concentrate on changes in industrial structure due to technological spill-overs, R&D joint ventures and emerging economic networks.

Chair: Carl Belding (IBM Europe)

Speakers: Frank P. Stafford (Univ. of Michigan): *"Technology, Spillovers, and Economic Growth"*

Morton I. Kamien (Northwestern Univ.): *"Virtual Patent Extension by Cannibalisation"*

Patrick Rey (Univ. of Toulouse): *"Network Competition"*

(Coffee break)

Philippe Caille (CESIA, Marseille): *"JOINT, A European Study on Telematics and Employment"*

Discussants:

John Beath (Univ. of St. Andrews)

Morten Hviid (Univ. of Warwick)

Bernard Sinclair-Desgagné (Univ. of Montreal)

Olof Gärdin (Eurostat)

Discussion :

- The implications of new emerging practices by firms on organising R&D and human resource management. Network firms, flat organisations, etc.

- The relationship between ICT investment and industrial performance and firm behaviour? Which sectors are achieving what performance? Growth, R&D, productivity, employment, skill distribution.

- The prospects for the emerging industrial structure. The ways the IT spillovers affect the restructuring of industries and firms. Service-orientation. 'Re-fabrication' of the economy. And the implications of perspectives for further globalisation.

20:00 Dinner

Dinner Speech: Jorma Routti, Director General (European Commission, DG XII)

Friday, 7 June 1996

09:00-12:00 Session 3: Problems of measurement and empirical analysis of the information society with special reference to human capital and job creation

Formulation of effective economic policy measures requires timely data and appropriate empirical analysis which depict the changing characteristics of economic agents and their actions. The availability of a set of data and statistics is also crucial to monitor shifts in the current situation of human resources and labour market performance. In the current transitional phase the statistical system may have to accommodate to rapid change and flexibility -- update business registers, adjust industrial, occupational and product classifications, timing of surveys and probably the means of collection. Also new empirical studies about impact of ICT on growth, productivity and indirect job creation is urgently needed. The session will discuss the analytical potential and shortcomings of existing data and also the needs arising for the data set and empirical studies for information-intensive economy and society.

Chair: W. Edward Steinmueller (MERIT)

Speakers: Jerry A. Hausman (M.I.T): *"Telecommunications: Building the Infrastructure for Value Creation"*

Timothy F. Bresnahan (Stanford Univ.): *"Changes in Computing and Organisational Change"*

Erik Brynjolfsson (M.I.T): *"Information Technology and the Organisation of the Firm: An Exploratory Firm-level Analysis"*

Lennart Grundbert (IUI. Stockholm): "*The Implementation of IT in MNC's, An Empirical Analsysis using Swedish Data"*.

Wendy Hansen (Industry Canada): "*Information and Communication Technologies: Employment and Skills Linkage"*

Discussants:

Lars-Hendrik Röller (Wissenschaftszentrum Berlin)

George Sciadas (Statistics Canada)

Heli Jeskanen-Sundström (Statistics Finland)

Discussion :

- Necessity to revisit the productivity paradox in light of new results about the impact of IT on productivity: Has the productivity paradox been resolved?

- Necessity for a framework for indicators of information infrastructure, its applications and impacts... indicators of information society.

- Reviewing the available statistics of installed capacity and productivity of ICT. ICT R&D. Industrial sector and product classifications.

- Statistical means for tracking organisational transformation: The effective tools to review the transformation of firms exist.

- Occupational statistics related to use of ICTs. Defining ICT intensive occupations. Detecting changes in skill requirements and nature of work -- remote offices, telework.

- Use of ICTs for data collection and conduct of surveys -- Internet, On-line surveys -- effectiveness and limitations.

- Results of surveys in Europe on the information society.

12:00-13:00 Lunch Speech: Juhani Kuusi, Senior Vice President (NOKIA Research Center)

13:00-15:15 Session 4: Implications for policy at national and firm level

In the transition process of the economy toward global information society, what is the role of economic policy? Governments face a dilemma for managing the rapid transition. Seeking growth and productivity, economies may go through a difficult and painful period of adjustment. On the other hand, governments might be able to prepare economic agents for the upcoming changes, and education. The session will review policy measures in the fields of industrial, technology, educational, and competition policies and regulation. The focus is on policies for ICT diffusion and for human resources. The purpose is to share information on existing best policy practise. Discussion will seek to identify possible policy actions, their effectiveness and future prospects.

Chair: Pauli Heikkilä (TEKES, Finland)

Speakers: Mihkel Tombak (Helsinki School of Economics): *"Technology Policy and the Organisation of R&D"*

Morris Teubal (Prest, London): *"The Nature and Scope of Horizontal Technology Policies"*

Olivier Cadot (INSEAD, Fontainebleau): *"Barriers to Imitation and the Incentive to Innovate"*

Discussants:

John Panzar (Northwestern Univ.)

Inuk Chung (Korea Information Society Development Institute, Republic of Korea)

Kalevi Kontinen (Merita Bank, Finland)

Discussion:

- The expected role of government in the period of transition toward the 'global information society'.

- Policy measures likely to be effective review of policy practices including:
  * Regulatory needs and modes in the IS.
  * Role of competition policies.
  * Utilising advanced network and information technologies. Potential practices and limits of the multimedia educational software.
  * Promotion of creative and dynamic firms -- economic environment to promote innovative ventures, and helping acquire high ICT skills.
  * Impact of ICTs for the promotion of high R&D industries. Roles of governments in advanced R&D in the further development of ICTs.

15:30-17:00 Session 5: Wrap-up and the needs for future research

This session will summarise and conclude the two days of sessions. The Workshop Rapporteur presents the key issues of the previous sessions. The chairmen of sessions 1-4 will comment on the session they chaired and conclude the issues to be investigated in the future.

Chair: John Dryden (ICCP, OECD)

Workshop Rapporteur: Robin Mansell (Science Policy Research Unit): *Summing up the key results*

Panel discussion: Chairmen of sessions 1-4 and

Ilmari Pietarinen (Ministry of Finance, Finland)

Carl Belding (IBM)

W. Edward Steinmueller (MERIT)

Pauli Heikkilä (TEKES)

17:30 Boat trip from Porvoo to Helsinki. Dinner in Helsinki.

RAPPORTEUR'S SUMMARY [1]

The Helsinki workshop was the fourth of a series aimed at developing economic data, research and analysis in the area of 'Global Information Infrastructure -- Global Information Society'. The main focus of this workshop was on perspectives on the development of human resources in the light of the emergence of a global information society. The challenge was to bring the insights of economic analysis to bear in the analysis of the impact of the diffusion of information and communication technologies (ICTs) on organisational structures and functions and to assess the portfolio of human resources and skills that will be required in a global information society. The demand for skills and training is expected to change significantly and participants were asked to consider the appropriate role of government in managing these changes and to suggest measures that might be taken by OECD governments.

Four main workshop sessions focused on: 1) the role of human capital in the information economy with particular attention to changing occupational patterns and skills profiles associated with the diffusion of ICTs; 2) the impact of ICTs on industrial transformation and the strategic behaviour of firms; 3) problems of measurement in the face of the rapid introduction of telecommunication and computing technologies; and 4) the implications of the information society for national technology and innovation policies and for firm-level innovation strategies.

Several important themes emerged from the workshop presentations and discussions:

- Occupational Shifts and Structural Changes
- Intangible Assets and the Knowledge Base
- Complex Technological and Social Systems
- Relationships between Types of Knowledge and Learning
  - -- Formal Education, Retraining and Lifelong Learning
  - -- Rivalry between Skilled and the Unskilled Workers
- The Workability of Markets in the Information Society
- Formal Accounting and Measuring for the Information Society
- Policies for Technological Learning

These themes are highlighted below, together with an outline of major issues for further research and policy consideration. This summary report is accompanied by a detailed session-by-session account of the workshop presentations.

1. Introduction: People at the Centre of the Information Society

The economic transformations that are underway as the global information society takes shape are characterised by heightened uncertainty about the determinants of an increasingly complex world. People, and the way they conduct their everyday and working lives, are at the very centre of this complex world. Their preferences, motivations, and requirements are increasingly difficult to determine as job functions are transformed and as employment patterns change both geographically and in terms of the demand for skills. These changes are among the most uncertain factors in this transformation process.

Workshop participants raised important questions that must be addressed if policy makers are to have a sound foundation for policy action. Nevertheless, many of these questions were not entirely new. For example, questions about economic behaviour under conditions of uncertainty in a complex world were raised by Frank Knight in the 1920s. Questions about whether competition is workable in economies in which sophisticated network systems play a major role were addressed by J. M. Clark in the 1920s. More recently, economic historians such as Fernand Braudel have investigated the impact of communication networks on trade and competitiveness and economists, including Herbert Simon and Sydney Winter, have considered whether the availability of greater quantities of information should be expected to result in greater rationality and predictability in decision making.

Today renewed emphasis is being given to the role of human capital in economies that must produce, access, process and apply information if they are to create useable knowledge. Information technologies and advanced communication networks increasingly are available for use within organisations and between them, within households and across geographically distant communities. The appropriate skills to use the new technologies effectively are unevenly distributed throughout the population and the policy solutions of the past no longer seem to work effectively.

OECD economies face the prospect of rising unemployment and uncertain demand for a skilled workforce in the information society. The assumptions and policy measures which have guided the management of human resources and capital in the past must be rethought and new policy measures introduced.

The questions addressed by Workshop participants will need to be answered if the fundamental problems that affect the workforce in OECD countries are to be resolved. Changing government policies and firm strategies will have a major impact on national competitiveness, job creation potential, the role of small and medium sized firms in the information economy, and future trade and investment patterns.

In the opening session of the Workshop, Mr. Risaburo Nezu commented that ‘it is people who use new technologies, they must be educated if they are to be the master rather than the slave of the technologies’. Mr. Alain Dumort emphasised the fact that ‘people are the centrepiece of the information society’ and a common theme throughout the workshop was the need for improved understanding of policy action that will alleviate the ‘feel bad factor’ in modern societies. The continuing challenge is to provide insights into the problems of job loss and unemployment, of mismatches between the skills of the workforce and the competencies, such as the capacity to engage in lifelong learning, that are essential in a global information society.

2. Occupational Shifts and Structural Changes

One of the major effects of technological change is substitution (Wolff). When firms invest in advanced ICTs, many production jobs are eliminated and these are compensated by only modest gains in the number of knowledge worker jobs. What is to be done with all the workers who are being displaced is a major concern in OECD countries. One answer lies in greater efficiency in the use of ICTs and in the export of information-based services (Caille). It is unclear, however, whether all OECD countries have the appropriate infrastructure and human resource capabilities to implement this solution. Greater understanding is needed of public policies that can help to ensure that an appropriate physical and social infrastructure is in place to complement the activities of the private sector.

OECD work on structural changes in the skills composition of the workforce suggests that there is increasing polarisation between white collar, high skilled employment growth and other categories (Papaconstantinou). In the manufacturing sector polarisation is more pronounced than in the service sector. Substitution effects are at work as up-skilling takes place within industry sectors. OECD data suggest that deviations from major trends in the eight countries for which data are available can be explained by different levels of R&D expenditure and by the rate of diffusion of new technologies. Innovation effort measured by R&D intensity and the accumulation of skilled human capital resources at the national level appear to be closely related. This relationship is not straightforward and it appears that investment in education and a shift to a service-based economy will not offer a panacea for the structural problems facing OECD countries.

Statistical evidence for the Canadian economy suggests that unemployment rates cannot be explained by educational attainment levels alone. Greater attention needs to be given to the analysis of changes in the structure of employment in the light of changes in the importance of different fields of specialisation and miss-matches between the needs of industry and the training provided by the formal education sector (Hansen).

3. Intangible Assets and the Knowledge Base

Statistical accounts of structural change accompanying the transformation toward a global information society do not enable a full assessment of the parallel transformations in competencies (or skills). New methods of measuring or valuing intangible assets and the knowledge base in the information society are needed. For example, a ‘competence specification’ of a firm’s assets yields a very different picture of whether a firm has succeeded in acquiring a ‘collection of competent teams of people who are organised to come up with solutions’ (Eliasson). Research on the proportion of a firm’s capital which is comprised of soft intangible or knowledge assets is needed. Such methods could provide new insights into the competitiveness of firms as compared to accounting methods that focus on the capitalisation of expenditure flows and tangible asset values (Eliasson).

At the organisational level, it is necessary to recognise the importance of path dependent development and learning and the fact that the choices or selections of firms which lead to mistakes and to new corrective measures are at least as important for firm survival and competitiveness as the firm’s sense of direction and the efficiency with which it co-ordinates its activities. Very small differences in knowledge assets can result in large differences in outcomes for firms.

4. Complex Technological and Social Systems

In complex systems there is a need for continuous reorganisation and for greater attention to co-ordinated action. Very little is known about the impact of ICTs within firms or about how the implementation of new information systems affects 'communication with the right people and the acquisition of the right information when it is needed'. Although firms need to reconfigure their knowledge assets to remain competitive many factors result in organisational inertia. Firm strategies may be designed to protect specific kinds of human capital because tacit knowledge is difficult and costly to replace (Sinclair-Desgagné). Research on industry capabilities, rather than firm-level capabilities is needed in order to determine how strategic alliances create new competitive strengths and knowledge capabilities. The build up of knowledge capabilities through co-operation within industrial sectors poses challenges to competition policy and may weaken incentives for interfirm competition.

When firms are faced with competition and the challenge of forging new intrafirm and upstream and downstream co-operative relationships, a variety of factors influence their adoption of ICTs (Bresnahan). There is growing evidence from case studies and surveys that as companies make greater use of networked commerce -- intranets and Wide Area Networks -- strategies designed to maximise the returns to ICT investment interact closely with those designed to introduce organisational changes including decentralisation and flexibility. Empirical evidence also suggests that low investment in ICT and the retention of traditional organisational forms can produce gains in productivity in some cases. Surveys of the introduction of computing technologies within firms suggest that the localisation of knowledge and learning-by-using are important factors which affect whether firms will experience productivity gains as a result of ICT investment. There may be limits to the outsourcing of computing expertise and many factors contribute to organisational inertia which locks firms into doing things in traditional ways. These include the significant adjustment costs revealed by firm level surveys and which do not appear in aggregate data on productivity gains (Bresnahan, Brynjolfsson).

The impact of ICT system implementation on productivity and competitiveness depends, in part, on the design of the system. There may be alternatives to the 'automate-obliterate' jobs epithet which frequently accompanies radical organisational change strategies. In particular, opportunities created by advances in the simplicity of ICT systems and the use of more user-friendly software applications may make it feasible to retain lower skilled employees.

One of the main lessons from empirical surveys of ICT system introduction is that it is in organisational change that the benefits and barriers to the effective use of ICT are located, i.e. in human capital and its reconfiguration. An appropriate social, cultural, and economic infrastructure must also be in place if positive change is to occur. More complex organisational sites often have the highest rate of return on investment in ICT, but these organisations tend to experience the slowest rate of change. Big waves of transformation in computing technologies come relatively slowly for large organisations and this is not simply a matter of the pace of technological innovation (Bresnahan).

Empirical studies of the ICT investment strategies of Swedish multinational companies indicate that gains from ICT investment are experienced but that there are no guarantees of substantial benefit (Grundberg). Although new ICT systems have the potential to reduce uncertainty in decision making, users must be convinced that the new systems will work effectively. This must occur in an environment where there are numerous examples of ICT systems failure.

The problem in achieving substantial returns on ICT investment is that organisational capital is specific and the required organisational learning processes also tend to be firm specific. Research is needed to develop a better understanding of the balance between the generic and specific skills needed to maintain creativity and sustainable competitive advantage through time and across geographical space when advanced ICT systems are introduced. Although there may be generic 'principles of the new organisation' that will apply to all industries and countries, at present empirical evidence suggests only that there are strong positive correlations between ICT investment in MIPs/LANs, decentralised decision making, subjective, team-oriented incentive systems, and the scale of investment in human capital.

Organisational design or architecture is closely associated with technical architecture. If research can produce more systematic knowledge about the relationships between complex organisational and technical systems it may be possible to develop an improved understanding of the optimal combination of investment in advanced ICTs, modern management techniques and decentralised organisational systems.

5. Relationships between Types of Knowledge and Learning

The appropriate balance between co-operation and competition in a global information society is closely related to the changing relationship between tacit knowledge embodied in people and the role of codified knowledge that can be transmitted around the world in manuals through the Internet at very low cost. Research is needed on the competencies required to enable people to engage effectively in distance learning using digital information products. There is evidence that new modes of distance learning differ from those of the past. Research is needed on the limits of codified learning and on the extent to which large educational institutions in some OECD countries will be able to use ICT-based learning to attract students who otherwise would participate in institutions of higher education in their home countries (Beath). The extent to which ICT-based distance learning needs to be coupled with direct exchanges with teachers to create a sense of community also needs to be investigated. There may be limits to competition across national cultural or linguistic boundaries. These may serve as correction mechanisms that will create new opportunities for national public and private organisations to offer new educational services. The growth of ICT-based knowledge distribution systems will need to be assessed to determine the impact on national education systems and the appropriate policy measures.

Factors that are likely to reduce the potential for the globalisation of training and education include the ways in which users respond to information when they cannot verify it and the impact of greater quantities of information that may not be congruent with social norms and institutions which enable trust to be established. The availability of greater quantities of information also could result in very complex problem solving situations that may heighten uncertainty and diminish efficient decision making.

5.1 Formal Education, Retraining and Lifelong Learning

The widespread diffusion of ICTs and access to global telecommunication networks has many implications for formal education and the content of lifelong learning. There is little understanding of the characteristics of a 'good' education system for the future information society (Eliasson). One vision of the future is of 'nomadism without inertia' (Caille) whereby all aspects of material goods and services production will change location frequently bringing huge volatility to global job markets. In this volatile environment lifelong training schemes may fail to compensate for regional differences. National governments may need to introduce policies aimed at creating jobs for young qualified workers, at

ensuring that existing jobs are upgraded, at providing retraining and public service jobs, and at finding new ways to support the lifelong unemployed (Caille). Governments will need to harness the 'dematerialisation of the economy' and new policies will be needed to ensure that learning provides people with positive expectations about their participation in the future information society.

5.2 Rivalry between the Skilled and the Unskilled and Technological Change

Rivalry between skilled and unskilled workers is becoming an important issue in the global information economy. The problem of growing income dispersion raises questions for policy and for firm strategy. When, for example, is it profitable for a company to require skilled workers to carry out productive activities formerly undertaken by lower skilled workers? When such shifts occur, increases in the productivity of skilled workers have a major impact on the real wages of less skilled workers (Stafford). One of the keys to strong economic growth is improvement in productivity as a result of ICT investment. The worst offenders in terms of relative productivity gains in the US are public services including legal and health services and the educational sector. It was suggested that although part of this could be attributed to measurement problems associated with productivity indicators in the services sector; Government policies aimed at stimulating productivity should be directed toward skilled worker sectors and toward accelerating access to information networks as a means of reducing the costs of education (Stafford).

6. The Workability of Markets in the Information Society

The appropriability of information is a central feature of the dynamic of competition in the information society. Firm strategies toward information disclosure often change in the light of policy changes, for example, in the patenting regime for the US pharmaceutical industry (Kamien). This sector qualifies as a leader in terms of the intensity of its knowledge assets. Changes in competitive strategies occur when a monopolist to "cannibalise" its own brand pharmaceutical product in a first period by introducing a generic product identical to its brand name product. The effect of advertising on consumer preferences produces the illusion of a differentiated product and a basis for price discrimination. In a second period, a theoretical model can be specified to show that the price of the original brand name product rises and that the distribution of the benefits between society and the private interests of the pharmaceutical firms is unclear.

This theoretical outcome is an important consideration for other highly knowledge intensive sectors of the economy. For example, greater understanding is needed of how firms producing information products react to changes in national copyright and patent regimes. Will relatively small changes in the intellectual property protection regimes in OECD countries creates substantial differences in the economic performance of firms located in different countries and in the market entry conditions? Will firms seek to create the illusion of variety and competition in markets for information products? Firm strategies and outcomes will be central factors that affect changes in services trade patterns.

Models are needed which can be used to shed light on the impact of changing intellectual property regimes on the strategic behaviour of imitators. There are models suggesting a tightening of appropriability regimes resulting in a slower rate of innovation but empirical analysis is needed to determine the impact of tighter protection regimes on firm entry behaviour.

Markets for telecommunication services may, under certain conditions, be expected to work less efficiently as ICTs and network systems diffuse throughout the OECD economies. There are also models that point towards the existence of opportunities for collusion when a degree of co-operation is needed

within a competitive framework. The case of telecommunication network interconnection provides an opportunity to assess whether competition in final markets is sufficient to discipline retail prices and the level of network access prices (Rey). Under certain conditions, co-operation leads to collusive pricing and monopoly prices for network access. The effects on entry behaviour are not clear and this creates a dilemma for government policy and regulation. Available models suggest that traditional competition policy rules are unlikely to be effective in ensuring that prices for network interconnection are pushed downward towards cost.

These observations raise issues concerning the workability of markets in the information society and the outcomes of the strategic behaviour of network operators, knowledge intensive information producers and information service-using firms. The outcomes will be significant in determining whether nationally-based firms are able to move from information service distribution into content provision and whether there will be incentives for incumbent firms to pre-empt new entry. Further work will be needed on the outcomes across a range of knowledge-intensive industries.

The role of competitive markets in the transformation toward a global information society must be considered from the demand as well as the supply side of the market (Hausman). The demand for an increased array of advanced information and communication services is expected to stimulate the construction of higher capacity networks and widespread access. There are questions about who will pay for the required network expansion and the relative distribution of the benefits of infrastructure investment to consumers and society as a whole.

As far as policy is concerned there are differing views. On the one hand, it is argued that as a result of technical innovation, there are no opportunities for monopoly structures to re-emerge in the information production or distribution sectors. Few if any opportunities exist for price discrimination that is not based on real differences in products. Policies and regulations designed to prevent monopoly have the effect of simply slowing down telecommunication network upgrading and modernisation (Hausman). The growth of Internet activities is benefiting consumers and this growth has occurred in a largely unregulated environment. On the other hand, in the absence of effective regulation a transition from monopoly to competition may be slowed down and regulation can play a role in stimulating competitive entry. Policy and regulation may continue to play a role in co-ordinating activities in a competitive environment and in reducing co-ordination costs associated with complex technical and organisational systems.

7. Formal Accounting and Measuring for the Information Society

Governments and the private sector confront a major problem in developing appropriate ways of measuring the transformations that are underway in the information society. Modifications in existing international accounting systems and statistical classifications are needed to ensure that they take account of the outputs of the information society (Gärdin). In economies characterised by virtual firms, traditional firm-based definitions and sectoral accounts offer inadequate insights into on-going structural changes. Major issues concern how to account for where value is added and realised. Improved comparative and time series data is needed as is a consensus on the appropriate units of analysis and the interpretation of disparate national statistical categories and classification systems.

Workshop participants urged that the collection of internationally comparable data be given a high priority and highlighted the need for international collaboration. Work is needed to consider the impact of the diffusion of advanced ICTs on the tax base, on worker mobility, and on the distribution of self-employed, and full time and part time employees (Sciadas). In addition, there is a need to bridge the

gap between interview and survey based studies of the factors driving the adoption of ICT and analyses based on aggregate estimates of demand. There is a clear need for a new repertoire of statistical tools rather than incremental changes in existing classification systems (Jeskanen-Sundström).

8. Policies for Technological Learning

Governments play a significant role in creating incentives for collaborative R&D through joint ventures and various forms of public subsidies. The issue for policy is what combination of industrial organisation incentives and subsidy rates is likely to maximise social welfare. Although there is some evidence that publicly supported R&D programmes yield socially optimal R&D intensities as compared to competitive R&D, there is a cost insofar as firms will opt for collaborative R&D in order to obtain a higher subsidy rate. Theoretical research suggests that under certain conditions, firm preferences for joint research initiatives may not be strong. They may prefer to engage in competitive R&D strategies despite the fact that co-operative strategies would optimise total social welfare (Tombak). The results of models are difficult to interpret because of the need to separate the factors creating incentives for competition and collaboration on R&D within the organisation and across organisational boundaries from those which prevail in final markets (Panzar). Further research is needed to determine the optimal R&D policies that should be pursued by policy makers.

The advantages of Horizontal Technology Policies as compared to vertical policies also need consideration (Teubal). Horizontal Technology Policies can create opportunities for learning by governments. They encourage a focus on learning and on technology selection mechanisms. Research on the benefits of such policies has now produced insights that are outside the scope of studies which focus on the determinants of market failure. Analysis of the role of Horizontal Technology Policies has pointed to the need for industrial restructuring and organisational change. It has also shown that these are likely to generate additional positive returns on R&D investment because of the gains from collective learning experiences. Explicit 'market friendly' policy designs can be used to encourage improved competitive performance of technologically lagging firms, technological leapfrogging and sustained innovative capabilities.

9. Conclusion

The Workshop presentations and discussion pointed to numerous areas in which very small differences in technology design, organisational practice and the policy or regulatory environments in OECD countries can be the source of substantial differences in the development of markets for goods and services in the information society. As Paul David has argued, small differences in initial conditions can make a big difference in economic outcomes. This observation applies as much to governments as to firms. Small shifts in government policy in the OECD countries with regard to human resource development are likely to make substantial differences in what skills are available within countries and to who is able to participate fully in the global information society.

In the final wrap-up session, the chairmen of earlier sessions pointed to the need for continuing analysis and policy advice in the following areas:

The need for continuing economic analysis as well as multidisciplinary approaches to the study of the impact of a global information society on national economies in the OECD area. (Pietarinen). This includes both new research and the consolidation of existing work on economic, social, legal, administrative and educational issues. Key research themes are: i) comparability of data and statistical sources appropriate to the information society; ii) studies of organisational change and the role of ICT in

skills development, education and employment trends; iii) the transfer of tacit knowledge, the measurement of intangible assets and the role of intellectual property protection; iv) the impact of regulation and market liberalisation on incentives to innovate and compete; and v) the institutional character of unemployment and its long-term social and economic implications. The need to ensure that the results of research are available to those who can benefit from them requires that they be presented in formats that are easily accessible to a wide variety of users in the government, industry and the wider community.

A well resourced, managed programme of further research (Belding). Priorities include: i) an emphasis on firm level data and studies complemented by macro statistical work possibly focusing on initial country studies; ii) analysis of factors contributing to fear and uncertainty which slow structural adjustments; and iii) the role of competition policy in the information society.

Rethinking and Consensus on Research Priorities (Steinmueller). Priorities include: i) deepening understanding and rethinking data needs and organisation of the collection process; ii) extended analysis of organisational and technological change and prospects for enabling greater labour mobility; iii) research on the sources and determinants of dissatisfaction with the economy and society is serious and the policies that will lesson their impact; iv) work on the extension of high quality and diverse public and educational services to complement efforts to reduce public sector employment and the growth of the commercial sector; v) greater attention to the use of ICTs to disseminate best practices.

Mapping and Measuring Transformation toward the Information Society (Dryden). A major priority is to move forward on the further development of statistics, indicators and measurement tools in order to enable the OECD to advise governments on rapidly changing major phenomena.

APPENDIX [2]

SESSION REPORTS OF PORVOO (HELSINKI) WORKSHOP

Session 1: The Role of Human Capital in the Information Economy

In the research and knowledge-intensive information economy, 'human resources' represent a key factor of production. Structural changes are taking place on both the demand and supply side of the labour market. This session aimed to define the new role of human capital in the information economy and to review recent studies and empirical work.

The Growth of Information Workers

Edward **Wolff** (New York University, US) outlined results of an empirical investigation of the composition of the US workforce and especially the role of the information workers. The analysis was based on US census data 1950-90 (five observations). The occupational group -- information workers -- consists of knowledge producers including scientists, engineers, etc., and data processors who are the main users of information including doctors, managers and clerical workers. The annual growth rates of the share of information workers were shown to be very high, and the growth of the subgroup of knowledge producers accelerated during the 1980s. In contrast, the shares of the other two occupational categories, service workers and goods-processing workers, were shown to be either stagnating or falling.

To decompose the factors affecting the growth of the share of information workers, three separate effects were investigated at the industry-level: changes in information intensity (substitution effect), changes in the share of each industry in the economy's total output (output composition effect); and the effects of possible lower labour productivity in more information intensive activities (unbalanced growth effect). The most significant factors appeared to be the substitution of information workers for other workers and the unbalanced growth effect resulting from differences in labour productivity.

The relationship between occupational changes and technological activity was investigated by industry. The change in the technological regime during the 1980s due to computerisation and the use of ICTs was shown to have had a large effect on demand for knowledge workers. Growth in knowledge worker employment is positively related to computerisation (measured by investment in office, computer and accounting machinery) and negatively related to TFP growth. The latter result suggests that technological change tends to simplify tasks and reduce reliance on knowledge producers. Computerisation also correlates negatively with employment of data processing workers. This reflects their substitution by ICTs and by the engineers and computer specialists who complement the new technology.

Employment increases over the period tend towards knowledge producers and away from data processors. ICTs appear to influence the demand for different workers and production technologies, and not as a result of a shift towards final products that are more information intensive.

Human Capital and Firm Organisation

Gunnar **Eliasson** (Royal Technical Institute, Stockholm, Sweden) focused on the importance of economically relevant knowledge, skills and information organised in a way that allows their productive use. The firm can be viewed as a team of competent people who are more valuable together than the sum of each member apart. Well organised team action creates synergies or positive externalities with respect to the knowledge of its members. Therefore, the essence of a firm can be described with an approach emphasising teams and competencies instead of regarding the firm as a computation or planning machine.

Competencies and the value of a team or an organisation are extremely difficult to measure. However, since these aspects play a major role in the economic performance of the firm, they should not be overlooked. Eliasson proposed a method to analyse the competence capital in a firm. Based on a survey of Swedish companies and a breakdown of the activities of an average firm, his analysis showed that most functions in the firm can be described as knowledge activities, i.e. producing or processing knowledge and information. Intangible assets in general make up a considerable part of a firm's value, e.g. 30 per cent of the visible capital may be intangible.

In addition to visible capital there are entrepreneurial assets which are not accounted for using the present method. According to Knight (1921), entrepreneurial talent is the capability to deal with risks. However, entrepreneurial capability is largely tacit and resides in people. It can be communicated only by moving people or units of firms. Eliasson argued that firms are largely ignorant and incapable in the face of (Knightian) uncertainty in the environment. As a consequence, firms should be seen as organisations endowed with different competencies that experiment in an environment characterised by fundamental uncertainty.

Firm competencies are present in three hierarchical functions: i) orientation, the function of the top level management and based on the capability to direct activities and the willingness to take risks; ii) selection, carried out by middle management who address the efficient identification and correction of mistakes; and iii) operative management, who co-ordinate production and give feedback based on learning-by-doing to the top level to enable them to redirect the operation. The conclusions of the competence-based view of the firm emphasise the following issues:

- Business mistakes should not been seen as waste because experiments are an important source of organisational learning.

- Competencies which are tacit can only be accumulated through a slow and gradual process; path-dependence is important in the firm’s evolution and performance.

- Selection mechanisms involve non-linear dynamics which create challenges for economic theory.

- Entry and exit of firms are crucial for economic growth and this is overlooked in traditional theories.

Evolution of Skills and the Role of Technology

George **Papaconstantinou** (DSTI/OECD) presented an analysis of changes in skill structures in OECD countries and the role of technological change. International comparisons of skills rely on rather crude data on occupations or use educational attainment level indicators. In this case, the analysis was

based on occupational categories: white-collar high-skilled workers (WCHS), white-collar low-skilled (WCLS), blue-collar high-skilled (BCHS) and blue-collar low-skilled (BCLS). The analysis showed that employment grew most rapidly for WCHS and that the number of BCHS jobs has declined suggesting a process of skill polarisation and the disappearance of middle skill jobs.

The overall up-skilling trend in OECD economies is characterised by differential development patterns within economic sectors. The shift towards WCHS jobs has been strongest in the manufacturing industries, whereas the service sector has experienced more balanced growth across occupational categories and even some increases in low-skilled employment. Within the manufacturing sector, the high technology industries have experienced the most rapid increases in employment especially for WCHS jobs.

The study investigated whether overall up-skilling is due to mobility of skills between industries, or up-skilling within the industries. No important shifts of skills between sectors were found and the shifts towards skilled employment have occurred within industries.

The role of technology in the up-skilling process in WCHS occupations was investigated using industry-level data on capital-labour intensity, R&D expenditure and growth in the number of patents. These factors were correlated positively and significantly with the rate of change in the share of WCHS jobs. Moreover, high-skilled sectors appeared to diverge from low-skilled sectors as initially higher skill intensive sectors experienced a faster increase in skill intensity.

Human Resources for Regional Development

Xavier **Venca Deza** (University of Santiago de Compostela, Spain) addressed issues of globalisation and the geographical division of labour which impact on regional development patterns. Structural changes affect the locational distribution of firms and industries. In view of the possible localisation of the diffusion of knowledge, firms may tend to cluster in some regions more than others and there is an uneven distribution of firms within the OECD area and within countries.

Less favoured regions tend to have lower levels of education and this may be further accentuated by a 'brain drain'. The returns on investment in education by less advantaged regions accrue to more advantaged regions when labour mobility toward economic centres includes the most educated people. Interregional immigration may involve a considerable transfer of income and resources from poorer to richer regions, increasing the divergence between regions.

Investment in education is not likely to be beneficial unless educational skills are utilised by experience in working in firms as skill accumulation occurs on the job in many cases. Education does not guarantee economic growth and greater attention should be given to firm decisions concerning the location of the operations.

Discussants:

Eve **Caroli** (INRA-CEPREMAP, France) pointed to the dynamic interaction of technical change, human resources and firm structure. An important factor in the effects of ICT on the demand for skills is organisational change in firms and there is some evidence that ICT investment is associated with decentralisation in work organisation. Team work and a decentralised organisation create new requirements for capabilities. There is also a possibility of screening or filtering effects underlying the

process of up-skilling. As a result of competition in the labour market, more educated people may be performing lower skilled jobs which may waste resources.

Reija **Lilja** (ETLA, Finland) emphasised that changes internal to occupations and jobs are not necessarily reflected in the shares of occupations. The use of education as a proxy for skill content could reveal important new aspects of skill demand and complement analysis to date. She called for dynamic analysis of human capital and technical progress in the information society.

Helena **Savolaninen** (Telecom Finland) raised questions about whether governments can conceptualise the future from the educational point of view and take account of the need to transform the performance of the education system. She also stressed the need to guarantee access to educational services particularly in remote and rural areas. Remote/rural areas may be great users of services, e.g. educational networks have been developing in Northern Finland. Technology was characterised as a fast mover, whereas the education sector is a slow mover.

Discussion:

A brief discussion followed during which Wolff commented that available measures may be biased toward traditional skills and occupational categories. Gunnar Eliasson stressed that human capital and competence are not necessarily associated with formal schooling and education. He stressed that we do not know what a good education system should look like especially as firms hire talented people; they do not hire educated people. There is a need to use ICT as a platform for retooling and flexibility on the job.

Session 2: Emerging Transformation of Industry in the Global Information Society

This session was aimed at examining prevailing views on the impact of ICT on industrial performance and changing industrial structures as well as on job creation. Speakers were invited to concentrate particularly on changes in industrial structure due to technological spill-overs, R&D joint ventures and emerging economic networks.

The papers raised several points concerning how industries are changing as the global information society emerges. Transformation will touch both the production and the employment sides of the industries, resulting in greater wage dispersion, job outflows, the need to secure information at the firm level and, in some cases, for government intervention to secure contracts between firms.

Information Technology and the Distribution of Real Wages

Frank **Stafford** (University of Michigan, US) aimed to show the effects on income distribution when ICT makes some workers more productive than others. ICT will affect the work of skilled workers in particular, which means their work will grow in importance relative to that of the unskilled workers. This signifies a new era after the early Post-war period when jobs involving less skill gained in importance as a result of relative scarcity. If ICTs help skilled workers to improve their ability to produce products previously produced by less skilled workers, the outcome will be greater wage dispersion because those who gain in relative real wages are the skilled workers. If, alternatively, ICTs make skilled workers produce their traditional products more efficiently, both types of workers will benefit.

Despite technical progress, an economic slowdown may occur as a result of heavy public subsidisation of sectors which have experienced slow productivity gains. For example, the US health care

sector accounts for 15 per cent of GDP and is extensively subsidised by government. Stafford argued that government intervention should be limited to the private sector.

Virtual Patent Extension and Generic Product Competition

Morton **Kamien** (Northwestern University, US) focused on intellectual property rights and the role of the US patent system. A model illustrating the behaviour of firms suggested the incentives for the US pharmaceutical industry, following the introduction of a new Act in 1984, to launch generic versions of a drug before the expiration of patents. As a result, entry by other generic product producers would become more difficult and the brand name drug developer would benefit. This case was contrasted with one in which the brand name drug developer does not launch a generic version. Kamien observed that it is difficult to determine whether consumers benefit from this strategy. The model has implications for the impact of ICTs insofar as intellectual property protection concerns are heightened together with a general fear of know-how leakages. However, it continues to be difficult to say what the policy implications of this type of new strategies are.

Network Competition and Policy Intervention

Patrick **Rey**'s (University of Toulouse, France) emphasis was on the development of network competition. He suggested that by 1998, the telecommunications industry will be completely deregulated in the EU and that when this occurs, consumers will be able to access many networks. Competing network operators may use access charges to slow down the use of competitors' interconnected networks resulting in two potential effects: i) reducing collusive practices as competing firms must reach interconnection agreements, or ii) limiting entry into the deregulated market.

A model was used to show that competition may not work effectively. For example, if access charges are too high, price competition may not become stable. This outcome is possible in a state of free competition and when price discrimination is allowed. Access prices also can be used as collusive devices when firms are permitted to freely negotiate and the access price can be used to block entry.

The model suggested several policy issues including the possibility that the outcome of free competition and free interconnect negotiation between firms may be harmful. This may suggest the need for government intervention to secure agreements among firms.

Telematics and Employment in Europe

Philippe **Caille** (CESIA, France) presented a survey of new markets which have opened up due to the development of teleworking and teleservices in Europe. The main focus of the European Commission's JOINT project was on whether telematics will tend to create new jobs in the EU, or result in nomadism and job outflows. The answer depends on actions taken by EU institutions to promote the development of non-material activities.

As telematics is nurturing a revolution in lifestyles and economic strategies, Caille argued that conceptual and statistical frameworks should be altered to provide tools for thinking about, and measuring, economic variables in a world where non-material activities are increasing in importance.

Telematics is transferring the highest value activities towards the periphery of traditional production processes. This implies a potential job outflow from Europe as a number of traditional and new producing activities are forced out when they are automated and because they generate less added value. At the same time, telematics create new opportunities in Europe if firms and governments harness

the dematerialisation of economies and if governments and international institutions can negotiate successfully. Job creation in Europe will depend on the ability to provide the young qualified unemployed with jobs they expect, to retain existing jobs by upgrading them, to retain jobs in public services via exports, and to support the lifelong unemployed and socially excluded.

Discussants:

John **Beath** (University of St. Andrews, UK) noted that the question of entry conditions presented by Ray was particularly interesting in the telecommunication industry. Beath raised the issue as to whether the pre-emptive competition illustrated by Kamien's model would be likely to be observed in the real world.

Morten **Hviid** (University of Warwick, UK) pointed out that firms in the information society have looser legal foundations than in the past and rely on trust and self-enforced co-operation to a greater degree. Although firms are the recipients of more information this does not necessarily mean that there is more verifiable information. He also noted that there may not be a need for greater skill levels overall in the information society, but rather for new skills in specific areas. Network externality issues may be relevant to other industries outside the telecommunication sector and this could provide a basis for further research, i.e. on the software industry where copyright does not limit rivals from producing compatible software products.

Bernard **Sinclair-Desgagné** (University of Montreal, Canada) suggested that the threat of a know-how leakage increases as the locus of competition shifts toward competition on know-how. Firms may seek to guarantee that certain employees are retained using higher wage incentives and promotions. Firms also may have a strong incentive toward vertical integration and this may not be desirable from society's point of view. OECD countries have adopted different practices in the area of anti-trust and competition policy and it is unclear whether multi-faceted competition will be good or bad for consumers.

Olof **Gärdin** (Eurostat) observed that in the EU the telecommunications industry will move into a more competitive environment at the beginning of 1998 and telematics will have a major effect on OECD economies. He suggested that there will be a need for more regulation following deregulation and questioned whether traditional competition rules will be effective in the presence of dominant firms. Policy emphasis should be on the ease of market entry. Three policy alternatives were possible following liberalisation: i) price regulation, ii) structural change, or iii) antitrust investigation.

The importance of statistical problems and the need for co-operation to develop a basis for international comparison of developments in the information society that are not presently covered by official statistics was emphasised. There is a need for data on spatially distributed and immaterial products and a focus on a taxonomy of enterprises and interaction; coverage of SMEs; and definition of the products of the information society, as well as the geographical and communication patterns in the use of and demand for services.

Discussion:

In discussion Stafford pointed to the need for forecasting if we are to understand the scope of products in the information society. If end products can be visualised this might lead to a better understanding of substitution and 'super-substitution'. Kamien commented that his model did not imply causality as between changes in the law and the behaviour of firms. It was observed that even the

definition of the firm varies between European countries and that the problem of incompatible definitions may grow. Rey suggested that there is a need to design competition enforcement institutions and to focus on how rules are implemented and evolve. Caille pointed to the importance of competition at the interface between customers and products and the future need for training users of products and for maintenance support (teletraining and telemaintenance). He called for new concepts for the information society based on case studies of product development at the world level rather than more statistical analysis.

Session 3: Problems of Measurement and Empirical Analysis of the Information Society with Special Reference to Human Capital and Job Creation

Formulation of effective economic policy measures requires timely data and appropriate empirical analysis which depicts the changing characteristics of economic agents and their actions. The availability of a set of data and statistics is also crucial to monitor shifts in the current situation of human resources and labour market performance. In a transitional phase, the statistical system has to accommodate rapid change and introduce flexibility to update business registers, adjust industrial, occupational and product classifications, alter the timing of surveys and the means of data collection. New empirical studies of the impact of ICT on growth, productivity and indirect job creation are urgently needed. The aim of this session was to discuss the analytical potential and shortcomings of existing data and the need for data sets and empirical studies of an information-intensive economy and society.

Building the Infrastructure for Value Creation

Jerry **Hausman** (MIT, US) focused on value creation and the importance of information services. The analysis addressed value creation in on-line multimedia services, who gains from new network services, and the Microsoft Network (MSN) debate.

A model was used to estimate that value of new multimedia services, illustrating that the value of these network services exceeds the cost of infrastructure investment substantially. However, the cost of building the required infrastructure is tens of billions of dollars and the best government can do is to ensure that the private sector has a strong incentive to build the network. The government should withdraw from regulation as the result of delayed investment will be costly due to the loss to society of consumers' and producers' surpluses.

Hausman noted that many of Microsoft's on-line service competitors have called for government regulation. This would decrease Microsoft's ability to compete. Hausman argued that Microsoft's actions are to be expected from a competitor and should not be taken seriously by anti-trust authorities. The MSN will increase competition and benefit consumers.

Infrastructure providers, hardware manufacturers, software producers, network service providers and content providers are all expected to benefit from the on-line services industry but by far the largest amount of value will be captured by consumers and business users of these new services.

Computing and Organisational Change

Timothy **Bresnahan** (Stanford University, US) addressed changes in computing and their impact on organisational change. Survey data were presented to illustrate that using new ICT in large firms is costly. This explains why the decision to move to a new generation of equipment is considered carefully before making investments. ICT has the potential to lower costs and to change product quality as a result

of learning-by-doing. The most common way in which ICT is adopted is through incremental change involving learning by doing, low risks and delayed returns on investments. Radical complementary change, in contrast, involves a big push to introduce new computerised ICT-based systems, high risks and frequently higher returns.

Client/server systems have superseded mainframe systems and the most important variables predicting the mix of systems that will be adopted by the firm are organisational costs, industry characteristics and the emergence of new software products. The analysis demonstrated that it is in organisational change that the benefits and barriers to effective use of ICT are located, that is, in human capital. Complex sites have the highest rate of return to introduction of ICT, but they are the ones where change comes slowest.

Information Technology and Organisation of the Firm

Erik **Brynjolfsson** (MIT, US) presented a firm level analysis of the impact of ICT investments and changing organisational strategies such as delegation of decision making, investment in human capital, and the introduction of incentive systems. Rapid changes in ICT are not visible in aggregate statistics on productivity growth, but at the firm level there is a positive correlation between ICT investment and productivity. The issue is what factors explain substantial variation across firms.

The analysis suggested that firms investing more heavily in ICT are more likely to use team-based decision making, to invest in training and education, and to use subjective types of incentive systems. This result holds after for controlling for industry, work force composition, and prior levels of education and training. Firms that both invest in ICT and employ this type of organisational 'system' appear to be more productive than firms that invest in ICT but do not use the system. One interpretation of these results is that the team-based organisational structure is complementary to high levels of ICT use.

The results showed a strong positive correlation between ICT investment in MIPs/LANs and more decentralised decision making; more subjective, team oriented incentives; and more human capital investments. Organisational design is closely associated with technical architecture; these are not independent factors.

The Implementation of ICT in Multinational Companies

Lennart **Grundberg** (IUI, Stockholm, Sweden) presented a study of the implementation of ICT in all Swedish multinational companies (MNC) based on ICT data and data on other MNC characteristics. The relationships between ICT use and firm size, industry characteristics, internationalisation and R&D were examined yielding results suggesting that large firms value ICT more than small firms although small firms invest relatively more in ICT. Traditional manufacturing industries have a low, and the chemicals industry a high, ICT investment share. A firm's internationalisation and R&D intensity also increase the ICT investment share.

Employment and Skill Linkages

Wendy **Hansen** (Industry Canada) presented findings on employment and skills linkage in the ICT sectors. In sectors where ICT is intensively used workers need a high innovative capacity and technical skills. It had been expected that the higher the educational attainment and skills level, the lower the level of unemployment would be. However, unemployment rates could not be explained by the level

of educational attainment alone and there was substantial variation in unemployment rates within fields of specialisation. Questions were raised about the need for post secondary skills and whether the skills of college and university graduates are being used to best advantage. The analysis suggested inefficient use of education insofar as clerical jobs are being occupied, to an increasing degree, by people with higher education.

It was noted that estimates of growth in the number of jobs in services and losses in manufacturing may be biased as a result of classification methods rather than actual differences in job creation, e.g. engineers move from occupations in Natural Science and Engineering in the manufacturing sector to Consulting Engineers under Business Services in the services sector.

Discussants:

Lars-Henrik **Röller** (Wissenschaftszentrum, Berlin, Germany) commented that Hausman's model was demand side oriented and linear and suggested the need to take account of network externalities, macro effects of new technology and the way technology affects both consumer and producer surpluses. With respect to Brynjolfsson's presentation, it was suggested that some of the results could be attributed to estimation methods and that instrumental variables might be incorporated to study adjustment costs by firms seeking gains from investment in ICT. He stressed the importance of assessing the costs of delaying negotiations to open markets in order to smooth the adjustment of firms. The importance of studying the kind of education system that firms need and the education supplied was emphasised in connection with Hansen's paper.

George **Sciadas** (Statistics Canada) commented that Hausman's work offered interesting estimates and favoured unconditional competition. The need to take account of changes in demand for existing goods when a new good enters the market was emphasised together with the need to consider time constraints on consumer purchasing behaviour. He noted that the changing intrinsic value of consumer surplus raised many new tax base issues and there was an increasing need to understand the impact of growing self-employment and the role of various insurance schemes. Grundberg's comprehensive data set was regarded as being helpful in the analysis of the relationship between MNC characteristics and the capacity to take advantage of investment in ICT.

Hili **Jeskanen-Sundström** (Statistics Finland) discussed developments in ICT statistics and presented data showing that higher education levels are associated with lower unemployment in Finland. She noted that developing statistics for the information society will be a long and difficult project needing a new repertoire of statistical tools and thinking.

Discussion:

Morris Teubal commented on the importance of case studies on the use of ICT and the creation of organisational capital which involves a collective learning process. He also emphasised the fact that the diffusion of ICT can have a market building effect especially in the software area which may be similar to Rosenberg's key sector processes. Rey suggested the need for a dynamic model to complement Hausman's results on the benefits of on-line services for different categories of suppliers and users. Onishi drew attention to the need to examine the outcome of ICT investment taking into account cross industry effects.

Session 4: Implications for Policy at National and Firm Level

Session 4 was concerned with the role of economic policy in the transition toward a global information society. Policy measures in the fields of industrial, technology, educational and competition policy were considered together with information on current best practice that will help governments to assist in preparing economic agents for a difficult and painful period of adjustment.

Technology Policy and the Organisation of R&D

Mihkel **Tombak** (Helsinki School of Economics, Finland) presented a study designed to examine how technology policy in the form of subsidising R&D and eliminating restrictions on research joint ventures affects the incentives of firms to invest in R&D in imperfectly competitive markets. A model was used to examine innovation under R&D competition and under co-operation. The results suggested that co-operative R&D yields lower research intensities in the absence of subsidies. The results also suggested that co-operation can produce larger socially optimal R&D intensities than competition, but that there is a high subsidy cost. Non-co-operative arrangements may be preferred by firms, thus reducing incentives to become involved in government sponsored technology R&D programmes. This creates a dilemma for government policy makers.

Horizontal Technology Policies

Morris **Teubal** (PREST, London, UK) introduced the concept of Horizontal Technology Policy (HTP) where the objective is to promote technological development and associated management and organisational routines irrespective of the industrial sector or technological area. Drawing on evolutionary economic theory, HTP is intended to promote innovation within a learning-to-innovative environment which involves collective learning, search and selection processes and market building. HTP enables learning-by-governments and provides a basis for the introduction of market friendly policies through a process of explicit policy design. This perspective on policy yields new insights on the factors which inhibit innovative behaviour and focuses on the learning process in contrast to traditional attempts to achieve greater understanding of market failures. HTP provides a framework for both market failure analysis and national strategic considerations.

Appropriability and Innovation Incentives

Olivier **Cadot** (INSEAD, Fontainebleau, France) focused on the barriers to imitation and the incentives to innovate. His model was intended to challenge the conventional wisdom which holds that more appropriability -- in the form of longer or wider patents - is conducive to greater innovation. This view is countered by regulatory policy where the assumption is that more competition is better for innovation. The presentation sought to clarify the conflicting roles of appropriability and the 'whip of competition' in the determination of the pace of innovation. Using a model in which successful innovative behaviour is certain, the incumbent's R&D intensity was compared with 'ease of entry' demonstrating that the relationship is non-monotone, i.e. easier entry may be associated with a faster pace of innovation. The policy implication follows that very long patents may not be beneficial.

Discussants

John **Panzar** (Northwestern University, US) observed that models separating R&D from other operational aspects of the firm may not reveal the possibilities for co-operative behaviour without collusion at one stage at least in principal, and not at another. He suggested that normative studies on the

behaviour of firms and the possibilities for innovation under different appropriability regimes would be needed. With respect to HTP he raised the question as to how it would be possible to evaluate the effectiveness of such a policy and to determine whether the public funds had been well spent.

Innchan **Lee** (KISDI, Korea) raised issues about the role of R&D subsidies and the incentives under certain regimes to seek to reap monopoly profits as a result of innovative behaviour. He also noted that it should be recognised that the identity of the incumbent firms changes frequently and that this should be taken into account in assessing the impact of changes in patent laws and other forms of intellectual property protection.

Kalevi **Kontinen** (Merita Bank, Finland) raised a number of questions about whether the research presented in the session was relevant, whether the assumptions were valid and about how to focus the research effort in the future. He noted that the drivers of success in the market include factors such as speed to market, accumulated investment in new product solutions to customer requirements -- not only the role of intellectual property protection. With respect to national technology policies he noted that there are three main strategies: i) public subsidies without asking how the funds are spent; ii) public subsidies targeting specific tasks and projects; and iii) public subsidies compensating those who succeed. The results might be very different if 'carrots' are given to laggard companies.

Discussion:

During the discussion, it was observed that intellectual property protection is vibrant within industries and has enhanced the prospects of firms such as IBM. Teubal commented on the degree to which HTP may be subject to political interference and noted that this issue concerns the characteristics of the policy subsystem in each country. He emphasised that the key issue was the stimulus that HTP can give to mobility between the public and private sectors. It was also stressed that there are significant interactions between competition policy and R&D subsidy policies. These need to be taken into account as new methodologies are developed for implementing technology policies.

Session 5: Wrap-up and the Needs for Future Research

This session was chaired by John **Dryden** (ICCP/OECD) and included the Rapporteur's summary together with summary comments by the chairmen of the earlier sessions.

Illmari **Pietarinen** (Ministry of Finance, Finland) presented an overview of the implications of the workshop proceedings for future economic and policy research.

Research Needs in Economics:

- improved comparability of data and statistical sources as a result of standardised definitions and classification of information society related phenomena;

- attention to the development of useful descriptions and classification of the labour market in terms of the changes accompanying the information society;

- studies of firm structure and organisation and the role of ICT in up-skilling and particularly of the nature of the causal relationships between these factors and unemployment;

- research on the need for a workforce with general competencies versus specialised skills and on the impact of ICT on the self-employed and the 'networked' worker;

- greater emphasis on the measurement of tacit knowledge and the transfer of knowledge embodied in people nationally and internationally, over the short and the long term and the structural effects on donor and recipient countries;

- research on methodologies for valuing information society assets -- intangible assets -- and the role of intellectual property protection;

- research on the impact of regulation and market liberalisation on the incentives of ICT suppliers and telecommunication operators to innovate and to compete effectively in the marketplace.

Interdisciplinary Research linking insights of economics with:

- sociology studies of the institutional character of unemployment and its long-term social and economic implications;

- educational studies of how the formal education system can become more flexible and adaptable to changes and the role of early childhood training in the effective use of ICT;

- historical studies of the lessons that can be drawn from the transitions which accompanied earlier waves of rapid technological change;

- legal and public administrative studies of the changing rules of the game and the institutions which are designed most effectively to respond.

The need for bilateral projects involving those who have access to, or generate data, and those with the research expertise to analyse its implications for economic, social and technology policy was stressed. Although there is a clear need for new research on the economics of the information society, there is also a need to consolidate the accumulated results of studies on issues of organisational change within the firm, firm and industry level transformations as well as those on macroeconomic changes accompanying innovation and the diffusion of ICTs. Consolidation is needed in order to develop a more coherent picture of the nature and broad societal implications of persistent unemployment. It is also needed to draw out generalizations which might provide lessons and guidance for countries within and outside the OECD area.

The need to ensure that the results of research are made available to those who can benefit from them was cited as a major challenge. This requires that results be presented in formats that are easily accessible to a wide variety of users and beneficiaries in the government, industry and the wider community.

Carl **Belding** (IBM Europe) observed that although the best economists had been assembled for the OECD series of workshops the contributions and insights remain a patchwork. He suggested that there is a strong case for a well-financed and managed programme of research which would be guided by industry, policy makers and academics. Priority issues for research might include: i) an emphasis on firm level data and studies complemented by macro statistical work. He suggested that one or two country

studies might be under taken, for example, of Finland and Sweden, both of which are active in 'future' industrial sectors, have a high penetration and use of ICT, sophisticated learning styles, a liberalised telecommunication environment and have recently undergone restructuring of the public and private sectors. A country such as Estonia which has skipped a generation of technologies and is not hindered by legacy systems might also be considered. ii) studies of the factors contributing to fear and uncertainty which haunt efforts to undergo transformations that are responsive to the information society including issues concerning union positions on telecommunications restructuring. iii) the role of competition policy and regulation in addressing issues which might otherwise lead to new regulatory regimes at the very time that de-regulation is needed. The analysis of the impact of competition law could benefit from economic analysis and improved theories applicable to the information society.

W. Edward **Steinmueller** (MERIT, Netherlands) suggested that there is a need for national statistical offices to move toward agreement on definitional problems and on the kinds of data that are needed. Their work is complemented by academic researchers who can mount only ad hoc data gathering exercises and their work is not supported by the stable interview staff that are available to national statistical offices. At present the collection of data is characterised by a patchwork of activities. A major priority is therefore to deepen understanding and to rethink what data we need to gather and how to organise the collection process to the benefit of statistical offices and researchers in the academic community.

A second priority is to deepen and extend analysis of organisational and technological change. An improved understanding of organisational change is one of the biggest elements in the 'death' of the productivity paradox. Organisational change is labour displacing, labour re-arranging, and labour transforming and there is no simple readjustment of jobs in the marketplace. There are no clear answers as to the nature of retraining that is needed and current programmes do not work insofar as they do not transform people. To date no clear formula has been developed for creating the scale of labour mobility that is suggested by the depth of transformation accompanying the information society.

Thirdly, dissatisfaction with the economy and society is serious and it will become worse. Instability and fear can only compound this over time as ICTs become more effective in application. This aspect needs to be the focus of research.

Fourthly, there is no place for complacency in the face of evidence of growth in consumer surplus as a result of the diffusion of ICT; attention also needs to be given to the impact of rising prices and market dominance. The role of ICTs in improving the quality of life must also receive attention. The growth of commercial ICT-based services is needed to generate tax revenues, to stimulate job creation, etc. However, public and educational services must be improved and extended and this focus should complement efforts to reduce public sector employment. An active policy of promoting diversity and a range of outcomes from which users can choose is necessary in order to avoid the lowest common denominator and to move toward higher returns on investment. Research is needed on what constitutes computer literacy for the information society and this must move beyond educational programmes which offer training in basic skills such as key-boarding.

Finally, work is needed to identify methods whereby best practice in the use of ICTs can be more widely disseminated in order to enable appropriate organisational change and the use of ICTs in ways that lead to productivity gains.

Pauli **Heikkilä** (TEKES, Finland) commented that we still do not know the full extent of what we are dealing with in terms of the extent of the changes which are likely to affect the workforces in OECD countries. There continues to be a need to improve our understanding. While the need for change is widely accepted, there continues to be a need to retrain and to consider the best ways to promote R&D and to ensure the protection of intellectual property via patents and other means.

John **Dryden** (ICCP/OECD) concluded the session by emphasising the need to map and measure transformations in the information society. This will require further development of statistics, indicators and measurement tools in order to enable the OECD to advise governments on rapidly changing major phenomena.

SPEECH SUMMARIES BY SPEAKERS

(Alphabetical order by names)

(Session 3)

THE IMPLEMENTATION OF IT IN MNC'S: AN EMPIRICAL ANALYSIS USING SWEDISH DATA

(Pontus Braunerhjelm and Lennart Grundberg, IUI, Stockholm)

Background

Over the last 30 years, IUI has collected and analyzed data from Swedish MNC's. The whole population of Swedish-owned MNC's has been studied on a regular basis at intervals of 4-5 years. As a special feature of the l994 survey, particular emphasis was put on the implementation and use of IT in firms. In this study we draw on this data with a view to investigate connections between IT use and other features of firm behaviour. The total survey collects data on a wide range of aspects of relevance to MNC's.

Details are given on single producing affiliates abroad and on trade patterns. Furthermore, areas such as R&D, market characteristics and composition of employment are included. In the part of the survey directly addressing IT implementation, firms are asked to give figures on costs and investments in the area of IT and telecommunications. Internal charging of these costs is also studied. The areas of IT importance in international co-ordination and in making way for a more efficient geographical spread of production are being dealt with through qualitative questions. In addition, we collect somewhat more technical details regarding types of applications used and how well extended they are within the company. The final aspect of IT use in the survey concerns geographical patterns of communication and the extent to which communication takes place on an external and internal level, respectively.

The study

Our general approach is to combine pure IT data with data on other aspects of MNC characteristics and investigate whether patterns may be detected. The study is of a descriptive nature with graphical illustrations and all data is taken from the IUI database. First, we examine connections between firm size and valuation of IT importance. We define firm size both in terms of total number of employees and in terms of total sales.

We then confront the results obtained by this qualitative measure with hard figures on what resources firms actually spend on IT. In this context we illustrate with different definitions of what constitutes IT costs and discuss suitable measures of IT-intensity. It would seem reasonable to assume that there exist differences between industries in respect of IT implementation. We explore this by dividing our material into 10 industries. Our hypothesis is that the more knowledge-intensive industries would display a higher degree of IT intensity. In a similar manner we search for connections between IT and international activity.

The idea is, again, that firms with a high degree of internationalization could prove to be more IT-intensive. Degree of internationalization is defined both in terms of employment abroad and in terms of sales abroad.

We study differences in levels of R&D-spending between firms. Do R&D-intensive groups seem to single out in their IT-intensity as well? Figures are given for the most commonly used applications. We track differences between the use of IT for internal and external communication. Regarding geographical direction of communication, we point to the areas with which Swedish MNC's seem to have the highest communication intensity. Connections are made with the geographical pattern in trade and production.

We conclude by comparing our results with those of other studies using other data. Finally, we also discuss other conceivable measures of IT use and how the survey questions may be consequently adjusted. Preliminary results in brief. We find that firm size matters in the sense that larger companies put higher value on IT. Furthermore, internal communication still seems a notably more common feature than external communication. More detailed results will be presented in a later version of this abstract.

(Session 3)

TECHNICAL PROGRESS AND CO-INVENTION IN COMPUTING AND IN THE USES OF COMPUTERS

(Timothy F. Bresnahan and Shane Greenstein, Stanford University)

In this paper we examine the diffusion of client/server computing systems to users of large scale computing systems, a group that places extremely high value on computing technology. We examine the development of the market for client/server and the features of competition between it and traditional large scale computing of the late 1980s, host-based mainframe computing. We provide broad quantitative evidence to bear on understanding the larger trends in competition between these two alternative platforms. We then examine detailed, user-based information about the adoption of client/server and the replacement of host-based systems between 1989 and 1994.

We argue that all these adoption patterns can be understood in terms of the costs faced by buyers when adjusting to the new client/server platform. These costs are high and tied closely to the idiosyncracies and complexity of the buyer's computing organization. The potential adopters with the most valuable computing use tend to also be those with the highest adjustment costs. Thus, the earliest adopters of computing systems also have the least valuable applications. We devote considerable effort to discussing and then rejecting competing hypotheses regarding this diffusion pattern. We reject simple theories of "lock-in", economies of scale, and easy substitution, emphasizing that the co-invention done by users makes new technology useful. The costs of adjusting to client/server also depend on whether market processes make this co-invention activity cheap or expensive.

(Session 3)

INFORMATION TECHNOLOGY AND ORGANIZATIONAL ARCHITECTURE: A FIRM-LEVEL ANALYSIS

(Professor Erik Brynjolfsson, Massachusetts Unstitute of Technology)

We examine the relationship between firms' IT investments and various organizational strategies such as delegation of decision-making, investments in human capital, and nature of incentive systems. We use firm-level data on several measures of IT capital stock for a nearly-balanced panel of about 750 firms for 1987-94 and match these data to data from other sources on ordinary capital, labor, sales, and using industry-level deflators in order to estimate a variety of production functions. In addition, we undertook a survey of human resources managers, and matched it to the input and output data described above. Our analysis suggests that firms that invest more heavily in IT are more likely to used team-based decision-making, invest in training and education, and use subjective types of incentive systems, even after for controlling for industry, work force composition, and prior levels of education and training. Furthermore, firms which both invest in IT and employ this type of organizational "system" appear to be more productive than firms that invest in IT but do not use the system, or vice-versa. One interpretation for the pattern we find is that this organizational structure is complementary to high-levels of IT use.

(Session 4)

BARRIERS TO IMITATION AND THE INCENTIVE TO INNOVATE

(Olivier Cadot, INSEAD, Steven A. Lippman, UCLA)

Information technologies are characterized by rapid technical change and equally rapid diffusion of advances. Although the analysis of technical change has been in recent decades one of the most thoroughly ploughed fields of economics, the relationship between imitative entry and the incentive to innovate still presents an interesting puzzle, as economic theory seems to be in phase neither with the business world's received ideas nor even with those of many government policies, both based on the idea that innovation is best promoted under the whip of competition.

Since the pioneering work of Nordhaus (1969), the economics of innovation has been predicated on the idea that a higher degree of appropriability of innovations enhances the incentive to innovate -- an idea that can be found exposed, if in a less formal way, in the works of Schumpeter and other Austrian school economists. In fact, this notion is at the root of the patent system, which imposes potential deadweight losses on society (as it allows inventors to exploit monopoly power) in exchange for providing incentives for continued innovation. Thus the problem of intellectual property rights reflects a basic trade-off between static losses and dynamic (incentive) gains. Building on this idea, most of the literature on patent design explores least-cost ways of providing adequate appropriability of inventive activity (i.e. of providing sufficient appropriability for a project with given costs and uncertain success to take place) using a variety of instruments -- typically patent length and breadth. For instance, Klemperer (1990) used a model of horizontal product differentiation to explore the trade-off between patent length and patent breadth when the return to the innovator is held fixed (so as to cover the cost of the innovation). In the same vein, Gilbert and Shapiro (1990) argued that as deadweight losses are a linear function of patent length but a convex function of patent breadth (measured by the original innovator's ability to raise price and profits), narrow but very long patents are socially optimal. Gallini (1992) explored a different problem, in which patent breadth affects the cost of producing noninfringing imitations. The imitator's problem is then to choose between waiting until the patent expires before entering, or entering with a (high-cost) noninfringing substitute right away, while the innovator's problem is to patent or not. She finds results that are in clear contrast to those of Gilbert and Shapiro.

Thus it can be said that the conventional wisdom -- namely, that more appropriability, be it in the form of longer or of wider patents, is conducive to more innovation -- has so far not been challenged. Yet, it would sound as an odd statement in the business community to say that competition is an unfavorable environment for innovative activity. Indeed, as noted by Lyon and Huang (1995), regulatory policy is often based on the assumption that more competition is better for innovation.[3] Is there a paradox here? The literature on innovation has long recognized that rivalry in a patent race is conducive to higher intensities of R&D (see for instance Grossman and Shapiro, 1987). But the -- quite distinct -- idea that an innovator's expectation of 'ex post' competition on the market for the innovation, in spite of the rent erosion that it implies, might still be conducive of a higher intensity of R&D, is not conventional. The present paper explores this issue, and seeks to clarify the conflicting roles of appropriability and the 'whip of competition' in the determination of the equilibrium pace of innovation. The analysis is carried out in a

simple framework where the innovator's R&D intensity is captured by the parameter of an exponential distribution driving the random arrival time of the research program's success. Thus success is certain, but its time is uncertain, which can be taken to characterize the product-development phase of an R&D program whose research phase has already been completed. We then explore the relationship between the incumbent's R&D intensity and the 'ease of entry' measured by the delay before the entrant is on the market, and show that the relationship is non monotone. In other words, easier entry may be associated with a faster pace of innovation.

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(Session 2)

A SHORT PRESENTATION OF THE JOINT PROJECT[4]

(Philippe Caille, Director at CESIA)

The question asked: does telematics (i.e. the alliance of new information and communication technologies which enables a remote delivery of services) tend to generate new jobs in Europe (or to retain or reconvert existing jobs) or, alternatively, does it foster job outflows towards low labour cost countries, for example to south-east Asia? Shouldn't we rather talk of nomadism in activities? What steps should European institutions and governments take to promote the development of non material activities in order to benefit from the job creation potentiality of telematics?

The answer is as follows: telematics is nurturing a true revolution in economies and lifestyles, just as the first industrial revolution did; economic strategies, together with conceptual frameworks and statistical frameworks should therefore be altered to provide us with the tools to think and measure economic variables.

What is new and original in this analysis?:

- it dissects the mechanisms whereby telematics-based jobs are created by showing how they originate from the fragmentation of the production processes of traditional goods and services with the incorporation of growing volumes of non material activities;

- it thus demonstrates the new operating rules of economies and of the new international division of labour;

- it draws the consequences of the functional integration of production at world level ("the global economy") and pinpoints its effects on how the global labour force is managed, widely evading the control of nation states;

- it shows that the incorporation of non material activities into traditional production processes has today a much stronger effect than the effect of so-called economic measures, such as large public projects, cuts in working hours or the multiplication of "neighbourhood" jobs;

- it explains why traditional conceptual frameworks have become unsuitable and how statistics are no longer able to give a fair account of major economic drivers, in particular transborder economic and job flows and the distribution of the added value in a good or a service.

A number of impacts of telematics in our modern economies may have been detected by economists, but they have not drawn all the consequences and have never, to our knowledge, shown them in an overall and consistent framework.

Telematics is analysed through three of its effects:

- The fragmentation of production processes resulting in the disconnection of decision centres and mere production units, which enterprises have become today.

- The decorrelation between trade flows, financial flows and job flows.

- The transfer of those activities which incorporate the highest added value towards the periphery of traditional production processes; as a consequence, a number of traditional or new producing activities (and occupations which are related to them), tend to be forced out of Europe because they concentrate less value added and are more or less automated, while new goods and services tend to generate new opportunities in Europe. In this context, it would be absolutely wrong to induce companies to outsource some of these new peripheral (but strategic) activities, on behalf of the necessity to concentrate on their core activity.

The consequences of these effects are immense and should lead to building new policies in a wide range of areas:

- economic policy;

- training policy;

- social policy;

- services of general interest;

- development of teleworking;

- labour laws;

- tax laws;

- attractiveness of regions;

- international relationships.

The methodology used by the group is based on a large number of monographs which can only provide signposts paving the way to a macro-economic understanding of drivers working on the non material and global economy. In this respect, statistics were of no help. The monographs resulted from the observations of individual cases which led the team around the world from Singapore to California, from Mauritius to Russia, but also from agribusiness to glass tiles, from telemarketing to medical telesecretariat.

Conclusions

Telematics is capable of creating many jobs on the condition that both enterprises and governments know how to harness the dematerialisation of economies and that governments and international institutions have the means to negotiate at world level. If Europe succeeds in the new industrial revolution, rather than being forced into it, it will be in a position to:

1. provide young qualified unemployed with expected jobs;

2. control existing jobs by upgrading them;

3. retain jobs in public services, via exports;

4. support the lifelong unemployed who cannot be reconverted and the socially excluded.

Will the activities thus created be able to greatly bring down European unemployment? Nobody can tell today. But what is certain is that if no wilful steps are taken to harvest the fruit of telematics, jobs will keep outflowing from a Europe which has turned uncompetitive, without the possibility of compensation by neighbourhood jobs. It is left to Europe to take up the challenge of reconversion, the challenge of employment and the challenge of the attractiveness of regions.

(Session 1)

THE EVOLUTION OF SKILLS IN OECD COUNTRIES AND THE ROLE OF TECHNOLOGY

(A. Colecchia and G. Papaconstantinou, OECD)

The aim of this paper is two-fold: to highlight stylised facts about recent trends in the skill distribution of employment and to analyse the role that technological change might have in explaining these dynamics. With respect to the first, the paper uses data on industrial employment broken down by occupation recently assembled by the OECD Secretariat in order to examine the changing skill composition of OECD economies, the occupational structure of industry and services industries, and the dynamics of upskilling. These data are then used in econometric work that explores the role of technology in explaining the changing skill mix.

Changes in the occupational distribution of employment give one measure of the changing skills structure of jobs. In most OECD countries during the 1980s, employment grew fastest in high-skilled jobs and slowest -- or declined -- in low-skilled jobs. Within the white collar group of occupations, high-skilled jobs have tended to show the fastest growth, followed by the white-collar low-skilled group. Blue-collar high-skilled jobs have declined in most countries, while blue-collar low-skilled ones show a more diverse picture by country. Despite these trends, the majority of occupations remain low-skilled ones (typically accounting for between two-thirds and three-quarters of the total, depending on the country), but the share of high-skilled occupations in the total is steadily rising in all countries.

While the tendency of white-collar and high-skilled jobs to replace blue-collar and low-skilled jobs is uniform across sectors in each country, a more careful examination reveals that the overall upskilling trend hides upskilling in the manufacturing sector, partly compensated by an increase in low-skilled workers in the services. The dynamics of employment shows an increasing polarisation: overall employment is dominated by white-collar high-skilled jobs and blue-collar low-skilled ones, while the blue-collar high-skilled category tends to disappear. Progressive upskilling among low-skilled workers in contracting sectors is thus more than compensated by substitution of high for low-skilled blue-collar jobs in the expanding sectors. At the same time, most of the shift away from unskilled and towards skilled employment has taken place within industries, rather than between them, a trend which is particularly pronounced in the manufacturing sector.

The role of technology in explaining upskilling trends is examined with the help of cross-sectoral regressions for 22 manufacturing industrial sectors in six of the G-7 countries (Canada excluded) in the 1980s. The results show a correlation between the relative position of each manufacturing sector with respect to the average and technology-related variables such as expenditure in R&D and growth rates in the number of patents. Moreover, human capital has accumulated faster in those sectors which were more intensive in the use of high skilled workers at the beginning of the 1980s. Localized economies of scale in production and/or localized increasing returns to human capital and relative innovation efforts can be used to explain these correlations which hold across industrialised countries.

The paper also presents some preliminary results concerning the impact of technology investment and diffusion on the employment of high skilled workers. The impact of R&D flows on the accumulation of human capital is examined through different channels, and a distinction is made between direct R&D expenditure and R&D diffusion through domestic and foreign spillovers. The role of diffusion of information technology in the manufacturing and service sectors on the accumulation of human capital is also examined through descriptive statistics and through a more structured framework.

(Session 1)

HUMAN CAPITAL AND FIRM ORGANISATION

(Gunnar Eliasson, The Royal Institute of Technology Reserach, Stockholm)

The bulk of resource use in a business organisation is devoted to various forms of competence intensive information processing (Eliasson 1990a) like R&D, product development, marketing, management etc. To understand firm behavior this information use and the building of requisite competencies have to become an explicit part of economic theory. This is not a matter of marginal and almost costless exchanges of asymmetrically distributed information, but of the allocation of tacit human embodied knowledge over internal (firm) and external labor markets and of team-based competence in the mergers and acquisitions (M&A) markets.

Addressing the problem of firm behavior in the *knowledge based information economy* (Eliasson 1990b), hence, means addressing the fundamentals of economic dynamics. And there is no better way of misunderstanding the dynamics of an economy populated with live firms and human beings embodying radically different endowments of knowledge capital, than beginning with the assumptions of received neo-classical economic theory. It is in fact rather embarrassing for the profession that students of such problems are referred to an intellectual construct that hardly even recognises the existence of firms. This paper addresses the role of knowledge in firm formation and performance and in economic growth and hence has to make theoretical room for a live and recognisable firm. Is this firm the minuscule computing and planning entity of received theory or the team of competent people that we see? If the latter a radically new theoretical structure exhibiting very different properties and policy implications will appear.

The small transparent state space upon which the entire neo-classical construction rests, and which is necessary to impose its static equilibrium properties, is utterly at variance with the dynamics of markets for competence. A small modification of this assumption is sufficient to push our analysis outside that theory, namely to replace it with a large, heterogeneous and non transparent state space; the *investment opportunity set*. In the new dimensions of the vastly expanded state space rational firms set up business experiments based on scant and biased information. Economic growth occurs through innovative entry, reorganisation and rationalisation among incumbent firms, and exit of low performers. In this non-linear environment of the experimentally organised economy dominated by selection mechanisms (Eliasson 1991) there is no way of obtaining a complete overview of the economy from any centralised position. Firms constantly commit errors and business failure becomes a standard cost for economic learning and development. Contrary to the advice of the static neo-classical model business mistakes should not be minimised. Contrary to the static neo-classical model a distinction is made between *uncertainty and risk* in the earlier tradition of Frank Knight (1921). Firms are seen as experts in organising themselves to convert uncertainty into subjectively calculable risks (Eliasson 1996).

The paper discusses the nature of firm knowledge creation and allocation in this theoretically new world, arrived at through modifying one fundamental assumption of the neo-classical model. And one fundamental conclusion from this analysis is that growth theory, to warrant the name, has to be based on an explicit foundation of firm behavior in dynamic markets.

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(Session 3)

INFORMATION AND COMMUNICATION TECHNOLOGIES: EMPLOYMENT AND SKILLS LINKAGE

(Wendy Hansen, Industry Canada)

Information and Computer Technologies (ICTs) provide potential for creating employment and changing the nature of employment and skills composition of the work force. With debate focussing on the impact of ICTs on employment, new tools are needed to measure and examine the linkages between ICTs and employment.

Key to industries that produce ICTs and industries that use ICTs are the innovative capacity and technical skills of their work forces. This brings more attention than ever before on the nature and composition of the work force. Using the OECD/EU Canberra manual on the "International Measurement of Human Resources in Science and Technology (HRST)" as a starting point, Canada is examining the skills base and transition of the work force in core ICT industries as well as other sectors in the economy to develop linkages between ICTs and employment.

The paper will present results of the analyses of the composition and transition of the skills base of the core ICT industries including Broadcasting, Telecommunications Carriers and Computer Services industries. It will use a HRST lens to focus on people with training in science and technology. For example, in Computer Services, statisitics show us that the field of specialization is a factor of the level of study. At the college level (ISCED 5), there are two main areas of training: engineering/applied sciences and technologies, and management/commerce. In contrast, at the university level, there is a broader range of specializations with mathematics/physical sciences leading the way; and significant representation of people with training in management/business administration and social sciences and engineering/applied sciences. The paper will also present the findings of the skills analyses of selected occupations within the sector(s) in an effort to develop linkages between occupation growth and skills transition.

(Session 3)

TELECOMMUNICATIONS: BUILDING THE INFRASTRUCTURE FOR VALUE CREATION

(Jerry Hausman, MIT)

Information service demand has grown by about 20 per cent per year over the last decade. Connections to the Internet have grown by about 10-20 per cent per month over the last 5 years. We are in the midst of "Internet mania" in which companies scramble to offer new services on the Internet, and stocks of companies which offer Internet products and services have increased by 200-500 per cent during 1995. Online service providers such as Prodigy, Compuserve and America Online are being joined by AT&T, MCI, and Microsoft in offering Internet access services. Software companies are offering products which permit easier use of the Worldwide Web (WWW). Thus both consumer demand and competition will continue to increase rapidly in the online service industry.

However, the vast majority of the service offerings have been limited by the copper wire pair which limits the bandwidth of service offerings to residential customers. This technology, in use in the US telephone networks since at least the 1920s, makes content beyond text extremely slow to transmit and receive. An existing technology, ISDN over copper, increases bandwidth but still imposes a significant bandwidth limitation on multimedia content. Thus, multimedia offerings typically are supplied on CD ROMs. Use of CD ROMs has grown exponentially; CD ROM drives are now included as standard equipment on the majority of desktop PCs.

In considering the infrastructure for value creation in online multimedia offerings, I first use economic analysis to demonstrate how to estimate the overall value to consumers and to the economy. The investment in the infrastructure for multimedia will cost hundreds of billions of dollars; is the value to consumers and the economy large enough to justify this expenditure? I find the answer to be yes as a single new successful service, voice messaging, has led to increased value to the economy of about $ 6 billion per year, and I estimate the value of online services to be in the range of $ 10-25 billion per year.

I next turn to the question of who is likely to build the infrastructure to provide broadband capacity so that multimedia content can be provided online. I find that the local telephone companies and the cable companies are the likely providers. However, government regulation is creating significant delays in building the needed infrastructure. This outmoded regulation must be eliminated or multimedia services are likely to be delayed in the US for many years.

Lastly, I consider who is likely to capture the value from the emerging online industry. I find that by far the largest amount of value will be captured by consumers and business users of these new services. This result is not surprising to an economist, but it seems to be missed in much of the public policy debate. Among service providers, I expect that the software providers and content providers are likely to be the most successful in capturing the (quasi) rents from online services. The equipment providers and transmission providers will face increased competition which will not allow them to gain

large rents. However, the outcome that consumers will benefit the most should not be lost among the public debate and charges of "unfair competition" from competitors who are trying to gain competitive advantage through government regulation, rather than producing a superior product or service. The market has been successful to date in providing these consumer benefits. Government regulation should be used only at minimum levels so that market competition can allow consumers and business to benefit from the dynamic technology in information services.

(Session 2)

TECHNOLOGY REGIMES AND THE DISTRIBUTION OF REAL WAGES

(George E. Johnson and Frank P. Stafford, University of Michigan)

Introduction

In the United States the early Postwar period marked the end of an era when jobs involving less skill gained in importance. In our interpretation the resulting wage compression was the outcome of an era when the market organizations increasingly applied Scientific Management (SM). Under this technology the main thrust was to simplify work tasks through extensive division of labor in the workplace. We hypothesize that from approximately the early 1960s on to today, there was a rise in the importance of technology in economic life, both in market and in non-market activity. Suppose this new technology regime augmented the capacity of skilled workers to carry out a wide array of tasks while being of much less advantage to less skilled workers. How would this skill-biased technical change (Bound and Johnson, 1992) shape the distribution of wages between skilled and non-skilled workers? If the technology favored the skilled in the non-market sector as well, how would this affect their well-being, beyond the apparent effects on market wages?

In this paper we present some stylized facts about changing technology and wages over the period 1965-1995. We then set out a model of skill-biased technical change which has strong similarities to our earlier work (Johnson and Stafford, 1992, 1993) and other recent work on the effect of technology changes and spillovoers in a general equilibrium open-econmy context (Gomory, 1994; Gomory and Baumol, 1996; Johnson and Stafford, 1996). That work studies the effect of industry-specific technology improvement by one of two trading partners when both countries are active in the industry. A central and robust finding is that technology improvement by the one country can raise the real wage there, partly at the expense of the laggard country, which experiences a declining real wage.

In this paper the approach is redirected to a closed economy setting where we address the following circumstance: skilled individuals and less-skilled individuals are potentially in the same type of competition as the separate countries are in the trade models. If one group avails itself of a new technology which improves its productivity in market sectors in which both are active, results similar to the open economy model are obtained. To illustrate, skilled workers, via the computer and more broadly, information technology (IT), have improved their ability to produce (more of) products previously producecd by less skilled workers. This will act to lower the real wage of the less-skilled. On the other hand if IT improved the ability of skilled workers to produce products which have been their traditional niche, both skilled and unskilled workers would benefit. In this environment the apparant demand for skilled workers, as indicated by a rising real wage, will not readily be subject to downward pressure via an increased supply.

The paper begins with a brief review of the earlier models as they apply to the open economy. We first adapt the model to a closed economy with two labor groups as the separate producers. Here we extend the model, leading to a second theme. Suppose one of the goods is a luxury good: good A could

include professional services which are subject to less technical progress as in unbalanced growth models or what we call the Keynes-Baumol "prosperity" model wherein slow real wage growth is caused by rising wealth, which leads to a consumer demand shift toward professional services. Because these services are subject to slower productivity growth, real wage growth will slow. In this way, economic success leads to a larger A good sector and slower wage growth, a form of self-limiting growth. A third theme centers on what we call the Lindbeck government expansion model. This highlights the impact of public financing of subsidies to the consumption of the particular sectors. From our observation it appears that subsidies are often directed toward the slower productivity growth sectors. This accentuates the tendency toward the income elastic goods in the second model and can speed the decline of the other goods. There is, however, a force toward the other goods if the public sector is inefficient: declining income induces a shift back toward the unsubsidized sector. The third section offers preliminary evidence on real wage and well-being effects and how our approach can be used to interpret the rather puzzling slowdown in the growth of real wages and increased wage dispersion in the United States over the last 25 years.

(Session 2)

VIRTUAL PATENT EXTENSION BY CANNIBALIZATION

(Morton I. Kamien, Northwestern University
Israel Zang, Faculty of Management, Tel Aviv University)

Ever since the initial granting of patents by the Republic of Venice in 1474, patents have served to provide a property right to new information in return for its public disclosure. Recently, ingenious new strategies are being introduced by patentees to extend their patents' virtual life. In this paper we analyze one such new strategy that has been introduced after the Drug Price Competition and Patent Restoration Act of 1984, also known as the Waxman-Hatch Act, was enacted by the U.S. Congress. The act favored developers of patentable drugs by extending a patent's life to partially offset, up to five years, the marketing delay imposed by the Food and Drug Administration's approval process. However, this good news was tempered by the bad news that marketing approval of generic substitutes for drugs coming off patent would also be accelerated. Thus, the time lag during which a patentee could maintain a monopoly position beyond its patent's expiration, while the suppliers of generic substitutes were having their products approved, was shortened. Ever seeking to accentuate the positive and eliminate the negative, the patentable drug developers embarked on a new strategy of exercising their unique ability to market a generic version of a drug prior to its patent's expiration. The intended purpose of the strategy is to prolong the manufacturer's monopolization of the drug, in the brand and generic versions, by preempting competition from rivals who can only provide a generic substitute after the patent's expiration. It has met with substantial success, according to *Business Week* (Sept. 5, 1994, pp. 67-68).

However, from a purely economic standpoint, the question this action poses is whether it results in an increase or decrease in total economic welfare, as measured by consumer surplus plus producer surplus. To this end we compare two scenarios. The first encompasses the traditional vision of the manufacturer producing only the patented drug prior to the patent's expiration and facing unlimited competition from generic substitutes thereafter. This competition supposedly forces the price of the brand name product to decline, possibly to its marginal cost of production. It is this scenario that serves as the standard of comparison for the other scenario. In the second scenario the patentee introduces a generic product prior to the patent's expiration and thereby cannibalizes some of his brand name product sales. However, this early sacrifice enables him to secure a Stackleberg leadership position in the generic product after the patent expires.

The equilibrium results in the scenarios described are remarkably consistent with empirical findings that the price of the brand name product often rises after the generic substitute has been introduced. Indeed, our analysis suggests circumstances under which this should occur and when it should not in terms of the number of competitors in the generic product market and the degree to which the generic product is perceived to be an inferior substitute for the brand name product. The overall welfare effect of the patentable drug manufacturers' effort to prolong their monopoly power beyond the patent's life by preempting the introduction of a generic substitute is inconclusive in general. It would depend on the specifics of the situation.

(Session 2)

NETWORK COMPETITION

(P. Rey, J.J. Laffont & J. Tirole, University of Toulouse & IDEI)

We investigate the prediction of many observers that, as network competition develops in the telecommunications industry, regulation will give way to competition policy. More precisely, we study how, in an unregulated environment, access pricing rules will be established between competing networks which are interconnected, and analyse the welfare effects of this decentralization in the choice of access pricing rules. We summarize here the findings, successively for the mature and unmature phases of network competition.

1. The Mature Phase of Network Competition

We consider two networks with full coverage and isotropic calling patterns: any consumer can be connected to any network by incurring a fixed (connection) cost, and has then an equal chance of calling a given consumer belonging to his network or another given consumer belonging to the rival network.

The isotropic calling pattern assumption implies, that, for equal prices, flows in and out of a network are balanced -- even if market shares are not. Of course, the actual inflow/outflow balance depends on the prices charged by the networks. In our model, a network charging a lower price than its rival generates more calls and its outflow exceeds its inflow. Networks differ only by their quality characteristics à la Hotelling.

First, we consider reciprocal access pricing rules and examine price competition for a given common access price. This price competition can take different forms: uniform linear prices, non linear prices or discriminating prices for which a consumer calling a member of the same network pays a different price than when calling a member of the competing network.

1.1 Uniform Price Competition

The first main result is that existence of an equilibrium in prices requires the access charge and/or the substitutability of the two networks not to be too high. The non existence for high access charges and high substitution is not a mere technical problem, but a robust economic problem. A large access charge inflates the final price in any shared market equilibrium. But when prices are very high and the goods are close substitutes, each network has an incentive to undercut its rival to corner the market. On the other hand, a cornered market configuration cannot be an equilibrium either, since either one network makes a positive profit, and the other could then mimic it and obtain half of this profit, or no network makes a profit, and then, if the access charge is very high, a network could obtain positive profit by raising its price and generating access revenue. This result points at a potential instability of price competition.

The second main result is that the access charge is an instrument of tacit collusion: the equilibrium price increases with the access charge and there is an access charge (decreasing with the fixed cost of connection and increasing with the substitutability of the networks) which induces the monopoly price as a “competitive” equilibrium. In contrast, the access price which would induce Ramsey prices is smaller than the marginal cost of access.

1.2 Competition in Two-Part Tariffs

The tension between excessive marginal prices implied by high access charges and the temptation of undercutting remains in competition with two-part tariffs, leading again to the inexistence of a competitive equilibrium for high access charges and high substitutability.

In contrast with the case of linear prices, however, the equilibrium profit is independent of the access charge. The increase in the access fee leads to an increase in the usage fee and makes it more desirable for networks to build market share. In the uniform pricing case, building market share magnifies the access deficit. There is no such countervailing incentive with two-part tariffs, as a decrease in the fixed fee enables network to build market share without generating an access deficit. While equilibrium profits need not be lower than under uniform pricing because of the enhanced ability to capture consumer surplus through the fixed fee, the industry is more competitive than under uniform pricing. The operators do not gain any more from high access charges, and the policy of pricing at marginal cost is now rather compelling and not resisted by operators (on the other hand, a non-cooperative determination of access charges fails to yield the socially preferable outcome).

Of course, all the traditional reasons which make non-linear prices difficult to design efficiently (incomplete information on consumers' tastes, negative redistributional effects of fixed fees), to the extent that they cannot be overcome by menus of tariffs, are likely to restore partially the tacit collusion effect of high access charges.

1.3 Price Discrimination Based on Call Termination

When we allow networks for on-net prices different from off-net prices, the non existence problem for high access charges and high substitutability remains. A proportionality rule holds, according to which the ratio of off-net to on-net prices is proportional to the mark up of the access price over the marginal cost of access.

The on-net price decreases with substitutability but, surprisingly, decreases with the access price, with the possibility that a local increase of the access charge may reduce profit.

The wedge between on-net and off-net prices is detrimental to consumption efficiency, but may intensify competition with ambiguous welfare effects. In particular, if the networks are poor substitutes, social welfare is higher under price discrimination than under uniform pricing. Also, price discrimination lowers the average price for small markups.

When we extend price discrimination to non-linear tariffs, the presence of a mark-up or discount for the access charge imposes a cost (due to the wedge it creates between on-net and off-net marginal prices equal to perceived marginal costs) which is entirely born by the industry. We would therefore then expect networks to agree on a reciprocal access price equal to marginal cost.

We have assumed so far that access charges were reciprocal and set by agreement between networks. If they are determined non cooperatively -- in the case of uniform pricing -- a double marginalization takes place. The double marginalization is maximal when the networks do not compete for market share. As substitution increases, competition for customers exerts a downward pressure on the retail price, but competition may also induce networks to jack their access price up in order to force their rival to raise its retail price and lose market share. Even though the result on the access charge of a higher substitutability is ambiguous, the double marginalization problem is alleviated by a higher substitutability, since the retail price decreases.

Finally, we examine the implications of the efficient component pricing rule (ECPR) when networks contract on a reciprocal access price and compete in retail prices subject to ECPR, and also when the networks choose simultaneously and non cooperatively access and retail prices subject to ECPR. First, we show that ECPR has no obvious interpretation. We must distinguish between the imputation approach and the opportunity cost approach, between a marginal cost ECPR rule and an average cost ECPR rule. The general tenet of our results is that ECPR softens price competition. In the case of an *ex ante* agreement, a high access charge is under ECPR a commitment to charge a high retail price. In the case of a non cooperative simultaneous determination, a network cannot undercut and gain market share without providing its competitor with a windfall gain on access.

2. Entry in Network Competition

We finally examine the setting of access charges in the entry process when the incumbent network has full coverage and the entrant chooses its coverage and incurs an investment cost increasing in the coverage.

If the incumbent cannot discriminate between its monopoly territory and the competitive territory, provided the access charge is close to the marginal cost of access, the entrant undercuts the incumbent; it therefore generates more outflow per customer than its rival and incurs an access deficit. Furthermore, the entrant underinvests in coverage in order to soften competition. So, if a reciprocal access price is mandated, the entrant may not be handicapped by its smaller coverage and it may even elect to maintain a small coverage for strategic reasons.

The picture is quite different if interconnection is freely negotiated. As long as the entrant's coverage is small, the incumbent can corner the market at a profitable price, maybe at a monopoly price. Then, the incumbent will try to delay indefinitely the interconnection agreement. The entrant has an incentive to overinvest in coverage to reduce the incumbent pre-agreement profit and reach a better deal.

With price discrimination, the use of access charges to blockade entry is even easier for the incumbent. The incumbent can charge a very high off-net price without raising its on-net price beyond the monopoly price. A high access charge has basically the same impact as a lack of interconnection.

The setting of access charge by an incumbent firm appears as powerful instrument to blockade entry as long as entrants cannot quickly achieve a high coverage of the market.

(Session 4)

TECHNOLOGY POLICIES (HTPs)

(Morris Teubal, The Hebrew University of Jerusalem)

HTP is a category of technological policies whose objective is to promote technological development *per se*, and associated management and organizational routines, irrespective of industrial branch or technological area. It is in principle applicable to various types of such activity, such as enterprise R&D; technology transfer, absorption and diffusion; and even technological infrastructure ('Socially Desirable Technological Activities'). This paper presents a conceptual framework for such policies which make use of the tenets of evolutionary theory and policy developed by Nelson & Winter, Metcalfe and others. The analysis is conducted within a learning-to-innovate framework with emphasis on collective learning, search and market building. The central outcome is a Technology Policy Cycle with distinct Infant, Growth and Mature Phases which largely mirrors the standard Product Life Cycle. In this context, proactive "generation" of a critical mass of projects for efficient learning and diffusion of innovation routines becomes the aim of the Infant Phase which, in addition -- due to uncertainty and ignorance of policy makers -- also involves largely neutral incentives. In contrast, the dynamics of learning-to-undertake technological activity on the part of enterprises together with enhanced Government Agency capability, lead to a Mature Policy Phase which focuses on policy restructuring with greater selectivity in incentives. This will usually involve drastic reductions in the support of routine technological development projects and enhanced support both of more complex projects and new types of technological activity. The policy framework assigns specific roles both to market failure analysis and to national strategic considerations. HTPs are market friendly with an emphasis on 'policy design' and on the complementary non-market policy mechanism in charge both of this function and of policy implementation. It is intended to be applicable to both Advanced and Newly Industrialized countries.

(Session 4)

ABSTRACT

(Mihkel Tombak, Helsinki School of Economics
Rune Stenbacka, University of Helsinki)

In this study we examine how technology policy in the form of subsidizing R&D and eliminating restrictions on research joint ventures (RJVs) affects the incentives of firms to invest in R&D in imperfectly competitive markets. We model innovation under R&D competition and under RJVs. We find that RJVs yield lower research intensities in the absence of subsidies. In the presence of optimal subsidy policy higher expected welfare is obtained with RJVs, but the optimal policy may also involve a more costly subsidy program. The analysis also identifies possible difficulties in implementing socially optimal policies arising from conflicting private incentives.

(Session 1)

THE ROLE OF HUMAN RESOURCES FOR REGIONAL DEVELOPMENT IN THE INFORMATION ERA: THE CASE OF PERIPHERAL REGIONS

(Xavier Vence Deza, University of Santiago de Compostela
Isabel Diéguez Castrillón, University of Vigo)

This paper is focused on analysing the new requirements in human resources for peripheral regions. The new qualifications required by structural change and the emergence of the information society tests the adaptive capability of regions and workers. Differences on competitive arises from there.

This paper tries to analyze the relationship between disparities in regional economic growth in Spain and its differences in the structure of qualifications and educational levels of workers and employees.

In this context, our work is to explain the relationship between economic development and education level of human capital. We study the example of Spain. We analyze the mobility of human resources between different Spanish regions and specifically the flow of human resources from one region considered objective 1, Calicia, that is characterized for its low economic development potential. This region is the perfect candidate to be one example of migratory movements from less favoured regions to developed regions.

THE GROWTH OF INFORMATION WORKERS IN THE U.S. ECONOMY, 1950-1993: THE ROLE OF TECHNOLOGICAL CHANGE, COMPUTERIZATION, AND STRUCTURAL CHANGE

(Edward N. Wolff, New-York University)

Fritz Machlup's classic 1962 book, The Production and Distribution of Knowledge in the United States, found that with the growth of clerical occupations at the turn of the century, "the ascendancy of knowledge-producing occupations has been an uninterrupted process... a movement from manual to mental, and from less to more highly trained labor" (p. 396-7). This paper updates information on the growth of information workers in the US and analyses the sources of their growth.

The paper is divided into three parts. The first updates the statistics on the composition of the workforce between information and non-information jobs to 1993. Particular interest in focused on the post-1980 period, which has seen a tremendous growth in the use of computers in production and which Freeman (1987) and others have termed a new "techno-economic paradigm," based on computer-driven information technology. For this analysis, I rely on the US Decennial Censuses of 1950, 1960, 1970, 1980, and 1990. In the calculations, the row figures in the Census tables of occupations-by-industry are first aggregated, in conformity with an internally consistent classification scheme, into 267 occupations and 64 industries (see Howell and Wolff, 1991, for details). The occupations are then aggregated once more into four categories: (i) knowledge production; (ii) data processing; (iii) supply of services; and (iv) goods production. I find that information workers increased from about 38 per cent of the workforce in 1950 to 57 per cent in 1990. Interestingly, the rate of increase, particularly for knowledge-producing workers, accelerated during the 1970s.

The second part uses a decomposition analysis to break down the changes in the information workers' share of the labor force into three parts: (i) the input substitution of information labor for labor of other types within the production process, i.e. the change in the proportion of information workers in each industry's labor force; (ii) the change in each industry's share of the economy's total output; and (iii) the change associated with relative variations in labor productivity of the different industries.

The first of these three components can be interpreted to indicate the extent to which the composition of the labor force in a typical industry has become more information-intensive (assuming all other things remain the same). The second element in our breakdown, output composition, relates to different industries' shares of the economy's total output and is pertinent in determining the extent to which the expansion in information-related employment is attributable to an increase in the economy's demand for products with a high information content. Finally, the productivity-growth component in our breakdown plays the part in testing the role of unbalanced growth in the information explosion -- that is, the extent to which growth of entire information workers can be attributed to relatively higher productivity growth in industries using less information. I find that the growth in information workers was driven not by a shift in tastes toward information-intensive goods and services (as measured by the composition of final demand) but rather by a combination of the substitution of information workers for goods and service workers within the structure of production of industries and by the unbalanced growth effect.

The third part relies on econometric analysis to analyse the sources of growth of information workers on the industry level. The dependent variables are the changes in knowledge, data, and total information workers as a percentage of total employment in the industry over the period. I use five measures of technological activity: (1) average annual rate of total factor productivity growth (TFP growth), (2) investment in office, computer and accounting machinery over the previous 7 years per full-time employee FTEE (OCA/FTEE); (3) ratio of expenditures on research and development to industry sales (R&D/Sales); (4) the ratio of computer programmers, computer systems analysts, computer specialists, n.e.c., and engineers to FTEE (CSE/FTEE); and (5) new investment in equipment per FTEE (EQUIP/FTEE), which may be interpreted as an indicator of the rate at which new vintages of capital are introduced into the industry.

A number of structural and organisational dimensions of production may have independent effects on the demand for information workers. These include: (i) the share of employees in an industry covered by union contracts (%UNION); (ii) the share of employees working in large establishments (defined here as those with 500 or more employees); (iii) industry employment growth; and (iv) a dummy variable distinguishing goods from service industries.

International competitiveness, as measured by the ratio of imports to industry gross output (IMP/GDO) and the ratio of exports to industry gross output (EXP/GDO), may also affect the rate of growth of information employment. Industries competing against imports and those competing in international product markets may be forced to recruit relatively more information workers (particularly, knowledge workers) in order to remain competitive.

Technological change, as measured by the growth in total factor productivity, has a negative effect on the employment of information workers. On the other hand, the pace of new investment as reflected in the growth in the capital-labor ratio, R&D intensity, and the rate of computerisation -- has a positive relation to the change in information employment. Unionisation has a negative effect on information employment, While import penetration does not seem to affect information employment, export-oriented industries appear to increase their share of information workers more rapidly than domestically-oriented industries.

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DISCUSSION COMMENTS BY DISCUSSANTS[5]

(Session 2)

COMMENTS ON SPEECHES

(John Beath, University of St. Andrews, Scotland)

Although I should like to comment on all four presentations, my detailed comments will be on the paper by Morton Kamien. However, let me start first of all with Philippe Caille's paper on Telematics and Employment. I agree with him that the growth in the phenomenon of teleworking has important implications for some forms of employment in Europe, though I have to wonder how far it will go. There is clearly the possibility that clerical forms of work will be exported to less developed countries and that secretarial jobs in Europe may be at risk. Certainly the information revolution is likely to change the way that many of us work. Only last week I attended a seminar on Wide Area Networks and discovered that it was now possible for me to sit in my own office and lead an interactive seminar with at least two groups of students, each quite some distance away. A possible implication of this, which might mean unemployed UK academics, is that the major US graduate schools could be teaching European students in Europe from their desks in the USA and so extending the market for US graduate education. Of course as a general development this would serve to enhance the productivity of Frank Stafford's skilled group, the group whose productivity had to increase to ensure that average real wages would continue to grow. Since it is from the taxes of the employed that we find the income transfers to the unemployed, such average real wage growth is critical. An interesting issue that was not explored was the issue of quality. The decentralised system that the information society seems to be suggesting involves a more complex system of organisation of production. Quality of input in the global market cannot be so easily monitored as it can be in the local market and there are serious moral hazard issues that need to be addressed. It is these that seem likely to place limits on the extent of decentralisation. I am reminded of the case of the English textile industry in the eighteenth century. The traditional system of "putting out" work to handloom weavers was discarded in favour of the factory system since this allowed the quality of the input to be monitored and controlled. Santayana reminded us that history repeats itself and maybe there is a lesson to be learned here.

A central concern in Patrick Rey's presentation was the effect that access rules had on entry. His result that free negotiation, asymmetric access pricing and price discrimination all served to block entry brought to mind the history of British Telecom (BT) and Mercury in the UK telecoms market. BT was the incumbent and was a universal provider prior to privatisation. It operated practised both price discrimination and two-part tariffs. Mercury was licensed to be an alternative provider of telecoms. BT employed asymmetric access charging and, within a couple of years, Mercury started to withdraw from the residential market and removed all its high street phone booths, and now concentrates on servicing a relatively small number of corporate customers.

The paper by Kamien and Zang is about pre-emptive competition and there are two particular issues of interest for policy makers.

1. Does the market system encourage firms who currently hold a patent to engage in behaviour that limits the amount of competition in the post-patent market? In other words, what is the likely outcome of market forces?

2. Given this, how does it affect the well-being of consumers?

The issue is neatly analysed by using a two-period model of the drug industry. The firm that holds the patent in period 1 can follow one of two strategies:

- The "classic" case of the simple generic in which there is a first-period patent monopoly followed by symmetric competition between the incumbent and new entrants in the post-patent market (C).

- The "Stackelberg" case of the pre-emptive generic where the incumbent cannibalises some of his patent profits in order to pre-empt later competitive pressure in the generic market (S).

A crucial parameter in the model is the degree of substitutability (γ) between the branded and generic drugs. If it is zero the branded good is perfectly protected, if it is one the two goods are perfect substitutes.

Comment: γ is potentially a choice variable and a strategy not considered in the paper might be to sink costs in reducing it. If this were followed what would happen is that when the generic was produced, consumers could be persuaded that the generic was such an inferior good to the branded good that the incumbent's market power in the branded market might be little affected.

Comment: potentially important in this discussion is the issue of discounting the future since cannibalisation involves forgoing current profits in order to protect future profits. If the future were heavily discounted the firm might be quite unwilling to engage in this.

Let me turn to the first question on whether the market always provides an incentive for the incumbent to pre-empt by early introduction of a generic, the analysis suggests that indeed this is a dominant strategy. The paper's results reveal that *industry* profits under S are *higher* than industry profits under C, for any given *n*. Formally this can be written as:

$$\Pi_1^S + \Pi_2^L + n\Pi_2^F > \Pi_1^C + (n+1)\Pi_2^C$$
$$\therefore \left(\Pi_1^S + \Pi_2^L\right) > \left(\Pi_1^C + \Pi_2^C\right) + n\left(\Pi_2^C - \Pi_2^F\right).$$

But since the last term in brackets is positive, it follows that S is a dominant strategy.

Comment: I just note in passing that n is assumed to be the same in both scenarios (and so is exogenous). However entry will be endogenous and determined by the appropriate zero-profit condition. (The condition should ensure that $n^C > n^S$.)

Given that the market equilibrium will be the pre-emption one, we can now ask the second policy question: are consumers better or worse off? One can see intuitively that this is likely to be uncertain. The benefits of the earlier introduction of a genetic alternative need to be weighed against the later costs of asymmetric oligopoly.

In period 1 the lower priced generic alternative is available and we have

$$p_B^S > p_B^C = p_G^C > p_G^S,$$
$$\therefore CS_1(S) > CS_1(C),$$

and consumers are better off because of this and enjoy greater consumer surplus (CS).

It is in period 2 where we have difficulties. The price of the generic alternative depends on the *total* output of the drug. So the question is now which scenario gives the greater output, S or C?

The first point is that for *some n* there is a $\gamma\ (=\gamma^*)$ such that :

$\gamma < \gamma^*, G^S > G^C; \gamma > \gamma^*, G^S < G^C$. In the first case $p_G^S < p_G^C$; in the second case $p_G^S > p_G^C$. It is in the second case that consumers lose for the price of the generic is higher.

The critical level of γ is decreasing in *n*. So there is a sense that, given the degree of substitutability, the more entry there is the more likely it is that consumers will lose.

Thus we cannot be sure if the first period benefits to consumers under S are sufficient to offset the possible losses in the second period. Again discounting will be crucial here. But the outcome also depends on γ^*. Policy might help by raising γ^*, that is by informing consumers. This is very much along the lines of what consumer user groups already do.

(Session 2)

EMERGING TRANSFORMATION OF INDUSTRY IN THE GLOBAL INFORMATION SOCIETY

(Olof Gärdin, Eurostat)

The starting point for this session is the observation that as use of ICTs becomes more and more intensive, firms are transforming their activities. New activities are now either blurring the existing industrial classifications, or establishing new relationships among industries. The fabric of industrial activities will be undergoing major changes.

The ”Big Bang” of the ICTs will result in tremendous modifications of industrial structure in the near future. The actors, the means and the purposes will be heavily modified. This will affect considerably the ways and means of services provisions, their market structure and competition.

The industrialisation process based on technological development was partly a process of specialisation and division of labour, i.e. building new networks and partly the creation of new products and services made possible because of new technology.

The process of turning the industrial society into the information society can be described in the same words but in spite of that the economy of the information society is not quite understood.

Our understanding of the economy and the changes and developments, the way we describe it and how we formulate the problems are dependent on the concepts and theories we use and are used to.

The production in the Industrial society is stationary and the products immaterial. In the Information society and the networked economy the production is mobile and the products immaterial.

The information society will be realised via social and economic networks using telecommunications networks or infrastructure.

The problem when using statistics to try to understand the networked economy and the transformation into the information society is that economic statistics are based on concepts, definitions and theories whose frame of reference is the industrial society and economy.

The statistical tools at our disposal today, such as activity and product nomenclatures or registers and statistical units, are not any more adequate for investigating the economy of the information society because they have been developed to serve national purposes in a manufacture based economy.

The consequences of the gradual international integration or globalisation of markets and the increasing presence of multinational corporations and the externalisation of services production is that production no more is a national concept.

The national accounts are at the center of the information used for describing and analysing the economy. But national accounts are not sufficient for the accounts for the global information society.

To understand and analyse the information society we must be able to describe it -- its development and the different elements and their relations.

The figure below is a try to illustrate my notion of an overall frame of reference for what we are talking about in this workshop.

Persons Enterprises Authorities Organisations	**Social** professions socio-economic groups **Economic** Industries	**Networks** Local Regional National European Global
Production and trade with ICT-goods and -services ICT-industries ICT-professions Employment	**Telecommunications** Infrastructure Telecom services	**Use of ICT-goods and -services** All industries All professions Employment Socio-economic groups Applications
Development factors R&D, Innovations, Technology transfer, Penetration Education, Training, Competence Attitudes Legal and institutional environment		
have effects on **GDP, Employment, Competitiveness, Economic growth** and have **Organisational, Social, Cultural and Environmental consequences**		

The transformation of industry in the global information society is in my illustration shown in the upper case -- the social and economic networks -- and the overall politically relevant issues are indicated in the lower shaded part. Between these two shaded areas are the elements that in this description model link the networks with the economic and societal impacts.

To improve the statistical description of the information society a number of measures to develop the statistical tools and the statistical system need to be taken. They include:

- We need to improve our ability to describe the new ways of organising production, the new interrelationships between enterprises and other organisations and the news of interaction.

- The borders between enterprises and other units of production are increasingly blurred and it is becoming more and more difficult to distribute the value added on the national and global market.

- So we need to develop a taxonomy of enterprises and their ways to interact as well as to pay different flows more attention in the statistics. There is also a need to develop descriptions of geographical and communication patterns.

- We need to develop our definitions and nomenclatures concerning the results or products of the activities in the information society.

- More emphasis should be put on statistics on different aspects of human resources.

- Economic statistics are supply or production oriented. Statistics for the information society need to be more focused on use and demand.

The conclusion is that to understand the emerging global information society and the effects on GDP, employment, competitiveness etc. new theories as well as new statistics and statistical tools have to be developed. Developing the data collection and statistics is an iterative process related to the development of economic and social theories and models. It is necessary to have access to both macro economic and micro economic data and statistics as well as case studies. In order to give impetus to this process of improving the understanding of the global information society we need to start the data collection.

(Session 2)

COMMENTS

(Morten Hviid, University of Warwick)

Several of the papers in this section consider network competition and network externalities. My main comments concern the extent to which these are empirically important, and implications for public policy.

Network externalities

Which industries are currently experiencing network externalities? How significant are these externalities empirically? What is the magnitude of these externalities? Which industries do we expect to experience important network externalities in the future?

Given that regulation is a costly enterprise, what, if any, are the practical policy implications of network externalities?

Network competition

As in the case of network externalities, telecommunications is the special case which seems to get most of the attention. Why? Is this because the theories do not have applications to other industries?

Can we identify characteristics of industries where there is network competition and where the networks cannot be expected to bargain to an efficient solution of the pricing of access to each others network?

In the case of software, having copyright does not as far as I know limit somebody else from producing software which allows for compatibility between your software and somebody else's. While you can copyright your software, you cannot prevent others from writing compatible software, nor software which makes your product a closer substitute to other software. If this is true, what are the implications for the incentives to produce software? What effect does this have on network competition?

(Session 3)

INFORMATION SOCIETY AND STATISTICS: EXPERIENCE OF STATISTICS FINLAND

(Heli Jeskanen-Sundström, University of Helsinki)

There are possibilities....

Statistics Finland has established an entirely register-based population and housing census system as the second in the world. The first one was established in Denmark in 1981. Moving towards the extensive use of administrative data was originally made for budgetary reasons. But in addition to the cost reductions, the new system of population census has made it possible to produce an entirely new kind of statistics with annual frequency.

The Finnish population census system is based on three basic administrative registers. The Central Population Register contains data on all persons resident in Finland along with their membership of families and households. The Building and Dwelling Register contains unit data and characteristics on all buildings, dwellings and business premises. Both of these registers are maintained by the Population Register Centre. The Statistics Finland's Business Register contains data on enterprises and the places where they operate.

Each of these registers uses standard identification numbers. The units can, by means of these numbers, be linked to each other: the persons can be linked with the building and dwelling where they live and with the enterprise or other employer and the place where they work. All units can also be located by means of map coordinates.

In addition to the above-mentioned three basic registers, the population census system consists of some 30 other register files, so called specialized registers. These have been established for specific administrative purposes, e.g. the pension registers, the unemployment register and various student registers.

In the longitudinal data files based on census data, each resident of the country is linked with his or her data of separate years. This makes it possible to follow the life course of each person and the changes which have occured during different periods, e.g. changes in occupation, the work place or work status. It is also possible to research entry into employment and outflow from employment by activities, mobility between industries or the educational attainment of the personnel according to the economic activities.

...and actions...

At the beginning of this year, Statistics Finland started a project to develop statistics on the information society. The main tasks of this ongoing project are:

- to chart the domestic and international needs and the existing information base for statistics;
- to specify the main data shortcomings and gaps;

- to chart and fix the essential concepts, definitions and classifications;
- to make a proposal for an indicator system for describing the information society and its development;
- to make a proposal for specific projects in order to fill in the most visible gaps in statistics;
- to prepare the first publication including the indicators for measuring the development of the Finnish information society.

In order to ensure the necessary co-ordination and contacts to policy makers, researchers and other users of statistics as well as data providers, the project is supervised by a high-level advisory group consisting of members representing organisations like the Ministry of Finance, Ministry of Education, Ministry of Transport, Ministry of Trade and Industry, The Technology Development Centre, the business associations of computer services, teleoperators and the Information Research Programme of the Academy of Finland.

In parallel with this project, we are conducting a specific study called "Finns and the future information society: An interview survey on the experiences and abilities of Finns to use new information technology at home and work". The aim of the study is to find out to what extent the different IT tools are used at home, work, school, in studies and leisure time activities. Another objective is to examine the experiences and the related expectations from the point of view of polarisation and marginalisation.

...BUT...

Starting our development work of statistics on information society without any commonly accepted international framework means naturally a great challenge. There are many conceptual problems which have to be solved. There is a need for improving the definitions and a need for internationally accepted classifications like classifications of information activities, products and services. What is actually needed, is a new repertoire of statistical tools and statistical thinking. Taking into account the rapidly changing technology and its impacts on the economy and the whole society, it might be wise to admit that the present statistics cannot give any precise measurements of these impacts but only an approximation of them.

(Session 4)

IMPLICATIONS FOR POLICY AND FUTURE RESEARCH COMMENTS ON PRESENTATION ABSTRACTS

(Vainö Kalevi Kontinen, Merita Bank Ltd)

1. General

The research themes of the five abstracts of the session can be classified into:

- patent protection of innovations (two abstracts);
- pricing in communications network competition;
- directing of public R&D support (two abstracts).

In the transition process of economy towards global information society these questions hardly play leading roles. Market success in information and communications technology (IT&C) does not seem to depend so much on patents and proprietary knowledge as on speed of development, market acceptance and somewhat ironically the openness and imitability of solutions. Public research funding has not been a significant source of IT&C innovations, and in some cases it seems to have misdirected and retarded the development.

This is no critisism against the presentations of the session; on the contrary the commentator feels incompetence in assessing the scientific merits of them. In theoretical research the questions must obviously be posed rather narrowly, and all relevant real-life factors cannot be taken into account. However, from the practical industry view one cannot avoid a recommendation for a major shift of both the issues and basic assumption of research.

2. Cadot & Lippman

Because the source of market success in IT&C in most cases is something else than patent protection, the analysis of length and breadth may not be as relevant as study of real reasons of excessive market power. A dichotomistic market explanation with “whip of competition” and “deadweight losses from monopoly power” also seems too simplistic to achieve practically useful conclusions.

3. Stenbacka & Tombak

The short abstract did not spin off any specific comments.

4. Teubal

Perhaps as a misunderstanding, the presentation abstract gave an impression of need to increase public support and complicate its control mechanism in order to force also the more conservative large organisations to change. A “National System of Innovation” reminds somehow of the State Committee for Science and Technology of a former centralised state.

In nearly all cases, behind a large and conservative organisation there has been public support, either in the form of direct operational subsidies or as a protected market position. Elimination of these has without exception stimulated innovation and progress, in some cases producing admirable results. This method, not added R&D support, should be studied.

5. Kamien & Tsang

The selected object of research may be quite relevant in drug manufacturing, but has little applicability for the information society. The “cannibalisation” referred to looks like a special case of market segmentation, which can be beneficial both to the patent hol-der and society also without the threat of patent expiration.

6. Laffont, Rey, Tirole

Competing communications networks are obviously in the “suicidal” market position, where the marginal cost never exceeds the average cost. Solely price- and cost-driven competition inevitably then leads to elimination of all but one party, or total bancruptcy of the industry. Study of tariff structures can only reveal details of this process.

In reality, the consumers seem to select their network supplier largely on other bases than today´s prices (general image, price development, perceptions of technical development...). Actual comparison of prices is far from simple, and the absolute sums of money in many cases relatively small.

Also the parties of the “suicidal” market often seem to understand the consequences of clean price competition and avoid it. This does not necessarily mean a real or implied cartel, but rather a more complicated market behaviour, which certainly would be an interesting topics of scientific research.

(Session 1)

ROLE OF HUMAN CAPITAL IN THE INFORMATION ECONOMY

(Reija Lilja, the Research Institute of the Finnish Economy)

In this session speakers have highlighted in an interesting manner how the demand for human capital has changed over time in some major industrialised countries and how these changes are interrelated with technical progress and information. We have heard about the new requirements in human resources for peripheral regions and the importance of the organisational structure for economic performance.

According to the studies the share of information workers has increased considerably between the years 1950-1990 in the United States. Further, in the 1980s employment grew fastest in high-skilled jobs and slowest in low-skilled jobs in most OECD countries. The blue-collar high-skilled jobs are disappearing in many countries leading to potential polarisation of the labour market. In the United States information workers have become substitutes for goods and service workers. The role of human resources is clearly growing in industrialised economies.

How much can changes in occupational structure reveal actual changes in the use of human resources in different countries? I suppose occupational structure reveals quite a lot as the studies presented in this session suggest. However, looking only at occupations can hide many important changes in the use of human resources. Knowledge requirements and use of information have changed over time even within the same occupations. Tasks that today's production worker perform are very different from those performed ten years ago. Educational level of workers in same jobs has risen. How can we take into account these changes when evaluating information society?

Business organisations are changing in ways which require different kinds of skills. To be able to spread competencies of individuals through the firm and to learn from experience are of vital importance for the success of businesses. In new forms of organisation people should be able to work efficiently as team members. The workers' ability to learn and to react to changing circumstances are competencies that can make the difference for the firm. There is a lot of tacit knowledge in organisations. When evaluating the use of human resources how should this knowledge be accounted for?

The competent work force is able to use technology and to make new innovations. It appears that technological activity is positively related with the growth of information workers in the United States. Technology seems to also play an important role in the upskilling trends in 22 manufacturing sectors in six of the G-7 countries. Human capital, technical progress and information are all important factors of production. The studies so far show that these factors are not independent of each other. It would be interesting to go one step further and to model the production process in such a way that makes it possible to say more about the dynamics behind the observed relationships. Could this be done with available data is another question which requires further investigation. There are efficient econometric tools that can handle the modelling part of the job if required.

(Session 3)

COMMENTS

(**George Sciadas, Statistics Canada)**

1. Comments on the papers

The paper by Jerry Hausman, MIT, provides interesting estimates for the loss to the society associated with the delay of the introduction of certain new services due to regulatory impediments. These are produced by means of consumer surplus estimates. The paper makes the point that such delays can be costly and favours unconditional competition as the best thing for consumers. Consumer surplus estimates can be arrived at for virtually every good or service that we consume now and did not before, and should take into account the substitution effects that take place elsewhere in the economy. For example, if we use some of the new services more (i.e. Internet) other activities will decline (i.e. television viewing), at least due to the inescapable time constraint.

The paper by Lennart Grundberg, IUI, Stockholm, is incomplete. It intends to examine the effects on employment from the introduction of ICT technologies using a survey that allows analysis by country of control, issues of trade and many other interesting factors. However, the author did not have yet the data available and therefore this work has not been done for Sweden. It would be interesting, though, to watch the methodology and the results when the work is completed.

The papers by Timothy Bresnahan, Stanford, and Eric Brynjolfsson, MIT, address firm-level issues. They deal quite well with intra-firm automation and the effects of Information Technologies on human resources. Brynjolfsson's paper, in particular, although it represents work in progress, is a very well-thought-out exercise which involves a lot of painstaking statistical work to actually produce new data, such as output and productivity estimates at the firm level. It is theoretically sound and when finalized it can make quite a contribution in increasing our understanding of how the introduction of IT technologies affects human resources and productivity at the firm level. Initial results show that at the firm level substantial productivity gains are realized due to re-organization of work structures, something that takes care of the tiresome Solow paradox. Caution is required, though, when interpreting the findings since firm-level results may not be applicable to the industry level.

The paper by Wendy Hansen is based on Statistics Canada's data and is comprehensive. It probes beyond education to touch the skill base of the labour force and shows a very good understanding of data sources and concepts. It makes very good use of data, something encouraging for those who produce them.

2. General comments

Despite talks about “nomadism” of the workforce, the issue of self-employment was not emphasized during this workshop, but in the context of the Information Economy, where distance is not as important as it has traditionally been and technology makes telework and self employment easier, it should be examined thoroughly. Not only the employment situation in terms of levels and rates of change, but its implications in terms of tax base, insurance schemes and the like should be examined. The above should be analysed in conjunction with issues of job tenure and mobility as well as the adaptability of the workforce. This links to lifelong learning. Finally all those should not be seen in isolation from overall macroeconomic developments which continue to remain important.

NOTES

[1] Professor Robin Mansell, Director, Centre for Information and Communication Technologies, Science Policy Research Unit, University of Sussex, UK.

[2] Session rapporteurs: Session 1: Aija Leiponen (Research Institute of the Finnish Economy), Session 2: Petri Lehto (Office of Free Competition, Finland), Session 3: Ville Aalto-Setälä (Helsinki School of Economics and Business Administration), Session 4: Professor Robin Mansell (Science Policy Research Unit, University of Sussex).

[3] They quote the chairman of the FCC as saying "The introduction of competition for local telephone services on a broad scale [...] will create strong incentives for competing firms to increase the pace of technological innovation..." (p. 1).

[4] The JOINT project was carried out with European Commission funding by a team coordinated by CESIA (a French consulting company specialised in information systems), composed of experts from DATAR (the French delegation for regional planning), IDATE (a French research and study centre on telecommunications), URBA2000 (a French organisation for the experimentation of new information and communication technologies), IDI (International Development Ireland), BVITeV (the German software association), Empirica (a German consulting company) and INMARK (a Spanish company specialised in consultancy in organisation).

[5] From those who provided written comments of discussion.

BIOGRAPHIES

Ville Aalto-Setälä is a Teaching Assistant and Ph.D. student of Technology Management and Policy at Helsinki School of Economics. He received his Master's degree in Economics (Econometrics) at Helsinki University. His research interest is in empirical industrial organisation and particularly in hedonic price and cost models.

John Beath is a professor of economics at the University of St. Andrews in Scotland and is currently Head of the School of Economics and Management. He is also the production editor of the Review of Economic Studies and in January 1997 will become, for three years, chairman of the national conference of heads of UK departments of economics. Currently he is a panellist on the national exercise in the UK to grade the research quality of departments of economics.

His training in economics was in Scotland at what is now the University of Dundee, at London University and at the University of Pennsylvania, where he was a Thouron Scholar. Since returning to the UK he has held posts at the Universities of Cambridge, Bristol and now St. Andrews, with a brief spell at the UK Treasury in 1979.

Though he started out as a macroeconometric modeller, his research interests are now in industrial organisation. In 1992 he published a CUP book titled The Economic Theory of Product Differentiation, and still retains an interest in that area, but his current research interests are in the economic issues involved in R&D and in strategic technological competition. His current work is on the structure of R&D costs and the nature of patent races.

Carl Belding is Senior Counsel -- Competition Law and EU Relations, at the IBM Europe Middle East Africa law department in Paris, France. Mr Belding has served in a number of positions within the IBM law departments in France, Sweden and the United States after joining IBM in 1981. At IBM he has been involved in all areas of commercial law, including significant Intellectual Property Law and Antitrust Law litigation, which has required extensive use of economic theory and analysis.

Mr. Belding has a Law degree and a Business Administration degree from the University of Stockholm, and a graduate law degree from New York University Law School. Before joining IBM, he clerked at the Directorate General for Competition (DGIV) of the Commission of the European Communities, a Swedish court and the United Nations Institute for Training and Research (UNITAR). At UNITAR he worked in the Research division on a report to the 1981 General Assembly on International Public Law principles relating to the New International Economic Order.

Mr. Belding is a member of the New York bar, the American Bar Association, the International Bar Association and is the Paris representative for the European Chapter of the American Corporate Counsel Association.

Pontus Braunerhjelm is a senior research fellow and Deputy director at IUI, the Industrial Institute for Economic and Social Research, Stockholm. He is also in charge of the Institute's research on "Foreign Direct Investment, Product Specialisation and Trade Patterns", a field in which he has produced several publications. He earned his Ph.D. at the Graduate Institute of International studies in Geneva, Switzerland.

Timothy F. Bresnahan is Professor of Economics and, by courtesy, of Business, at Stanford University. He also serves as Co-Director of the Stanford Computer Industry Project and Co-Director of the Technology and Economic Growth Program in CEPR. A 1975 graduate of Haverford College, he received a Ph.D. in Economics from Princeton in 1980. Bresnahan's research interests lie in Industrial Organisation Economics and in the Economics of Technology. In the industrial organisation area, he has been concerned with econometric measurement of market power and testing of models of imperfect competition. Publications in this area include a chapter in the Handbook of Industrial Organisation. In the economics of technology area, he studies the economic process by which raw technology generates value in use. Publications in this area include "General Purpose Technologies," "Large Firm' s Demand for Computers," and "The Competitive Crash in Large-Scale Commercial Computing." In both research areas, most of his work is detailed industry studies.

Erik Brynjolfsson is the Douglas Drane Career Development Associate Professor of Information Technology at the MIT Sloan School of Management. His research analyses how the structures of markets and firms are being transformed by advances in information technology and assesses the productivity of information technology investments. He has written numerous articles in academic journals, is on the editorial boards of the Communications of the ACM, Information Systems Research and Information Technology and People, and has served as the editor of special issues of Management Science and Journal of Organisational Computing. Professor Brynjolfsson hold Bachelor's and Master's degrees in Applied Mathematics and Decision Science from Harvard and a Ph.D. in Managerial Economics from MIT. Before joining the MIT faculty, he directed a software consulting and development firm and created two of the first courses on artificial intelligence at Harvard University.

Olivier Cadot is Assistant Professor of Economics at INSEAD, France. He holds a Ph.D in Economics from Princeton University and an M.A. in Economic History from McGill University, where he has also held a visiting appointment. Before starting his academic career, Professor Cadot has worked for the OECD and the IMF. He has published articles on industrial and technology policy, particularly in relation with international trade and environmental policy, and has co-edited a case book on industrial and trade policy in Europe. He has also written on regional economic integration.

Philippe Caille, an economist and a statistician, has further specialised in information technologies and their application in government departments and IT policies. He has worked for the French government, for various European governments and for the European Commission. Among major achievements, he was the leader in such projects as JOINT (a survey of new markets opened up by the development of teleworking and teleservices in Europe), TELER (automation of statistical data exchanges

between governments and businesses in Europe), ATTICA (legal constraints on the development of transborder telework), CMDP (feasibility study of a project involving the professional distant training of over 100 000 Chinese business and government managers), co-operation between Europe and India in the area of telecommunications, reengineering of the Senegal Administration, the use of IT for regional development in France and strategic IT planning in various French government departments.

Eve Caroli graduated in History from University Paris VII, and in Political Science and Economics from the Institut d'Etudes Politiques de Paris. She obtained her PhD in Economics in 1995. She has been a research assistant at CEPREMAP and a teaching associate at University Paris IX-Dauphine. She is now a research associate at INRA and CEPREMAP. Her main contributions deal with education and training systems in OECD countries as well as with the modelling of the education-growth relationship in cross-section analysis. She has also studied the conditions for institutional transitions, especially in training systems. She is now increasingly interested in organisational change, in relation with skills, technological change and growth dynamics.

Alessandra Colecchia is a Young Professional in the Economic Analysis and Statistics Division of the Directorate for Science, Technology and Industry of the OECD, where she works on technology, employment and skills issues. She has participated in the work on Technology, Productivity and Job Creation (the “G-7 report”). Before joining the OECD, she worked at the Bank of Italy and at the Italian Confederation Union of Private Industry (Confindustria) Research Department. She holds a DES in International Economics from the Graduate Institute of International Studies in Geneva and a degree in Economics and Business from the University of Rome La Sapienza.

Isabel Dieguéz Castrillón, can be reached at IDEGA (Institute of Studies and Development of Galicia), University of Santiago de Compostela, Campus Sur, Santiago de Compostela. She holds a degree in Business Studies, followed the Courses of Doctoral Programme “Structural change and economic development” by IDEGA and the Postgraduate Course “Management of Innovation and Technological Change”, in the University of Santiago de Compostela.

Ms Dieguez also published several papers. She was a Member of the organising committee of the international congress “The European periphery facing the new century” which took place in Santiago de Compostela on 30 September, 1 and 2 October 1993. She worked as a research fellow for IDEGA, for the University Autónoma de Madrid and for the University of Pais Vasco.

Gunnar Eliasson is a professor of Industrial Economics at The Royal Technical Institute (KTH), Stockholm, since May 1994. His previous positions were : President of the Industrial Institute for Economic and Social Research (IUI), Stockholm, 1977-1994; Chief Economist of the Federation of Swedish Industries 1970-76; Senior research fellow and instructor at IUI 1965-70; Research fellow at the National Institute for Economic Research (Konjunturinstitutet), Stockholm 1963-65; Various academic positions; President of the International Joseph A. Schumpeter Society 1995/96 and organizer of its sixth international conference in Stockholm, June 2-5, 1996.

He obtained the following degrees: 1963 Master of Social Sciences in Mathematics, Statistics and Economics, University of Uppsala; 1968 Dr Phil and Docent in Economics at the University of Uppsala. He is also a member of various professional societies, etc.

Olof Gärdin (born in Stockholm 1942) studied at Stockholm University where he graduated in Social Sciences and Economics. After service in some private and public organisations he joined Statistics Sweden in the early 70s, where he worked on a reorganisation of Statistics Sweden. After that he joined the staff of the Director General for tasks concerning statistical development and strategic planning. From the middle of the 80s he was responsible for statistics on Information and Communications Technologies and the Swedish representative to OECD and ECE concerning statistics on ICT and automation. Between 1993 and March 1996 he was a national expert in Eurostat working with statistics concerning i.a. Information and Communication. He us now at Statistics Sweden, but continues as a consultant to Eurostat concerning statistics on Information and Communication.

Lennart Grundberg is a junior research fellow at IUI, the Industrial institute for Economic and Social Research. He graduated from the University of Göteborg and has also gone through the Advanced Studies Program at the Kiel Institute of World Economics, Kiel, Germany.

Wendy Hansen is employed as a Senior Policy Analyst, Human Resources in Science and Technology, Federal Science and Technology of Industry Canada in Ottawa, Ontario, Canada. She was a member of the team which drafted the OECD/EU/Eurostat Frascati manual on "The Measurement of Human Resources in Science and Technology" (The Canberra Manual), 1991-1995. Within the framework of the first European Report on Science and Technology Indicators of the EC, she was a member of the Scientific Validation Panel (1994). She was on the Board of Directors of the Human Resources Board of the Canadian Council of Professional Engineers (1991-1993), and a member of the Interdepartmental Committee on Education and Research (Canada, 1989-1994), and continues to participate in various international study groups which touch on the scientific and technical work force.

Ms. Hansen is currently in charge of two projects to examine the changing nature of the S&T skills base. She is working on a report on the transition of the skills base in Telecommunications Carriers due for release by the end of 1996. In 1997, this work will be extended to other heavy IT user sectors. In the longer term, Ms. Hansen is working on linkages between a highly skilled scientific and technical work force and economic prosperity and employment growth.

Jerry A. Hausman is the John and Jennie S. MacDonald Professor of Economics at MIT in Cambridge, Massachusetts, USA. He is Director of the MIT Telecommunications Economics Research Program. Professor Hausman teaches a course, "Competition in Telecommunications," to graduate students in economics and business. Professor Hausman received the John Bates Clark Award from the American Economics Association in 1985 for the most outstanding contributions to economics by an economist under 40 years of age. He also received the Frisch Medal from the Econometric Society.

Professor Hausman has done research and been a consultant in telecommunications since 1974. He has worked in the areas of demand for voice and data services, central office switches and PBXs, mobile telecommunications and information services. Professor Hausman has published a number of academic papers in telecommunications. He has written two books, *Future Competition in Telecommunications*, (Harvard Business School Press, 1989) and *Globalization, Technology, and Competitions: The Fusion of Computers and Telecommunication in the 1990s*, (Harvard Business School Press, 1993).

Dr. Pauli Heikkilä was born in Tampere, Finland in 1962. He received his M.Sc. and Dr.Tech. degrees in electrical engineering from the Helsinki University of Technology in 1987 and 1992 respectively. In 1987-91 he worked as a project and group manager in Nokia Corporation, where his main responsibilities were analogue and RF circuit design and simulation. In 1992-93 he was a technical advisor and electronics programme manager in Technology Development Centre (TEKES), which is a governmental agency co-ordinating and financing R&D in Finland. Since 1994 Dr. Heikkilä has been the director of the Information technology division of TEKES. His interests are all aspects of information and communication technologies, both software and hardware as well as manufacturing paradigms, including their impact on our society as a whole.

Morten Hviid is a lecturer in Economics at the Department of Economics, University of Warwick, England. Before that he held Research Fellowships at the University of Copenhagen, Denmark. His fields of research include Theoretical Industrial Economics, Strategic Trade Theory and Law and Economics (especially Contract Law). He holds a Cand Oecon from Aarhus University, Denmark and a MA(Econ) and a PhD. from the University of Warwick. He is an editor of the Journal of Industrial Economics. He has published papers in i.a. Canadian Journal of Economics, Economic Inquiry, Journal of International Economics, Journal of Industrial Economics, and Scandinavian Journal of Economics.

Heli Jeskanen-Sundström is graduated as M.Sc. (Econ.) from the University of Helsinki. She is director of business statistics at Statistics Finland. She has supervised or managed a wide variety of projects related to the development of new statistics on information economy and business behaviour. Among which are the development project of information sector statistics, the development project of statistics on mass communication and audio-visual services, the development project of science and technology indicators and the development project of statistics on business services.

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