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OECD WORKSHOPS ON THE ECONOMICS OF INFORMATION SOCIETIES

WORKSHOP No. 1

TORONTO, 28-29 June 1995

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris 1995

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TABLE OF CONTENTS

OECD WORKSHOPS ON THE ECONOMICS OF INFORMATION SOCIETIES
REPORT OF THE TORONTO WORKSHOP

Preamble

The OECD Workshops on the Economics of the Information Society are aimed at developing economic data, research and analysis under the aegis and direction of the ICCP Committee as a precursor for policy discussions within the Committee. The work programme discussed at these fora concentrates on identifying lacunae in the social and economic definition of an international information society, has a quantitative and empirical stress and aims to identify and refine the analytical and statistical tools for dealing with these issues.

The development of an information society within OECD countries is expected to have profound and far-reaching economic and social effects at the national, regional and global levels. Although there is much discussion of the impact of information infrastructures and multimedia services, there is little consensus of where these developments are (or should be) leading the economy and society. The vagueness of the vision of future outcomes is a result of a paucity of economic theory, analytic methodology, quantitative data and empirical work. Yet such data and analysis are necessary to ensure that the upcoming policy debate concerning the rapid and fruitful yet orderly and equitable transition to an information society is conducted in an informed way.

The broad, dynamic but cohesive membership of the OECD, combined with its long history of impartial but constructive policy, economic and social analysis, makes it well placed to conduct a co-ordinated approach to international analyses of the economic and social effects of the development, implementation, and application of national and global information infrastructures and contribute to assessing their implications for policy.

The first of the OECD Workshops on the Economics of the Information Society was held in **Toronto, 28-29 June 1995**. It was hosted by the Center for International Studies (CIS), University of Toronto, and was organised jointly with the Organisation for Economic Co-operation and Development (OECD). The other institutions co-operating in this Workshop series are ENSAE-CREST (Paris), WZB (Berlin), Brookings Institution (Washington), MERIT (Maastricht), European Commission, the Korea Information Society Development Institute (KISDI) and Industry Canada.

The Workshop had a broad objective to cover the theory, methodological and analytic tools and the available data required for a better understanding of how information and communications technologies and infrastructures shape the economy and society. Empirical work on impacts on productivity and jobs, in line with the OECD's current objectives in this area were a special focus of this first workshop. Future workshops will address other specific themes.

On the occasion of this Workshop leading experts from major economic research centres, academic bodies, consultancy, 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 economic and analytic methodologies, provided a stimulus for development of quantitative data and empirical work and highlighted priorities for future investigation. This report outlines the highlights of the contributions and discussions at the Workshop, and provides a list of participants. The OECD would like to gratefully acknowledge the support and enthusiasm of all those involved.

TORONTO WORKSHOP: POLICY IMPLICATIONS

This report outlines the policy implications of interest to the ICCP Committee arising from the Toronto Workshop on the Economics of the Information Society. The Workshop covered a range of structural, policy and methodological issues concerning the impact of information infrastructures and new service development. Based on the Rapporteur's report, the major policy implications coming out of these discussions were following:

- Governments can create conditions to help the private sector develop new services, and should remove regulatory barriers to competition -- particularly those between telecommunications and broadcasting -- if they are not to face severe macro-economics penalties.

- But governments must not encourage firms to force the pace of adoption, as "staff may be untrained and resisting, and new equipment would be operated to old standards, with likely ill effects for productivity."

- In the long run, governments can do little to create employment in service sectors, and policies "should not be formed on the basis of their local employment or spending effects, as these are unimportant in the long run and are the wrong criteria in the short run." The most effective measures governments can pursue to optimise growth in services are in providing a framework which facilitates macro-economics rates of return, such as efficient infrastructure development.

- In the short term, governments can optimise employment opportunities by focusing on education and training measures which overcome short-term imbalances caused by rapid skill-biased technical change and which "ease the pace or share the costs of adjustment." However, as there is evidence that IT can move jobs to people by decreasing the need for physical mobility of labour and the geographic mismatch of jobs and skills, governments must exercise care in devising such policies.

- However, measurement of the impacts of new services are elusive, and are often hard to disentangle from impacts caused by other factors. New and improved indicators are needed to identify barriers to and opportunities for service development through combining "different methodologies, preferably applied in complementary ways to comparable issues and data sets.".

- New indicators should not replace, but should supplement existing industry data. Parallel accounts for IT activities are needed to take into account that IT is pervasive, and involves production by specialised establishments, by secondary establishments, or by own-account activity in countless firms and households."

- IT should be used to "improve the flexibility, breadth and timeliness of data collection and analysis."

- International harmonisation of indicators is needed in order to identify comparative advantages and disadvantages in government policies for the development of new services. The OECD is important in this process.

- International co-operation in the OECD is also important in defining frameworks for competition in content which respect national cultural values "in the face of technologies that provide multiple ways of delivering the same services, [and in which] control of content and delivery is increasingly difficult, and may be counterproductive."

- The impact of information infrastructures and new service development are so economically extensive and socially pervasive that many areas of policy outside those of the government ministries normally responsible are affected. Governments need to ensure that policy co-ordination is increased between all affected ministries. At the international level, the OECD needs to ensure that co-operation is developed between all the Committees and Secretariat directorates responsible for offering policymaking analysis and advice to Member countries in the development of a global information infrastructure and global information society.

As the above list indicates, much work still needs to be done to clarify the policy implications which governments need to consider and the steps they need to take in order to deal with the issues involved.

PROGRAMME

OECD WORKSHOPS ON THE ECONOMICS OF THE INFORMATION SOCIETY

Workshop Number 1, Toronto
Wednesday, 28 June and Thursday, 29 June 1995

Organising Institutions: Centre for International Studies (CIS), University of Toronto
Organisation for Economic Co-operation and Development (OECD)

Co-operating Institutions: ENSAE-CREST, Paris
Wissenschaftszentrum Berlin (WZB), Berlin
The Brookings Institution, Washington D.C.
Korea Information Society Development Institute (KISDI), Seoul
Maastricht Economic Research Institute on Innovation and Technology (MERIT), Maastricht
Department of Canadian Heritage, Ottawa
Industry Canada, Ottawa
European Commission, Brussels

Venue: **All sessions and lunches:** ***Faculty Club*, 41 Willcocks Street, University of Toronto**
June 28 reception and dinner: ***Le Rendez-Vous Restaurant*, 14 Prince Arthur Avenue**
June 29 reception: ***Faculty Club*, 41 Willcocks Street, University of Toronto**

Mission and Structure of the Workshop

As the first in a series of workshops, the Toronto Workshop on the Economics of the Information Society is devoted to taking stock of the current situation and to setting the stage for future research work in this area. The workshop is organised in two groups of 3 sessions:

Group 1: Economic and Social Effects of Information Infrastructures

These sessions will ask: "What will be the impacts on the economy and the society by information infrastructures and multimedia services?"

- Session 1 "How IT/Telecom Affect the Economy -- Theory"
- Session 4 "Productivity and Growth"
- Session 5 "Employment and Jobs"

Group 2: How to Study These Effects

These sessions will take stock of the current prospects for analysis and then focus on how further investigation of the issues could be conducted.

- Session 2 "Method and Tools for Analysis"
- Session 3 "Data"
- Session 6 "Research Agenda"

Proceedings of Each Session

Each session will start with presentations by invited speakers (each approx. 15-20 minutes), followed by comments and questions from the discussants (each approx. 5-10 minutes). Towards the end of each session, the floor will be open to questions and comments from participants.

WEDNESDAY, 28 June 1995

08:30 Registration

09:00 Welcome: Luc Soete, OECD, Paris/MERIT, Maastricht

Leonard Waverman, Director, CIS, Toronto

09:15 Session 1: *How IT/Telecom Affects the Economy -- Theory*

The objective of the session is to define a qualitative framework to guide and set priorities for the study of the implications of the developments in the IT/Telecom field. The presentations should, from the point of view of each speaker, provide a broad view of the causalities in on-going developments, and set the stage for a discussion on how these should be studied.

Chair: Robert Crandall, The Brookings Institution, Washington D.C.

Speakers: Ed Steinmueller, MERIT, Maastricht
Neglected Dimensions of the Productivity Paradox: Users, Complementarities, and Infrastructure
Robin Mansell, SPRU, University of Sussex, Brighton
David Teece, University of California, Berkeley
Telecommunications in Transition: Unbundling, Reintegration, and Competition
Bruno Jullien and Anna Creti, CREST-LEI, Paris
How the IT/Telecommunications Affect the Economy

Discussants: Carl Belding, IBM Europe, Paris

Calvin Avertick, General Manager, Bell Sygma, Toronto

11:00 Session 2: *Methods and Tools for Analysis*

This session is oriented to share experiences on research methods and results, and identify possible methods and players for the future analysis of this area.

Chair: Chang-Bun Yoon, KISDI

Speakers: Jerry Hausman, MIT, Massachusetts -- The Aggregate Approach
Valuation and Regulation of New Services in Telecommunications
(excerpt from paper with Tim Tardiff)
Georges Ferné, OECD, Paris -- The Firm Level Approach
Infrastructures and Jobs: A "Firm Level" Approach
Yasuhisa Nishikawa, Ministry of Posts and Telecommunications, Tokyo -- The Intersectoral Approach
Influence of the Development of the Info-communications Industry on the Economy and Employment: Analysis Using Input-Output (I-O) Tables
Shane Greenstein, University of California, Berkeley -- The Demand Side Approach
The Demand-Side Approach to Information Technology

Discussants: Lester Taylor, University of Arizona, Tucson

Hal Varian, University of Michigan, Ann Arbor

13:00-14:00 Lunch: *Faculty Club*

14:00	Session 3: *Data*

It is well recognised that the data in this field is difficult to obtain, but is still a key requirement for analysis. The objective of this session is to identify available data sources and future data needs for analysis of socio-economic impacts of information infrastructures. Some of the questions to be addressed are: Which data are available for such analysis today, and how can it be improved? How will the data needs evolve with time? Are there new tools available for developing statistics? What will be the role of official statistics?

Chair: Leonard Waverman, CIS, Toronto

Speakers: Donald Bellomy, IDC, The IDC Data Base, Massachusetts
Fred Gault, Services, Science & Technology Division, Statistics Canada, Ottawa
Canadian Statistics on the Information Society
David Luck, Bureau of Transportation and Communications Economics, Canberra, Australia
Broadband to the Home: Evolution Scenarios for Australia
Marie-Louise Caravatti, Technology Administration, US Department of Commerce, Washington D.C.
Günter Möller, Eurobit, Frankfurt

Discussants: Charles Hulten, University of Maryland

Genio Staranczak, Revenue Management, Bell Canada

16:00	Session 4: *Productivity and Growth*

This session is devoted to the understanding and measurement of impacts of information infrastructures on productivity and economic growth in both their micro and macro aspects. Key questions to be addressed are: How do investments in information and communications technology and related organisational change influence productivity and economic growth and how can these changes be measured?

Chair: Ed Steinmueller, MERIT, Maastricht

Speakers: Hendrik Röller, WZB, Berlin and Leonard Waverman, CIS, Toronto
The Impact of Telecommunications Infrastructure on Economic Development
Jean Barbé, France Telecom, Paris
Hans van Meijl and Luc Soete, MERIT, Maastricht
IT Spillovers and Productivity Growth: An Empirical Application to France
Franco Morganti, Databank, Milan
Cristiano Antonelli, University of Turin
Telecommunication Services and Productivity Growth
Charles Hulten, University of Maryland

Infrastructure, Unemployment, and Economic Growth: The Macro Policy Environment of "Information Society" Investments

Discussants: Jeff Bernstein, Carleton University, Ottawa

Ernst Berndt, MIT, Massachusetts

19:00 Reception: Sponsored by Sprint Canada
Le Rendez-Vous Restaurant

20:00 Dinner: Hosted by Mayor Barbara Hall, City of Toronto
Le Rendez-Vous Restaurant

Dinner Speech: David Johnston, Information Highway Advisory Council, Industry Canada

THURSDAY, 29 June 1995

09:00 Session 5: *Effects on Employment and Jobs*

This session will seek to understand and quantify how changes in organisations, industry dynamics and service structures coming from use of information and communications technologies impact the labour market. The session should bring elements of response to, among others, these questions: How should the transition to an information intensive economy be managed to reduce negative implications of industry and service restructuring? How can governments help translate the growth in productivity into new jobs? How many jobs will be created in new industries and services? This session should also attempt to give some initial policy recommendations guiding labour market policies responding to these challenges.

Chair: Hendrik Röller, WZB, Berlin

Speakers: Frank Lichtenberg, Columbia University, New York
Conclusions from *"The Output Contributions of Computer Capital and Labor: A Firm-Level Analysis"*
Steve Nickell, Oxford University, Oxford
The Collapse in Demand for the Unskilled: What Can Be Done?
Susan Baldwin, Department of Canadian Heritage, Ottawa
Alain Dumort and Werner Herrmann, European Commission, Brussels
Employment issues and Opportunities in the Information Society,
Adaptations to Industrial Change
Employment Issues and Opportunities in the Information Society
Yumio Imamura, Japan Users Association of Information Systems, Tokyo
Prospects of New and Growth Markets Implicating with Advanced Information Technology

Discussants: Erik Brynjolfsson, Sloan School, MIT, Massachusetts

Riel Miller, Advisory Unit, OECD, Paris

Inuk Chung, KISDI, Kwachun-City

13:00-14:30 Lunch: *Faculty Club*

14:30	Session 6: Panel: The Way Forward: *The Research Agenda*

The expected output of this session is a plan, which will subsequently be considered by the OECD, which identifies how our knowledge of the economic implications of information infrastructures can be advanced through further research, and who can be the main players in this work. The speakers are expected to interpret and synthesise the debate from preceding sessions, and outline how work in this field can proceed.

Chair: Luc Soete, OECD

Rapporteur: John Helliwell, University of British Columbia, Vancouver

Panel: Pasi Rutanen, Ambassador to OECD, Government of Finland
Carl Belding, IBM Europe, Paris
Peter Johnston, European Commission, Brussels
Dimitri Ypsilanti, OECD, Paris
Len Waverman, CIS, Toronto
Hendrik Röller, WZB, Berlin
Robert Crandall, The Brookings Institution, Washington D.C.

19:00 Reception: Sponsored by Northern Telecom
Faculty Club

OECD WORKSHOP ON THE ECONOMICS OF THE INFORMATION SOCIETY

TORONTO, 28-29 JUNE 1995

RAPPORTEUR'S SUMMARY

The workshop had two main groups of sessions, one focusing on what is known about the economic and social effects of information infrastructures (theory in session 1, productivity in session 4 and jobs in session 5), and the other on the research required to fill the gaps (session 2 on methodology, session 3 on data, and session 6 on the research agenda). This summary report attempts to cut across these session boundaries, and to spell out issues that seemed of general importance in several sessions. An appendix reports the discussions on a session-by-session basis.

Setting the Toronto Workshop in Context

In the light of the broad menu of topics and approaches presented during the conference, it is natural to conclude first of all that the next step should be to narrow the range of topics to be considered, with an eye to establishing priorities and division among subsequent workshops. In this regard, it should be noted that the first workshop, coming as it does in the middle of the study period for the mandate pursuant to the Detroit jobs summit, had a strong emphasis on the technology and employment issues that lie at the centre of that mandate. Those topics will be dealt with further in the completion phase of that project, so that it may be sensible to leave them off the agendas of the next one or two information society workshops. Should they prove important enough and remain unresolved, then they could then provide a useful focus for follow-on work in the information society series of conferences.

The remainder of this summary considers four sets of issues, the first dealing with theory and methodology, the second with data, the third with empirical issues, and the fourth with policy.

Theory and Methodology

The importance of timing, dynamics and the institutional setting, both domestic and global.

It was recognised in several papers (Mansell, Teece) that taking institutions seriously was not easy, but was crucial to the understanding of both the development and adoption of information technologies. Slow adopters of new technologies often face internal barriers that required time and/or resources to surmount (Greenstein). If the pace of adoption is forced, then staff may be untrained and resisting, and new equipment would be operated to old standards, with likely ill effects for productivity. Time may also be important to permit new equipment to be installed at normal replacement times, or after resources could be devoted to appropriate training. All of this suggests that optimal dynamic adoption paths vary in length among firms and industries. Faster or slower adoption is always possible, but will in general imply lower net benefits, to a degree that also will vary by industry and type of technology being adopted. Some technologies may really be plug-and-play; more usually there is a risk of short circuit if suitable advance preparations are not made.

Research methods should include case studies as well as statistical studies based on firm, industry and aggregate data.

My conclusion here is that research agendas and conferences alike should attempt to combine results from different methodologies, preferably applied in complementary ways to comparable issues and data sets. The case studies can be used to explain results and suggest hypotheses for more methodical testing. The enterprise and firm-level data permit much closer identification of which structures and strategies affect the success or failure of technology adoption. Industry and aggregate level data can more easily be used to translate into national aggregate results, but may require the use of evidence from more detailed studies to pin down key parameters, thus permitting the scarce aggregate data to be used to better effect. In all four types of study, the use of internationally comparable data sets adds an additional degree of richness. An example here was provided by Steve Nickell's use of the educational and income characteristics of the bottom deciles of the US and German populations to illustrate the importance of education.

Institutional differences matter.

The use of international comparative data comes into its own even more when institutions are under study, since they typically change so slowly within any given country that comparison across countries becomes essential. Of course, there is often the problem that too many institutions are different, so that disentangling their separate effects may be very difficult. It is a bonus when institutional change takes place in one country but not in its neighbours, as it may then be easier to trace the effects of the institutional changes.

What are the linkages between jobs and information technologies?

This is the central Detroit question, and was the focus of several of the papers at this conference. Confusion reigns, and should be cleared away, either in the course of further study under the Detroit mandate or elsewhere. From the IT industry and government departments, the focus is often on how many jobs are likely to be created by a specific IT project or set of investments, often buttressed by macro-economics assessment of multiplier effects. This does not have much scientific or policy value, in my view. Policies toward different industries should not be formed on the basis of their local employment or spending effects, as these are unimportant in the long-run and are the wrong criteria for project selection in the short run. What matters is the rate of return - hence all the attention that was placed on the Aschauer infrastructure results (Hulten). In the long run, the growth effects of IT investment are based of the extent to which they have higher returns, either internally or through external effects, than do other investments. Their impact on jobs will be zero in the long run, except to the extent that they worsen or improve the regional balance or skill-matching between employment and the labour force. During the adjustment period, the effect on total employment will be the net of any direct new jobs, indirect jobs created by increased demand, and job losses through the implementation of cost-saving IT equipment. The gains and losses may differ by industry, by geographic area, and by skill group - hence the interest in chasing down the extent to which IT has contributed to skill-biased technical change, should the latter prove to be a general phenomenon.

Theory and analysis must recognise that change is slow and costly.

Although many theoretical frameworks assume that information is equally and costlessly available, and that adoption of new technologies is limited only by the need to rebuild capital equipment,

the papers and discussions at the workshop showed the contrary to be the case. For one thing, institutions matter (Baldwin, Miller) and are slow to change. In addition, case studies (Ferné) and statistical analysis (Greenstein) alike show that information is costly to obtain and not easy to apply. Better modelling is likely to need more explicit treatment of information availability and costs, and a clearer analysis of the gains and losses from faster and slower adoption of new technologies.

Data Issues

More efforts are needed to develop concepts and standards, national and international.

Fast-changing activities require quick and concerted action to find ways of collecting and classifying data in comparable ways. The best time to develop standards is before too much effort is sunk in diverging or inconsistent methodologies.

IT accounts should supplement rather than replace existing industry data.

New industrial classifications should be done so as not to destroy the ability to make continued use of consistent time series for previously defined industries (Hulten). This suggests the use of parallel accounts for IT activities, a solution that in any event may be necessary to take into account the caution (Gault) that IT is pervasive, and involves production by specialised establishments, by secondary activities in other establishments, or by own-account activity in countless firms and households.

IT should itself be used to transform data collection.

The conference had much discussion of the need for better data about IT activities, and of the fiscal difficulties posed for data collection agencies (Caravatti), but not enough on the contributions that IT can make to improve the flexibility, breadth and timeliness of data collection and analysis (Rutanen). To be most efficient, IT should draw on information already collected for other purposes, so as to use the degrees of freedom provided by micro data without requiring extensive and expensive new surveys. It should be increasingly easy to transform data on individual units so as to maintain confidentiality while keeping the richness of the underlying data. Work on the methodological aspects of this issue is a natural for the OECD, which has long been a focus for collaborative establishment of statistical standards and innovation.

Empirical Issues

IT and productivity growth: Positive spillovers or creative destruction?

The conference received evidence of positive spillovers from IT capital to productivity using enterprise data (Lichtenberg), from IT R&D to productivity in other industries using French data (Soete) and from telecommunication penetration to per capita GDP growth using cross-country data (Röller and Waverman). There were risks of simultaneous causation, and the Röller and Waverman effects were regarded as implausibly large, by the authors and others. The issue is important, as it lies at the heart of any discussion about the preferred pace of R&D and network expansion in IT.-If spillovers are large and positive, then the case strengthens for faster rather than slower IT adoption, and the argument for regulatory delay looks even more suspect.

Does IT create jobs or unemployment?

There is a link here to the question of total employment. There was lots of concern about the possibility that in the short run at least, any productivity gain means lost jobs. In the longer run, aggregate employment will return to normal values (Nickell), just as it has done over the centuries. Is there anything special about the current set of changes? The big issue here is whether the technical change in telecommunications and IT is an important part of what appears in a number of countries to be skill-biased technical change that is lessening the relative incomes and/or job prospects for the less-skilled. If so, then rapid technical change, and/or more rapid adoption of new IT, may increase structural unemployment for as long as it takes to adjust the skill mix. In extreme cases, this process could take many years, depending on the costs of re-training and sometimes relocation of older workers. As mentioned earlier in the methodology section, in surveying and extending the results linking IT and employment it is crucial to distinguish impact vs. equilibrium output and employment effects, direct and indirect employment, with the latter taking into account resulting movements of exchange rates and other macro adjustments, and structural vs. short-term unemployment. Beyond the possible links between IT and structural unemployment, this issue not likely to be worth another conference in the information society series.

The conference also provided further information on some more specific questions on the linkages between IT, employment, and growth:

Can IT move jobs to people?

The issue here is whether IT increases or decreases the need for physical mobility of labour. The example was given of cheap telecommunications making it feasible to transfer many phone-linked jobs to northern Sweden (Belding) where there were low costs and workers with appropriate skills and few alternative employment opportunities. In the Canadian context, the case of Moncton, New Brunswick, is often used to illustrate the same point. If these examples have general application, then they act directly to reduce structural employment, at least to the extent that it is due to a geographic mismatch of jobs and skills.

Does IT make workers obsolete?

The issue here is the extent to which workers displaced by IT are too old or otherwise unfit to be retrained for alternative employment. If so, then a case strengthens for policies to ease the pace or share the costs of adjustment. In the background is the general presumption that faster adjustment tends to dominate slower (Hausman), in the absence of clear evidence to the contrary.

Is the nation becoming obsolete?

Several references were made to the diminishing relative importance of national boundaries. Yet there is also the new research by John McCallum (American Economic Review, June 1995) showing that trade linkages among Canadian provinces are more than twenty times tighter than those between Canadian provinces and US states, after using a gravity model to allow for differences in size and distance. This result is for trade in goods, while for services the markets are even more strongly national, and the twenty-times figure become more than fifty. Even if the direction of the globalising influences seems clear, they appear to have along way to go before the nation state is economically obsolete. More research on the reasons for this, and of the role of IT, would be very helpful.

Is it better to be on the bleeding, the leading, or the trailing edge of IT?

This is the empirical counterpart of the optimal-pace-of-adoption question addressed earlier in the methodology section. Further research on this issue should involve studies of events, establishments, firms, industries and countries, since there are differences in rates of IT adoption across all these dimensions. Early adopters, on the bleeding edge, may gain a market niche, but bear the highest costs of adjustment, the high costs of buying and installing first-round technology, and uncertainties about whether they are backing the right horse. Cutting edge positions are second into the market but learn from the first-round experiments undertaken at the expense of others. Trailing-edge adopters get the benefit of lots of trail-blazing by others, and can often by later generation equipment at a fraction of the price of that in the first generation. Of course, they may find many of the relevant new market positions staked out. Case studies presented at this conference suggested that information-producers were faster to adopt IT than were IT users (Ferné). Could it be better to be faster to adopt in new products, where market position is important, and slower in cost reduction, where you can afford to wait until total costs are at a minimum before taking the plunge, without any adverse consequences to market position? This could explain the case study results, and rationalise fast adoption by IT producers, and slower adoption by IT users. Further research could help on this score.

Does the information highway supplant or support neighbourhood, family, and community ties?

It is argued (Graham) that the new communities created by the Internet offer no real threat to other community linkages, and by being user-defined may offer an important adjunct to more traditional communities, which are often based more on top-down delegation and authority. This is an appealing argument, which needs to be juxtaposed with the queries raised by those who worry that networks may facilitate forms of community, whether of organised crime or disaffected militia movements, that pose clear threats to the societies in which they operate. At the micro level are questions about whether the hours spent alone in front of the screen are being substituted for passive television-watching or for more direct involvement with others in the home or community. If the more dramatic of the information highway scenarios (Miller) comes close to fruition, even over a fairly long horizon, then there are clearly major changes in train for the existence and structure of communities.

Policy Issues

The appropriate national policy stance depends on the circumstance, but the balance of conference discussion (Hausman, Dumort) seemed to favour facilitation rather than either delay or direction.

What is the appropriate policy stance with respect to the expansion of the information society: to regulate, to stimulate, to facilitate, or to stand back and watch? This is related to the question (Johnston) of whether the main focus of national policy should be plumbing (fixing problems caused by the evolution of the information society) or the design and implementation of Grand Visions.

Who are the losers from deregulation?

This question was posed (Orr) with an eye to seeing if compensation in some form may help to expedite the process, or at least to understand the political dynamics of regulatory delay.

Ensuring efficient and equitable provision of and access to networked information.

What control of content, if any, is appropriate? By whom, and for what ends? Can the standards of civic society imposed on the anarchy of the internet? What are those standards? The answers to these questions depend importantly on the answer to the empirical issue raised above about the nature of the linkages between electronic communities and more traditional civic, family, and national communities. Increasing connectivity tilts the long-standing debate between censorship and unfettered expression in favour of the latter, since it becomes increasingly difficult to find the source or trace the movements of information, whether it be seditious, pornographic, hateful, libellous or laudable. The global nature of the network frustrates national control of content, which may be just as well, since one person's democracy wall is another's sedition.

IT creates new needs and new tools for education.

The conference had much discussion about the need for better education enabling students and workers to use IT. There was little said about the potential for IT to reduce the costs and improve the spread of education. Content issues (Baldwin) arise here as well.

Flexibility is still the watchword for national IT policies.

This OECD catchword, now prevalent among national governments as well, appears especially apposite with respect to the spread of the information society, which cuts across many institutions and industries, exposing unanticipated needs for fast policy response. For example, the separate regulatory systems for cable and telecommunications need reforming fast if they are to retain any value. In the face of technologies that provide multiple ways of delivering the same services, control of content and delivery is increasingly difficult, and may be counterproductive.

International standards are needed to make connections work.

This is the area where the appropriate policies are likely to be international rather than national, and where the OECD is likely to have the largest role to play. The industrial countries are the major players in the hardware, software and networks that define the information society, and collaborative fora like those supplied by the OECD are most likely to be fruitful. Clearly industry representation is crucial to the design of standards, since governments are often not in a position to know best which are the more likely standards to provide the most connectivity and the fewest constraints to effective technological evolution. If standards are open-ended and flexible enough, future losses of the sort due to the failure to replace the QWERTY keyboard layout may be avoidable. If standards are not to provide a barrier to free entry and user access, then user interests need also to be represented in their design.

Agendas for Future Conferences

Some areas that could well be worth conference sessions, or entire conferences, might include:

1. Establishing the social dimensions of the information society, under alternative views about how it is likely to develop. What will be the consequences for local, regional, national and interest-based communities? Will interests and sympathies tend to become more fractured

and divided, or are they more likely to coalesce? What are the implications for national and group identities and cultures?

2. Technical standards, connectivity, and content. These issues are separate, but have such important implications for each other that they ought to be considered together.

3. IT and productivity. There is potential, given the unstructured wealth of establishment, enterprise, industry and national data suitable for comparative analysis, for substantial increases in understanding of the direction, size and nature of the direct and spillover effects of IT on productivity. There is lots of work going on in individual countries, and even some that is internationally comparative. Especially in the latter case, there is a role for the OECD to encourage the use of international data to better understand the domestic and international consequences of information technologies.

4. The dynamics of technology adoption. This would combine a concern with institutional issues with more attention to the modelling of the costs and benefits of earlier and later adoption of new technologies, at the levels of the firm, the industry, the nation, and the international community.

APPENDIX

Session-by-Session Summary of the Toronto Conference

In setting the stage, the chair (Waverman) noted the pervasive scepticism and uncertainty about the linkages between IT and growth. The linkage with other conferences and mandates was described (Soete) with the trio of technical change, productivity growth, and employment being seen as a major focus of national and international research. The Washington conference received some papers suggesting that there appeared to be less evidence for Europe than for the US that skill-biased technical change underlies the widening gaps in the distributions of employment and income (Soete). He also noted that the nature of the debate about the importance of small and medium-sized businesses appears to differ from continent to continent. This suggested to him the importance of linking researchers from many countries, to avoid the debate and conclusions being driven too much by evidence or theory that is specific to one or a few countries.

Session 1: Theory

The first session made it clear that there is no universally accepted view of how to theorise about the linkages among information technologies, telecommunications and the economy, whether the economy in question be viewed as local, national or global. Implicit agreement seemed to exist that the information technologies themselves were fast becoming global, along with some of their patterns of adoption.

Steinmueller emphasised the need to account for the supporting institutions and attitudes if the productivity paradox was to be resolved. Doubling of performance levels each decade has been a feature in information technology for five decades, and he saw no reason for this pace to slow over the next decades. (Indeed, since past progress at the frontier may have increased the gaps between leaders and laggards, there may be grounds for faster average rates of productivity growth at a global level over the coming decades.) In 1955, the focus was on computers moving outside science, and telephone networks becoming global. In 1965, the menu of new technologies was growing, as was concern about their control. In 1975, the scope for new entrants was increased because the high pace of technical change allowed newcomers to leapfrog established firms. By 1985, ICTs were seen to fuel anew the debate about the right size for organisations. In 1995, the end of the cold war and the beginning of fiscal stringency have changed the slogans and agendas once again.

ICTs make new worlds, in terms of products, services, and organisations. This requires adjustments for quality change and new products. For example, how can we compare financial services in 1965 and 1995? "Information wants to be free." The chasm is between the low marginal cost of knowledge distribution combined with the need to cover average costs. "User friendly is an oxymoron." The counter-example most favourable to IT might be anti-lock braking systems, which add to driver capacity without removing volition. Steinmueller also conjectured that there may be higher payoff to using knowledge, rather than its production. This leads to: "Codification is becoming the essence of

economic activity". Also relevant is the need to find standards: interoperability (failure so far), vs. internet and WWW (successes).

Robin Mansell emphasised the importance of a conjuncture of technologies and organisations required for successful innovation. She noted how important it is to take into account the time taken in successful adoption and diffusion. However, time is not the only issue. If the current system is not being used to capacity, if there are institutional barriers or mismatches in skills, then returns to ICT investments will be much diminished. Life cycles, time dependencies, and organisational competencies need to be considered together. She suggests comparative research on life cycles of representative technologies. The missing link may be a metric linking technical capacity, human capabilities and regulatory and institutional capacities. Failing this, the paradox may remain.

David Teece focused mainly on telecommunications. The gap in understanding is of the link between technical capacity and organisational capacity to use techniques to good effect. Benefits appear to flow through more rapidly where competition is permitted to operate, making use of networks of networks. Competitive principles require integrative enterprises to deal with the obvious complementarities. The US model is moving from an integrated monopoly to competition among a number of competing systems, linked by common standards and interconnection. These complementarities mean that interconnection is necessary for the benefits to flow through to the consumers. But need it be mandated? This is still an open issue. Unbundling is widespread in telecommunications, with basic system capacity being made available to competing providers of services. Here mandating has been crucial, although this may diminish the incentives to develop future cost saving innovations to the basic network made available to all at cost. In the future, policy-makers should encourage the drift towards competition, and keep the playing field level by encouraging competitive neutrality and avoiding the temptation to pick and support champions. To the extent that regulation and competition conflict, the latter should be allowed to rule. New Zealand was offered as a good example, with falling prices and fast productivity growth being achieved as a result.

Bruno Jullien and Anna Creti's main emphasis was on network externalities, especially in telecommunications. Current theory is far from adequate. The direct network externalities are exemplified by communication networks, where the value of the network is a positive function of its size and scope. Reduced-form studies express demand for network services as a function of price and anticipated network size. Network externalities imply the inefficiency of the competitive solution. Problems with the reduced-form models include uncertain dynamics. A second approach is mix-and-match, with consumers buying systems where the utility is a function of the bundle of components. Issues include the temptation for dominant firms to reduce compatibility. There may also be a quality problem where system performance is a complicated function of the quality of the components. Other issues include frictions in shifting from one system to another. Turning to ways of measuring the aggregate impact of telecommunications on aggregate productivity growth, Anna Creti noted that some growth models assume exogenous productivity growth, while others take for granted externalities of the sort that telecommunications are often thought to provide. Cross-sectional studies so far relate IT to growth of output or of total factor productivity. The problem of reverse causality is emphasised.

In discussion, Carl Belding of IBM Europe said that ICT affects productivity by making ventures using ICT more able to design and deliver new products to the market at competitive prices. Technical change in hardware has reduced the need to economise in writing software code, and the communications bottleneck may be about to be eliminated. This will make a far greater range of services available. In 1980, IBM predicted 250,00 PCs for the world. Now there are 100 million. In five years 5 trillion bytes per second will be transmittable in a single cable. Twenty-fold increases in the capacity of given cables are now possible just by filters. All of this will have an impact on the economy. He distinguished several eras:

Efficiency era: inventory control, accounting.

Enabling era: weather forecasts, CAD/CAM.

Restructuring era: Financial sector, teleworking, retailing.

Knowledge era: data-mining of customer records, tailored images from digitised images. The home domain is equally important. Patterns of work: salesmen on the road. Help desks are being distributed wherever there are people able to do the job. Examples in northern Sweden (also Moncton in Canada). Jobs may be created where workers are located, and costs are low, with resulting job losses, perhaps temporary, in other locations. Traditional tools for forecasting the pace and nature of future technological change and the resulting markets are notoriously bad. In mainframes, $1 million ten years ago is $10,000 now, still being called mainframes. Software is much developed by users, but not so accounted. The PC dominance in the 1980s to some extent came about because the central data processing services in large enterprises were not able to deliver the potential of new technologies. The fax machine was under-forecast. The links between telecommunications and travel needs also remain ill-understood. The Internet has two million new users a month, a development based on the availability of a network, and a proliferation of low-cost means of access. The only regulation likely to help in IT is basic anti-trust. In telecommunications, access to the basic system may need to be mandated.

Calvin Aterteck of Bell Sygma noted that the cost reductions in computing power are there, but wondered whether the increasing power being put on desks is really needed, and hence really productive. If word-processing is all that is being done, how should the power of the system, and the scope for productivity increases, be measured? With respect to Mansell, he agreed that sub-components of systems did not have the same rates of technical progress, but thought that was to be expected. With respect to Teece: the emphasis seems to be on making the organisation adapt to the technology. Should there not be equal emphasis given to making the technologies adapt to the organisation?

From the floor, it was asked why PCs are vertically disintegrated, while telecommunications are forecast to be vertically integrating? Teece answered that the complementarities may be more important in telecommunications. Steinmueller thought that vertical integration in telecommunications had no economic logic: What is the link between the highway and the cars?

Another questioner wondered if, even though productivity measures may not show increases, the quality of work life nonetheless may have been improved by information technologies. Robin Mansell replied "maybe", with there being advantages and disadvantages (screen fatigue, carpel tunnel syndrome?)

Session 2: Methods and Tools for Analysis

In session 2 on research methods, Hausman followed John Hicks' suggestion of estimating the consumers' surplus as a means of valuing the introduction of a new service, thus paving the way for analysis of the costs and benefits of regulatory delays in the introduction of new services. First one finds the price that would set demand equal to zero, using Hicksian compensated demands. Then calculate the consumers' surplus that the innovation would provide if implemented. Data from 14 states and five years are used for the messaging calculations, with demand for messaging explained by fixed effects and prices, with a price elasticity of 1.1 and an income elasticity of about 4. The consumer surpluses they estimate to be 5 billion per year from messaging, and 25 billion from cellular phones. These values are large enough to make delay very costly in the cases examined. Earlier introduction would reduce consumers' surplus

somewhat, since technology improves during the interim, but the calculations suggest these adjustments are not large in the two cases examined. What about diverted demand? (Forecasts are often wrong: At the time of the AT&T breakup, they estimated that by 2000 there would be only 5 million cellular users, wrong by fivefold five years early.)

Georges Ferné described the OECD case studies covering information-technology-using transnational firms in several OECD countries. Their confidential approach enables the collection of data too recent, too unquantifiable, too sensitive or too specific to be obtained by other means. Preliminary results, in manufacturing, commercial services, and public services provide support for the notion that information technology adoption is slow to get started and has a long way to go. Supplier linkages and internal resistance are both important, and firms producing information seem to be more advanced in IT adoption than are firms using IT in goods production. One firm cut its staff in half and used IT to replace them - productivity under pressure? Another firm used IT not to replace people but to broaden the range of services offered. Eventual workforce cuts seem likely, with productivity improvements exceeding the increase in product demand. A car producer thought of IT to enable leaner and more flexible production with more out-sourcing and more customised products. Employment down 13 per cent since 1991, with revenue per employee up 20 per cent. The general conclusion was that the pace of transition towards more intensive use of IT is likely to accelerate, and spread among networks of suppliers and customers. For example, the IT use by a customers service will impact on the importers, brokers, and so on. The examples support a general view of heterogeneity, discontinuity and experimentation.

Yasuhisa Nishikawa described the input-output models being developed by the Japanese Ministry of Posts and Telecommunications. They have found that a comparably defined info-communications industry was responsible for 6.7 per cent of Japanese value added, compared to 7.3 per cent for the United States. The corresponding figures for employment are 5.8 per cent in Japan and 6.1 per cent in the United States. Comparison of the value-added and employment results suggests that either capital intensity or productivity levels in the information industries are relatively high (in comparison to the rest of the domestic economy) in both countries, and more so in Japan than in the United States. The input-output approach invites us to measure the importance of an industry in terms if its relative growth rate, and to measure its impact on the rest of the economy by in terms of what it purchases from those other sectors. What is missing is some measure of the relative rates of return on investments in this industry and elsewhere in the economy, and some way of measuring the external effects of innovation in this sector, including consumers' surplus calculations of the sort presented by Hausman for messaging and cellular phones.

Shane Greenstein illustrated his paper on the demand for computing by using his joint work with Tim Bresnahan revealing once again the long lags in technology adoption. In this case large enterprises kept using mainframe computers long after the smaller alternatives appeared to be more cost-effective. In explanation of the slow pace of changeover from mainframes to smaller platforms, they hypothesise institutional rigidities (referred to as internal adjustment costs) and IBM's joint role as mainframe supplier and provider of software services to large enterprises. The tie to the vendor did not seem to matter nearly as much as the internal costs of adjustment. The new client server technology posed higher costs for some classes of user, especially banks and insurance companies, and their slow pace of changeover appeared to be mainly due to the advantages of their existing systems and the costs of changeover. In terms of research strategy, he emphasised the need for selective eclecticism in research methods, and emphasis on the process of commercialisation of IT products and services.

In discussion, Lester Taylor admired the Hausman performance, echoed the Ferné call for well-chosen case studies, noted the value, but inherently out-of-date nature of the Japanese input- output study, and applauded the Greenstein plea for more careful institutional study as part of the empirical

researcher's tool-kit. The papers as a group show the limits of traditional methods and theory. Taylor notes that Hausman estimated the demand for new services using data for old services. At this stage, the results do not help to indicate the demands for services still to be introduced. The Ferné study shows that there may be job losses in firms when IT is introduced, but jobs in the real world do turn up, even if the micro and macro models available cannot forecast exactly where and when. Still missing is to make the link between the place where innovations lead to job cuts and the places where prices of related outputs fall and demand increases, inducing new capital investment in its trail. On the demand side, although macro studies can indicate aggregate growth, industry studies are needed to tell which activities, on the basis of the income elasticities, are likely to grow faster.

Hal Varian noted that Hausman did not pay attention to network externalities, since he was dealing with an incremental use of a given network. When network growth is rapid, these may be large, and are difficult to measure. He used a setup with heterogeneous buyers showing that there are three equilibria, of which only the highest (and highest welfare) equilibrium is stable. In the world, the lowest level equilibrium is often found. How does this relate to the Hausman paper? Varian suggests that the benefits of the new technologies he is evaluating would be even larger if the network externalities were properly taken into account. Turning to the Ferné paper, he noted that it is always easier to make money than to save money, so that information sellers will be more likely to adopt new IT, as Ferné found. He noted that Japanese data are better than US data for developing IT-related input-output tables, since they are better disaggregated by line of business. Turning to the Greenstein paper, he noted that fixed costs of adoption were augmented by technological uncertainty and the assurance that delay will permit even further technological advance and cost reductions.

Peter Johnston of the EC liked Taylor's mention of the limitations of traditional methods of analysis. Although case studies are interesting, selection bias is a real hazard. On the input- output analysis, timeliness of data is a problem. Riel Miller of the OECD asked how it was possible to quantify the internal costs of adjustment.

Dale Orr wondered if the Hausman calculations overstated the possible consumer surpluses.

Jerry Hausman predicted that delay on technical standards in the EU would be used to permit delaying tactics by companies or countries, which in turn would be very detrimental for consumers, echoing Taylor's comment that the consumer surplus lost through delay is never made up. In reply to Dale Orr, he acknowledged the need to allow for foregone consumer surplus elsewhere in the economy, and said that the size of the adjustment is very small. (Are there examples of too-fast technical adoption?)

Session 3: Data

The third session dealt with data. Donald Bellomy of the International Data Corporation presented data on the global information technology market, sketching its growth from the late 1980s to the mid 90s. He reported that the in-home IT market is already larger than that for the telecommunications industry, and that software and hardware sales are of roughly equal size. Within the hardware half, twice as much is spent on single-user systems as on multi-user systems. IT spending as a percentage of GDP is about 1.5 per cent (in Europe) to 2.5 per cent (in the US) in the OECD, compared to about 0.5 per cent elsewhere. Since 1990, IT spending growth has been higher in North America than in Europe and Japan. Proportional rates of growth are fastest in Latin America and SE Asia outside Japan, mainly for catchup reasons. The current IT market of $430 billion is about 5 per cent data communications equipment, 18 per cent packaged software, 28 per cent single-user systems, 34 per cent services (including training, repair, consulting, etc.), and 15 per cent multi-user systems. The fastest growth has been in services and

single-user systems. In the hardware category, the fastest growth is in PCs, with some growth in work stations, and none in the other categories. By class of user, there has been a broader distribution of spending, with almost all sectors having IT spending fairly equal to GDP share. In terms of stages, the first was that of proprietary mainframes, the second of PCs and open LANs, and the third, just starting, is that of pervasive connectivity. Fifteen years in the future, he sees the era of multimedia content, where content providers will re-acquire supremacy. In the meantime, a more open and innovative scene.

In discussion, Lester Taylor queried the comparison between telecommunication and home IT spending. Bellomy responded that just PC spending for homes is now as large as all IT spending in the telecommunications industry. Asked how the data were collected, Bellomy said that the primary sources were the vendors, but direct surveys are done of users covering 16,000 sites worldwide.

Fred Gault of Statistics Canada reported on some of the collaborative efforts, mainly by countries in the Voorburg Group, to develop standard classifications and surveys for service industries. He emphasised that deregulation and convergence of broadcasters and carriers would affect the statistical system and the delivery of other services ranging from health to education. He also reviewed the structure of the Statistics Canada data collection efforts, based on the system of national accounts, driven by and driving surveys, industrial classifications, satellite accounts, and special purpose studies. In addition, surveys are done for clients, for regulatory authorities, and for purposes of international data exchange and standardisation. Price indices are being developed for the telecommunications and IT industries. Output of IT is the sum of sales by firms in IT industries, secondary production by firms in other industries, and own-account production by the using firms.

David Luck described Australian efforts to assess the likely evolution of broadband service to homes. Their emphasis was on the demand conditions, with the technology assumptions being used primarily to inform estimates of the prices of alternative services. The three levels considered were distributive services (pay TV), centralised interactive services (pay TV on demand), and generalised interactive services. The main user classes considered were time-rich and cash-poor families (retired and unemployed, a principal market for entertainment)) and the time-poor cash- rich (professionals, a principal market for information and education services). Because of much higher costs of supplying remote areas, the contestable market is much higher in the urban than in rural areas. The results suggest that without telephony, cable networks are unlikely to be profitable even in urban areas. Microwave distribution systems would be profitable. With telephony revenue added on the same cable, the present value becomes positive for inner urban areas. interactive services do not seem likely to be profitable until the end of the century, and fully interactive services thereafter. Luck noted the need to develop independent data sources based on individuals and their heterogeneous interests and incomes.

Maria-Louis Caravatti noted the difference between economic and political considerations; with the latter meaning that in the US even current data collection efforts are under threat. The data problems are worst in the service industries, which have themselves been in the forefront of the development and application of IT. Deregulation has spawned new firms and industries, but has also reduced their obligations to provide data, making the industrial structure harder to track.

Gunther Moller of Eurobit spoke, as a data user, of the need for new data. His first example was of the differing estimates of the effects of information infrastructures on new jobs in Germany. The estimates vary from +5 million to -10 million. (But is this not a question of analysis rather than of data?) The issue areas he emphasised include: impacts on growth, on jobs, on societal structure, and on the physical environment. The status quo data were summarised, from national, OECD, EU and ITU sources. The biggest data gap is in production and employment in software and services. He presented EITO (European Information Technology Observatory) estimates of global market totals and shares that differed

substantially from those presented earlier by David Bellomy. He attributed the substantially larger estimated size, and the greater EU share, to the use of a broader range of data sources. (Perhaps a broader definition of the industry as well?) Future needs include better basic data, wider distribution, more uniform standards for data classification and collection.

In discussion, Chuck Hulten pleaded information overload. In searching for themes, he noted that both the speed of change and the ill-defined concepts are adding to the funding shortfall in contributing to the problems of building a suitable data base for IT. Cross-cutting issues include data quality, network issues and classification issues.

Units of measurement are a key problem in IT measurement of prices and quantities. Adjusting for quality change is naturally a key part of the appropriate division of value between price and quantity.

The network issue was raised most directly by the Luck paper. It applies to information itself, as well as to the hardware and software networks that permit its distribution. Network capital, unlike normal physical capital, simply cannot be accounted for without some measure of how and who it connects.

To achieve comparability over time, multiple classifications may be the only way of permitting consistent analysis over time while also capturing the rise of new industries and the decline of old ones.

Genio Staranczak of Bell Canada wondered how such a large industry as telecommunications could not have a deflator prepared by Statistics Canada, when there are indexes for everything for electric motors to breakfast cereals. In general, goods industries seem to get more than their share of the data resources. Second, statistical agencies should tailor their output more closely to their audiences. Sometimes data are re-organised into a form where they are not recognisable, and are then used to charge his company with predatory pricing. It would be easier for the industry if the collection staff had more knowledge of the industries. Third, more efforts should be made to adjust for quality changes. He was not sure about the use of hedonic price indexes: could it really be true that the price of computers has gone down by 99.9 per cent over twenty years? Is calculations per nanosecond a sufficient statistic?

Fred Gault responded that comparability of statistics with company use would be easier to achieve if companies used more similar methods to keep their accounts. The data are for the use of the people, and it is not for the statistical agency to control those uses.

Session 4: Productivity and Growth

Session 4 turned to productivity, led off by Chuck Hulten. Hulten drew the parallels between IT and the physical infrastructure debate. He noted that in the physical capital debate much of the interest was sparked by the supernormal rates of return estimated by Aschauer and others. Hulten's own estimates of rates of return to infrastructure in the developing countries run around 10 per cent, compared to five times that high in the Aschauer estimates. He also noted that his studies in developing countries found more evidence favouring telecom investment than other forms of infrastructure. On the methodological side, he noted that taking network effects into account was quantitatively important. His example related to congestion effects. He also noted that quality adjustment in service prices is very important. (It also has implications for productivity measurement.)

Jean Barbé of France Telecom started by presenting statistics on the growth of the telecom sector in France, with an average growth rate of 4 per cent in the 70s and 8 per cent in the 80s. Their explanatory model shows an income elasticity of 0.54, much less than that estimated in most other countries, and a price elasticity of -.32. The income elasticity result is made consistent with the fast growth of telecom

output by means of a trend growth of 4.8 per cent per year. Turning to the reverse causality, they make use of results from several French macro models. The shocks to the model are investment expenditures in the telecom sector, with the resulting effects on GDP ranging from 0.07 per cent to 0.12 per cent. They would also like to consider spillovers from telecom investments abroad to GDP growth in France. Another project is to build an input-output model with special allowance for the contribution of the telecom sector. (All of these types of research are representative of the kinds of studies that have been made over the years to show linkages. But what can they show?)

Franco Morganti of Databank presented a number of scenarios for growth effects of EC growth under alternative telecommunications strategies. They estimated productivity gains for early and late adopters of IT. (What is the evidence on the returns to early and late adopters?) The neutral scenario has BB in private networks 93-98. followed by two more cycles of fuller penetration. His proactive induces more and larger late cycles, while an accelerated scenario speeds the process up. The estimated GDP effects for incremental growth to 2008 range from 2.7 per cent to 6 per cent for the three scenarios. Rather than assume that productivity gains are fully translated to output growth (as Coen did for the comparable US study), the European study assumed a less than complete translation, which differed among countries but apparently falls in the range from 0.8 to 0.97.

Christian Antonelli described a study using input-output tables for the Italian economy, emphasising the telecommunications sector. There are some branches that are catching up in telecommunications intensity, and others which are forging ahead. The next problem was to search for linkages between communication intensity and the levels and rates of growth of productivity. To do this, they estimate the rate of growth of output from an equation using the rates of growth of capital, labour, and communications intensity. They found an output elasticity for capital of 0.55, for labour of 0.10, and for communications intensity of 0.15. This implies quite large diseconomies of scale, along with capital and telecommunications elasticities far higher than their cost shares, and a labour elasticity far lower.

In discussion, Ernie Berndt first dealt with hedonics. He did not accept the idea of dividing the quality increase proposed by Hulten. He agreed that the costs of introducing new products were important, but not easy to quantify. To the Barbé paper, he pointed out the difficulty of untangling the two-way causality between telecommunications investment and GDP growth. Both are difficult. Had Apple priced its services differently, the equilibrium solution in the small computer market could have been very different. He also noted the importance of substitution effects, changing the mix of goods that will be produced. Finally, he noted that Antonelli's coefficients suggest substantially decreasing returns to scale.

Morganti says that there must be an explanation for lower growth in Europe. He hypothesised that the US economy has fewer mature sectors, and has a growing market, thus making it more able to produce output growth rather than just employment decline in response to technical progress. (The economics literature generally traces this back to the greater flexibility of the US labour market. The latter is not an unmixed blessing, in this literature, since it is also responsible for the worsening income gaps between rich and poor in response to what is thought to be skilled-biased technical change.)

Jeff Bernstein commented on externalities, noting that there are network and spillover externalities in the telecommunications sector, while only the network effects are present in the case of physical infrastructure. He reported his finding that 10 per cent of manufacturing sector productivity growth is due to R&D in telecommunications. These spillovers can be international as well as among industries.

From the floor it was asked how you could square the estimated labour coefficient of 0.1 with the labour share. Antonelli blamed a low cyclical situation, which would mean that labour hoarding would

have been in operation. (By implication, the labour coefficient is downward- biased, leading to net upward bias in the other coefficients.)

Another questioner asked how you should estimate the rates of return to infrastructure. Hulten said that matched samples may help, but this will not deal adequately with network effects.

Morganti was asked about the accelerated scenario, and what it required. He noted education, plus some incentives. He noted that the US was achieving accelerated adoption without specific subsidies.

Hendrick Röller presented preliminary results from joint work with Leonard Waverman on the spillovers from telecommunications infrastructure to economic growth. They utilise pooled time series and cross section data based on Summers/Heston ICP GDP data plus penetration rates for telephone service. Despite their attempts to separate the two-way effects linking telecommunications and growth, they estimate spillovers from telephone penetration to growth so high as to be unbelievable. A 10 per cent increase in telephone penetration increases GDP per capita by 6 per cent. This is a social rate of return well over 100 per cent. Since neither they nor others believed the results, the question then arises as to what to do next. (One way of cross-checking is shown in Figure 1, which shows average growth rates of TFP in OECD countries from 1971 to 1991 plotted against the 1970 rates of telephone penetration. The apparent negative relation is significant, showing that the countries with higher telephone intensities had higher average rates of growth of total factor productivity over the subsequent twenty years. Since other research has shown convergence among the OECD countries over this period, and since the initially richer countries tended to have higher values for telephone intensity, Figure 1 needs correction. If an equation is estimated explaining productivity growth in terms of initial income and initial telephone intensity, the apparent negative influence from telephones is reduced, but both variables have significant negative coefficients. These results also obtain if the productivity growth is measured over the 1970s only, to eliminate the possibility that the fast growth was of countries that increased their telephone intensity and their productivity after 1970. The implication of this cross-sectional evidence is to cast further doubt on any very high estimates of positive spillovers from telephone intensity to aggregate productivity growth.)

Hans van Meijl presented joint work with Luc Soete using French sectoral data to estimate the spillovers from IT to productivity growth. They find significant spillover effects from R&D in the IT sectors to productivity growth, especially at the end of the data sample. They find these results consistent with the earlier studies using US and Canadian data.

Jeff Bernstein raised conceptual, specification, and measurement issues. On the conceptual side, he distinguished technological spillovers from pecuniary externalities based on changes in product prices. Bernstein regards it as more difficult to make the case for externalities from IT capital than from R&D, whether in IT or elsewhere. On measurement, if there are various inputs to innovation, it may not matter whether you measure the stock of knowledge in terms of the inputs to knowledge production or to the outputs of research, *e.g.* patents. He prefers using R&D or R&D capital. He made a case for better data, both for R&D spending and prices and durability. On weighting procedures, the weights are usually independent of the production decision. These fixed weights may bias the measure of spillovers. Perhaps alternative weighting systems should be tested and compared. Using input-output tables to weight spillover variables may not be relevant. His research with Nadiri suggests that neighbouring industries (in an input-output sense) do not appear to be the primary recipients of R&D spillovers. Turning to estimation, he argued that the specific functional form influences the form that spillovers may take, and suggested that more complex production or cost functions may be appropriate.

Bob Logan of the University of Toronto asked whether the van Meiji and Röller analyses could be used to show whether there are spillovers from education to the rest of the economy. The authors said that this would be feasible.

Steve Nickell asked what the exogenous driving variables were in the simultaneous equation system. He wondered what the penetration variable was standing for, as a means of explaining why the estimated result was as large as it is. Dale Orr asked van Meijl if there was an omitted long-distance externality due to the fact that the recipients do not pay for calls. Network externalities, by contrast, are likely to be smaller in mature systems. Lester Taylor noted that calls tend to give rise to further calls, especially with Canadian data.

Len Waverman asked why IT should not be the source of externalities, since Bernstein was willing to accept that R&D should be a natural source. In answer, Bernstein noted that for R&D there were knowledge spillovers, while there were are well-defined prices for IT services, and hence fewer grounds for expecting spillovers to exist.

Frank Lichtenberg estimated a production function with firm-level data splitting capital between computer and non-computer capital, testing to see if there are different marginal products to the two types. He is searching whether there are excess returns to computer investment. If there are excess returns, then one would expect TFP to rise with computer investment, other things equal. He finds substantial excess returns to computer investment, based on cross-sectional data. This leaves open the possibility that efficient firms are buying more computers, with computers getting credit for the efficiency. Accounting for firm effects, to allow for this risk, cuts the excess returns in half, but they remain significant. The share of capital in computers is remaining flat, with the dramatic rise in the power of installed computers being offset by price reductions. There appears to have been a decline in excess returns from the 1980s to the 1990s, while these returns remain large. A parallel test using profits data shows a correlation between computer intensity and profitability, with the possibility of two-way causality remaining. He considers also the possibility that computers are increasing efficiency by improving inventory management and reducing average inventories. He finds that computer-intensive firms do indeed have lower ratios of inventories to sales. With respect to firm size, he finds that smaller firms are more computer intensive than larger firms, although all of the firms are large enough to be in the Fortune 500. Turning to labour market aspects, he finds strong linkages among education, age, and computer use. Computer use strictly increases with age, and is higher in the middle age groups than among the very young or older workers.

Steve Nickell argues that it is impossible to predict the number of jobs created or lost through IT. What should be a concern is if IT impinges on the efficient structure of the labour market. If IT introduction creates turmoil in the labour market, then there may be cause for concern. But since the overall amount of labour market turnover is no higher now than twenty years ago, there is no prima facie case against IT on this score. A more likely idea is that IT may be contributing to the skill-bias of technical change, to the detriment of unskilled workers. In itself, this is no problem, given the increasing supply of skilled workers. Yet in some countries the fall in the demand for unskilled workers has proceeded faster than the fall in supply. In the United States, the drop in the fall of the relative income of the bottom decile of the population has been socially corrosive. Nickell presents the case of Germany as one where the bottom decile of income earners has not suffered, hoping thereby to see how this has been achieved. Over the 1980s, the bottom decile wages rose 4 per cent per annum faster in Germany than in the United States, so that by now the poorest German workers earn twice as much as their US counterparts using purchasing power parity, or even more if market exchange rates are used. Among unskilled workers, the unemployment rates in the two countries are rather similar, suggesting that labour market rigidities in Germany are not the source of the result. Public sector employment does not seem to be a factor; and nor do labour market factors. He thinks a more likely candidate is the education and training system. The

proportion of highly educated has grown in both countries, even more in the United States than in Germany. But what is striking is the high levels of education in the German workforce, especially at the bottom of the income distribution. In Germany, the number of people who score very badly in standard test scores is very small, while it is very large in the US and the U.K. In addition, the German post-school training system is much more extensive and more effective than in the United States. His conclusion is that if IT is not to have negative effects for those at the bottom of the income distribution, then education policy has a key role to play.

Susan Baldwin took a broadcasting perspective, with emphasis on content. The hard aspects of IT are easier to measure and deal with than those related to content. StatCan estimates that the cultural sector broadly defined was of the order of 4 per cent, and fast-growing. The content is the cars on the information highway. (Are the people being hit by the cars, or are they in the cars?} IT now permits content to be developed and customised in far-flung locations. If content is to be regulated, it must first be understood. If IT creates productivity and cuts jobs, perhaps the content industry can provide the jobs, she suggested. The challenge is to ensure that individuals have the skills necessary to live and work in the information society. Her questions: What will be the impacts on trade, employment, and output? What are the education consequences? How is content related to these issues? Low cost infrastructure is crucial, but content is what will determine the consequences of the highway. Her choice of topics: Where are new jobs being created? Are the right data being created? Are the right classifications being used? Who are the content providers? Is there a case for a Bill of Rights for the Information Society?

Alain Dumort of the EC projected future increases in volumes and decreases in prices in EC telecommunications, with rationalisation being both a spur and a consequence. What is uncertain is the extent of job losses from rationalisation, and the number of offsetting job increases from the growth of new services encouraged by deregulation and lower prices. There is likely to be a continuing shift of employment from the telecommunications sector to the business services sector. The IT equipment industries are not likely to be a major source of jobs in Europe, given the strong foreign competition. IT is also permitting the creation of jobs by increasing efficiency in traditional industries, such as agriculture and textiles, moving them toward a position of cost comparability with foreign producers. His policy recommendations include removal of obstacles to competition, removal of financial obstacles and reducing market failures, adjustment of labour market rules, and improved training and awareness.

Werner Herreman of the EC focused on structural policy issues. If there are to be structural polices, they must be in response to structural problems. These are, in his view, insufficiently open economies, too much instability in macro-economics policies, inadequate co-ordination of adjustment polices, and obstacles posed by inefficient social welfare polices. These are exemplified and exacerbated by the high rates of unemployment. Education does not focus enough on life-long learning, and the tax system contains barriers to job creation. ICT provides the possibility for new industries with an EC comparative advantage. ICT also poses the prospect of job dislocations, so that to move toward an information society, policy changes are needed to encourage flexible responses and to promote rather than to stop change.

Yumio Imamura of the Japan Association of Information Users concluded the session by explaining trends in new and growth markets. The strong yen and the recession combine to force changes in the industrial structure, with continuing decline (via foreign production) of manufacturing and heavy industry, with corresponding increases in housing, living, culture, information and telecommunications. He noted that computer use, in terms of MIPS per capita in 1992 was 139 in Japan, eighteenth among the OECD countries, well below the US at 516. He was confident that narrowing this computer gap would support further productivity growth.

In discussion, Erik Brynjolfsson summarised the Lichtenberg evidence as adding to the new productivity paradox: how can information technology possibly be so productive? To deal with the new paradox, he thinks that computers are merely a part of a larger restructuring being successfully undertaken by some firms. In short, there may be several omitted variables whose credit is being given to computers. He liked the approach and the use of firm level data, but queried whether excess returns could be inferred from the estimation of gross marginal products, since the depreciation rates are much higher for IT than for other capital. Thus you would find a significant coefficient even if there were no excess returns, although the coefficients are high enough to suggest that the excess returns will remain intact. He noted that adopting new technologies with existing procedures and workers may be difficult, given the extent to which existing procedures are known and loved. Does this perhaps mean that faster IT change favours new entrants? To make the change acceptable, it may be necessary to help insulate the losers from the worst effects of the winds of change.

Riel Miller of the OECD noted a division of opinion and approach. On one hand are traditional approaches, and on the other a greater concern for institutional factors. Both groups seem to think there is rapid change and a sense of urgency that there are problems to be dealt with. By way of constructing a bridge, he proposed the use of scenarios that would embrace collectively the presumptions of different groups. In one scenario, for example, the spatial and temporal radicalism implied by the Internet stories comes to pass. Jobs are temporary, as are firms, with production done by networks. Skills are gone, since the consumer controls the system. Schools are gone, and the ecology of daily life is transformed. But how? National governments are gone too, with international establishment of a framework and local government doing the rest.

Inuk Chung of KISDI linked the productivity surge in the early 1990s to network externalities and extensions. He agreed with Susan Baldwin that the convergence of cable and broadcasting was bound to raise many issues of content, requiring much more thought.

A question from the floor asked Susan Baldwin if the current policy of local content rules and bundling will not lead to losses rather than gains in employment in the content-producing sector, Also, the polls do not suggest much support for subsidies of culture and the arts. Is it therefore sustainable? She replied that a new look was needed at current broadcast regulation. Quotas are not the policy objective; the objective is to maintain a significant Canadian content on Canadian screens and bookshelves. On the survey evidence, she noted that it also shows that one of the biggest public concerns about the information highway is for Canadian content.

Riel Miller's scenario was supported from the floor by Garth Graham of Telecommunications Canada, speaking from his involvement with groups that are establishing operating contacts and community-based control via the Internet. The content creators are concerned that the multiplication of intermediaries in the interest of creating jobs may in fact stand in the way of communities making best use of the new possibilities.

Session 6: The Research Agenda

Pasi Rutanen, Finnish Ambassador to the OECD, noted agreement within the OECD and the conference that much more substantive research needed to be done. He supported Robin Mansell's plea for a broader theoretical approach, and the idea of using IT itself to help generate data on IT and other industrial sectors. The challenge for the OECD is to develop first an international consolidated data set. The data have to be relevant to policy makers as well as the data providers. Part of this should be to develop better measures of the nature and extent of human capital development. The role of education is

likely to be key, but here too the data base is still weaker than it should be. He wondered if the pervasive use of international networks may force more decentralisation of national governments.

Carl Belding of IBM Europe regards the available data as inadequate for policy purposes. In terms of gaps, he was expecting to see more from and about the developing economies and the emerging democracies in Eastern Europe. Some of these countries are leap-frogging mainframes right into PCs. Better data will permit a better vision of what the information society will look like. One agenda with milestones would be better than short-run and long-run research agendas. A business panel could work in concert with a panel of experts, supported by panels of officers of national statistical agencies.

Peter Johnson of the EC recalled the starting article of faith in the great benefits of a rapid transition to an information society, but noted that there did not seem to be enough convincing research for this belief to achieve broad social support. Even in the absence of such research support, the intuition of politicians will do the job, perhaps quite well. The political leaders are not asking what the information society will look like in twenty years, they are after some indication as to what has to be done now to make the best of future developments. Points arising from the discussions: Externalities were often referred to. Structural change was widely thought to be in train, making it dangerous to extrapolate from past trends. Third, complexity is rife, making analytical solutions either multiple or complex. Why not use information theory and complex systems? Data do not capture the invisible economy, and where do you record trading over the Internet? If he had to make decisions now, he would opt for intuition over current research results.

Dimitri Ypsilanti of the OECD admitted that there had been some hope for getting answers from the conference, while in fact there was more progress in expanding the list of questions. There was much talk of data, and there is clearly a role for the OECD in helping to co-ordinate the development of standards. What is the message to policy-makers? There was too little emphasis on the fact that the telecommunications industries are so highly regulated. The message that must go forward is that there are large gains from accelerated deregulation, taking Jerry Hausman's evidence as a guide. To deal with the possible interim job losses, some cushioning policies may have to be designed. He noted the importance of studies like that of David Luck in assessing the potential demand for increased services. Finally, there was little attention paid to the extent to which globalisation of information was changing the scope and potential for macro-economics policies.

Len Waverman thanked the participants for coming, and noted that there is no single magic technique for analysing the data; rather it is important to use all methods, and relate the results obtained from diverse data using diverse research methods. There are many studies to be surveyed. Finally, he was suspicious of the Johnson view that policy makers would prefer to ignore the current state of research and proceed by use of intuition.

Hendrik Röller wished to support the Belding proposal to improve the international data base. His three chosen research areas are on the demand side for IT services (including allowances for changing institutions), the infrastructure-productivity nexus, and the impacts of IT on employment. In reply to Helliwell's reference to the data shown in Figure 1, he noted the need to use fairly current penetration rates. (See the parenthetical comment in the part of this report dealing with section 4).

Robert Crandall of Brookings noted the lack of discussion of the effects of competition policy. He thought David Luck's Australian example was interesting, and thought that satellite service might leapfrog ground-based land systems. In the US, satellite services now seem likely to dominate broad-band services, unless there is a strong demand for interactive services. On the demand side, the most interesting paper was by Hausman, with its indictment of restrictive government policies. Every time Crandall hears

'the need to consider the effects of.." he assumes the consequence to be a lowering of GDP by 0.1 per cent. He suspects that unemployment will be found to be explained by labour market factors, and not by what is happening in information technologies. Excuses to slow down deregulation are easy to find, but expensive to heed. Increasingly research is fuelled by panel data sets that are purpose-built, and which do not require the involvement of statistical agencies. This suggests that for many purposes the data will have to be found by the researchers.

Luc Soete noted the increasing use of firm and establishment data, producing results that are very interesting but specific to the data samples. In the OECD, there is need for getting data sets that are more consistent. Where are we in the meeting point of the two OECD mandates (the Detroit jobs mandate and the information society mandate). Four points: The global information structure seems not to be delivering new services sufficiently rapidly. One possible reason is regulation, or the lack of deregulation. The second is the failure of service providers to come forward, perhaps also for regulatory reasons. There may also be convergence on the productivity issue, with some of the newer results supporting the idea that IT has induced productivity gains. Since these are agreed positions, it is not surprising that they were not debated strongly here. Third, there is no convergence on the question of whether there is skill-biased technical change. He thinks the US and UK results favouring skill-biased technical change may be specific to other institutional changes that took place in those countries.

Finally, Pasi Rutanen wondered whether there was a case for the OECD Interfutures study of the 1970s to be repeated in the 1990s.

SUMMARIES / OUTLINES PROVIDED BY SPEAKERS

TELECOMMUNICATION SERVICES AND PRODUCTIVITY GROWTH

Cristiano Antonelli
University of Turin

New information technologies should be regarded as a new emerging technological system. A technological system is characterised by high levels of complementarity and interrelatedness among different technologies that are at the same time product innovations as well as process innovations, organisational innovations and more broadly markets. Such an array of technological innovations is characterised by a strong complementarity that affects productivity levels. Telecommunications services play a strategic role in this context: their prices and delivery conditions are likely to influence the more general patterns of adoption of the new technological system based on new information and communication technology and hence the overall levels of total factor productivity.

In this paper we have measured the output elasticity of telecommunications services used by 30 Italian industries by estimating the role of telecommunications services on the growth of output in the years 1985-88 within the framework of a Cobb-Douglas production function. Data used to measure the use levels of telecommunications services were drawn from input-output tables.

Because of the high values of output elasticity of telecommunications services, estimated in our empirical analysis, it seems clear that all reductions in the prices for telecommunications services delivered to the business sector are likely, especially with elastic portions of their demand curve that make it possible to increase the total amount of telecommunications services sold in the market place and used by firms as a strategic production input, to induce a significant increase of the overall levels of output and total factor productivity.

So far the reduction of the prices for telecommunications services becomes an issue that is relevant not only in specialised debates on the "appropriate" market structure and industrial organisation of the telecommunications industry, but for a much broader set of issues concerning the overall growth of the output and the productivity of the entire economic system.

In this context the present characters of the industrial organisation and market structure of the telecommunications sector, at least in most European countries, where it is respectively based on high levels of horizontal and vertical integration among switching, transmission and distribution for both data and voice communication and state-owned monopolies, is far from ensuring that minimum prices for telecommunications prices are actually practised.

First, even under proper regulatory schemes state-owned monopolies are in fact unlikely to fix market prices that respect the standard rules, *i.e.* that are determined where marginal costs equal average costs as well as the marginal revenue.

Second, a large empirical evidence suggests that the performances of state-owned monopolies are often characterised by objective functions of the management that do not necessarily lead to cost minimisation. The empirical evidence also reveals that wages in state-owned enterprises are far higher than in other industries that can be compared in terms of skill requirements and job profiles.

Thirdly, the lack of competitive pressure is likely to have significant effects in terms of delays in the rates of introduction and adoption of technological organisational innovations in the production of telecommunications services.

Fourthly and most important, in most European countries the prices for telecommunications services delivered to the business sector, by means of differentiated pricing with respect to the basket of product specifications, reflect high levels of cross-subsidisation in favour of the prices or telecommunications services most commonly used by households.

Following the well established procedure of Ramsey pricing the levels of telecommunications tariffs are fixed assuming that the supply curve for telecommunications services has still a negative slope, because of important economies of scale, so that standard pricing rules cannot be applied. Hence, in order to minimise welfare losses, determined by prices that are necessarily above marginal costs, the anelastic portions of the aggregate demand curve are discriminated and the prices are fixed to far higher levels than those practised to the basket of services most used by households, that is the more elastic portion of the aggregate demand for telecommunications services.

Our results suggest that Ramsey pricing do not seem appropriate when the aggregate demand taken into account is the result of the summation of a derived demand, that is the demand for telecommunications services of the business sector for productive uses, and a final demand such as that expressed by households.

The positive welfare effects of Ramsey-pricing fall under question when the indirect effects of prices above average costs for the services delivered to the business sector are to be taken into account. A proper calculation should in fact take into consideration the comparison between the direct effects of below-average-costs pricing to households with the indirect effects in terms of the opportunity costs of the output and productivity gaps determined by above-marginal-costs pricing for the basket of services most used by the business sector.

Our estimates suggest that such indirect effects are likely to be very high so that the net result in turn is likely to be negative. Elaborating on our empirical estimates one can argue in fact that the opportunity cost of output and productivity gaps determined by the application of Ramsey pricing and hence cross-subsidisation appear to be very high.

According to a large body of empirical evidence in fact the price-elasticity of the demand for telecommunications services, estimated in the proximity of the equilibrium conditions, t current market prices, is very high. It can be easily argued that even small reductions of the prices for the basket of telecommunications services most used by the business sector, such as data advance and long distance services, are likely to be paralleled by a significant increase in the total amount of service used by the telecommunications services delivered to the business sector, are likely to "induce" significant increases in the overall levels of output and productivity for the whole economic system.

These conclusions are likely to become even more relevant when we take into account a more dynamic context of analysis, one where the characters of the transition from one technological system to a new one are properly considered. The adoption of new information and communication technologies is far from saturation levels. The diffusion process of new information and communication technologies still underway and even more so the new networking technologies based upon the enhanced complementarity between informatics and telecommunications. Moreover their diffusion is delayed by a variety of factors, among which the prices for complementary services such as telecommunications is by no means a

negligible one. Hence the emergence of such a technological system is a lengthy process that requires time and a variety of complementary efforts and actions.

All reductions in the prices for telecommunications services delivered to the business sector are likely to engender even sharper increased in the levels of actual usage of telecommunications services than those expected on the basis of the values for price demand elasticity. Their indirect effects on the adoption of information and communication technologies should be accounted for.

Reductions in the tariffs for telecommunications services delivered to the business sector in fact have a direct effect on the variable costs of all the technological system characterised by new information and communication technologies, so as to affect directly their profitability of adoption and to push their rates of diffusion.

SUMMARY OF COMMENTS

Susan Baldwin
Director General - Broadcasting Policy Branch
Department of Canadian Heritage

Statistics Canada indicated that in 1992-93 the estimated *direct and indirect* impact of the Arts and Culture Sector, which includes written media, broadcasting, film, sound recording etc., was over 600,000 jobs and contributed $24 billion towards our GDP, accounting for 4 per cent of Canada's GDP. At present we can only speculate on the repercussions of the new technological advances. As a result of technology, content "pieces" can be developed in many different places and integrated in its final service form. The structure of new service development, the opportunities for developing countries as both markets and service providers, skill and education requirements, and the potential to reduce cost in other areas must all be examined.

Assumptions

- While productivity and wealth is increased by the introduction of new technologies, (infrastructure) is also responsible for a decrease in jobs. The services (content) and their applications on the information highway will create jobs, which are highly specialised and well paid.

- Canada will be in a position to cope with social and political transformations and develop a new economy only on the basis of a strong "content" industry (**content** is the value added to data: in other words information on information that takes the form of services, applications, knowledge bases, programming (television/film), multimedia (print, video, graphics, sound music, animation, etc.) coursewear, interactive television, "infotainment", etc. to name a few.

- The backbone of future information societies, the cultural industry, relies on the integration of critical mass of creators, producers and business leaders, and content that could be developed based on a network integrating all these players.

- This industry will have to be supported by a series of actions designed to create, produce and disseminate internationally competitive (quality) Canadian content.

- The "information society" in which we are already living is based more and more on knowledge and communication links and less on material tangible values (*i.e.* personal banking is no longer filling out a paper slip and handing it to a teller, in the information society the automatic banking and electronic transfers are now common place). The challenge will be to make using these types of applications of technology cultural everyday practices in the same way the reading, writing and mathematics were introduced over 150 years ago.

Questions

- What we do not know, and what is not yet quantifiable, are the employment, cultural and societal benefits that may be realised through the hard technology.

- What will be the impact of information services on our labour markets, on our current trade practices and policies, and on employment?

- Who is being displaced by the new technologies, and who is replacing them?

- How can we orient our education systems and training programs to meet these changing patterns in employment?

- Is the terminology we use to describe, and the indicators used to measure data relating to the information society relevant and accurate?

There is also the overriding issue of access: whoever controls access to the *content* will also control access to the economic and cultural benefits of the technology. In order to deal with the attitudes of disenchantment and uncertainty felt by the populations of many countries, as outlined in the OECD paper intended for the upcoming Ministerial meeting, we need to understand the impact of what will be on the highway, how it got there, who will create it and how it might benefit society.

- The purpose of further study, which was first proposed by the G-7 Ministerial meeting on the Information Society (Brussels, February 1995) and agreed to in principle at the OECD Ministerial meeting (Paris, May 1995), would complement OECD work in progress entitled Technology, Productivity and Job Creation study which is examining the impact of new information technologies. This second study would examine the impact of information services -- the content carried by the technology, on productivity, job growth, wealth creation, and the promotion of indigenous cultural products and services created by the new information services on the information highway in the information society.

- It is important to know where new employment is occurring, not only in order to determine what education and training programs will be need, but to determine the trends before they occur.

- Services on the Information Highway are very much the reason that we are seeing global economic integration -- the “how” is possible through hardware; the reality occurs when services flow.

- There are both short and long term issues that must be examined in a study of this nature. One element of the analysis may be the longer term monitoring for the purpose of understanding where trends are developing.

- If governments wait to see the results, by measuring after the fact, we may very likely miss the economic, social and cultural opportunities for our citizens.

- No matter what the technology who ever controls access to the content will determine who will have -- or not have -- access to the information society.

- In order to address the attitudes of disenchantment and uncertainty felt by the populations of many countries, as was outlined in Secretary General Paye's conclusion released at the OECD May 1995 Ministerial meeting, we need to understand the impact of what will be on the highway, how it got there, who will create it and how it will benefit society in order to make it relevant to our citizens.

PRODUCTIVITY AND GROWTH

Jean BARBE
France Télécom

Introduction

This paper presents a few macro-economic studies --either completed or in progress in France Telecom, on the link between GDP growth and the telecom sector. It has originated from a paper project for the "*Annales des Télécommunications*" by Michel Gensollen et Antoine Laubie and from work in progress within the Bureau of the Economic Studies of France Telecom.

Study of growth of the telecom sector in France in the past 20 years

The growth in the activity of France Télécom (yet still concentrated in the telecom sector as such) becomes more and more dependent on the economic environment. The diffusion of the telephone in the population is quite finished and therefore growth is no longer the result of supply phenomena. The following graph shows historical data for the volume growth of turnover over the last 25 years.

Using econometric analysis, the impact of some economic factors on growth has been quantified. The following equation has been adjusted:

Elasticity / GDP	0,54
Elasticity / Relative Price	-0,32
Elasticity / Household Equipment Rate in Tel	0,29
Trend	4,8 %

Other studies by SEE within DPS,[1] give precise values for each of these parameters for several sections of the FT market (household, enterprises, enterprises in the primary, secondary and tertiary sectors, in Ile de France or in the Provinces). In the future, the development of traditional vocal telephone services may show down. However, new services will contribute to the growth of the telecom sector. Re-estimating models will not be easy and will have to be preceded by a phase of surveys.

Impact of the telecom sector on growth in France

Once the impact of economic conditions on the growth of the telecom sector has been measured, one can reverse the problem. For this one uses the following variables:

- Receipts from the sales of telecom services, taking into account gains or losses in the purchasing power of economic agents following tariff changes;

- Intermediate consumptions or capital expenditures for the use or development of the network.

The share of intermediate consumptions in the national total is still small (0,3 per cent now). But the share of investment of FT rose from 4 per cent in the 1970s to 8 per cent in the 1980s, before decreasing again. Modelisation of the impact of investment on the economy has been made using macro-econ. models, built by INSEE[2] or DP.[3] The following table shows the effect of an increase of FF 1 billion 1970 (*i.e.* + 10 per cent in volume in the 1980s) of capital expenditures of FT between 1983 and 1986 in the models COPAIN, METRIC, DMS and PROPAGE.

	COPAIN	METRIC	DMS	PROPAGE
GDP Volume	+0,1%	+0,07%	+0,11%	+0,12%
Employment - thousands	4,2	5,9	11,0	12,5
Inflation	0,04%	0,04%	0,1%	0%
Trade balance - FF billions	-2,0	-0,7	-2,1	-1,0
Public Financing - FF billions	+1,6	+1,8	+1,7	X

Study prospects

Two types of studies have either been planned or started:

- Construction of an econometric model taking simultaneously into account both causalities separately studied above : sensitivity of the telecom sector to economic conditions and economic development resulting from the expansion of telecom networks;

- Construction of an input/output table, so as to simulate the impact of the telecom sector on the economy.

NOTES FOR OECD PRESENTATION

Donald Bellmy
International Data Corporation

1. International IT Data and International Data Corporation

After expanding to over 40 countries in the 31 years since it was founded, IDC has developed considerable experience in tracking the vicissitudes of information technology spending.

2. Worldwide IT Market by Sector, 1994

IDC estimates the global information technology market to have reached $430 billion in 1994. Over half (52 per cent) is now accounted for by packaged software and by support (maintenance) and professional services. Within hardware, almost twice as much is expended on single-user systems (PC's and workstations) as on multi-user systems.

3. Worldwide IT Market by Sector, 1987-1994

The changing dynamics of the market can be seen by taking a longer perspective in time, which accentuates the emergence of single-user computing at the expense of multi-user systems, and underscores the increasing importance of software and of services.

4. Worldwide IT Market by Sector Proportions, 1987-1994

Nevertheless, the overall split between hardware expenditures and spending for software and for services has begun to stabilise at just under 50 per cent for hardware. This is due less to weakness in the markets for software and services than to the explosive growth of the PC market, especially the emergence of the home consumer market.

5. Worldwide Systems Market by Product Type, 1987-1994

The changing dynamics are even more obvious when contrasting the historical trends for large-scale systems (mainframes and supercomputers), medium-scale systems (superminis and Unix database servers), and small-scale systems (minicomputers and designated LAN servers) vis-à-vis single-user workstations and personal computers.

6. Worldwide IT Market by Region of Vendor, 1994

Still in the arena of products and services, US-based vendors in 1994 continued to maintain their leadership position in terms of the name of the final manufacturer or provider. Of course, if components were the criterion, the picture would look very different.

7. Worldwide IT Market by Consumer Industry Group, 1994

In terms of who is consuming IT products, the distribution by industry (SIC code) is now starting to resemble the breakout by GDP or overall relation to GDP (*e.g.*, for GDP consumers like the public sector). This is partly due to other sectors of the world economy catching up with IT pioneers such as banking and governments, and partly to the PC explosion, which has become a function of the distribution of white-collar workers and of consumer penetration (and confidence). Indeed, even without drawing on multi-user products or on services, the world-wide home sector is already as large as IT spending for the telecommunications industry.

8. Worldwide IT Market by Region of Consumption, 1994

Despite widespread assumptions earlier in the decade, the United States gained market share as a proportion of global IT spending over the past couple of years. Fuelled by this phenomenon, the Americas represented almost half (48 per cent) of all IT spending in 1994, with North America 50 per cent larger than Western Europe. The Asia/Pacific region accounted for 20 per cent of the world-wide IT market.

9. Regional IT Spending Growth, 1994

There is no meaningful metric for comparative regional growth. In US dollars, the $430 billion IT market in 1994 was 10 per cent larger than in 1993. If all regions were computed in 1994 exchange rates against the US dollar, the growth would have been 8 per cent. However, if exchange rates against other currencies were used as the conversion factor, the results would have been slightly different.

10. Worldwide IT Market by Region of Consumption, 1987-1994

The North American IT market has consistently outperformed GDP growth. However, after strong growth into the early 1990s, IT spending in both Western Europe and Japan have lagged behind nominal GDP growth.

11. CAGRs for Worldwide IT Expenditures by Region of Consumption, 1987-1994

In terms of 1994 exchange rates, the global IT market grew at a compound annual growth rate of 8 per cent from 1987 through 1994. The balance of good years against bad left North America, Western Europe, and the South Pacific at the world average. The recent hard times in Japan have dropped it several points below average, while the transition from Communist economies in Eastern Europe have kept the Eastern Europe/Middle East/Africa segments at only a little better than average growth. The only consistently strong double-digit growth has been in Latin America and non-Japanese Asia.

12. Worldwide IT Expenditures Per Capita by Region, 1994

Population continues to be very weakly correlated with IT spending. Almost 85 per cent of the world's population is in regions spending considerably less than the $77/capital global average. Four regions (North America, Japan, the South Pacific, and Western Europe) are hundreds of dollars above the average.

13. Worldwide IT Spending/GDP Ratios by Region, 1994

In North America, Western Europe, Japan, and the South Pacific, IT spending per GDP has stabilised in the 1.5-2.5 per cent range, while elsewhere in the world it hovers around 0.5 per cent.

14. Worldwide Personal Computer Spending/IT Market by Region, 1994

One intriguing difference between the IT market in developed and in developing regions is that the latter spend much more comparatively on personal computers. In part this is due to less mature services sectors and to higher rates of software piracy, but they are also less inhibited by past investments in legacy systems.

15. Change in Worldwide IT Spending by Region of Consumption, 1994-1995

Except for Latin America, which is temporarily hamstrung by the implosion of the Mexican economy, IT growth in 1995 (and for the remainder of the decade) should continue to follow the patterns developed over the previous seven years and invert the ratios for IT spending per GDP.

16. Stages of IT Industry Growth, 1970-2030

Nevertheless, it is important to note that this apparent stability will be because the IT industry is consolidating the second stage of industry development. The most significant events of the next half decade will involve the inception of a third stage of pervasive connectivity.

REMARKS PREPARED FOR THE OECD WORKSHOP ON "THE ECONOMICS OF THE INFORMATION SOCIETY," UNIVERSITY OF TORONTO, JUNE 28 AND 29, 1995

Marie-Louise Caravatti
US Department of Commerce

Information technology has been changing the nature of manufacturing for a number of years. It has increased productivity, shrunk payrolls, and changed the successful management of technology into a systems approach. Now the new information networks -- a combination of computing and telecommunications are transforming the much larger service sector.

Tracing and understanding these effects is a very ambitious undertaking and enormously difficult. As a recent article in the *Wall Street Journal* notes: "No technology has ever been as protean, so unrestrained by physical limits, so capable of cutting huge swaths through unrelated industries such as banking, power utilities, insurance and telecommunications."

Moreover, the pace and intensity of technological change are accelerating at an unprecedented rate: the power of microprocessors is roughly doubling in performance every 18 months and costs are falling at an equally dizzying rate, with the result that microchip based technology is finding wider and deeper applications.

Information passes along wires or radio waves, it is contained in software or in the minds of people. The location and nature of the contacts between consumer and provider are undergoing constant change (TV, telephone, computer, multi-media systems). Information is both an end product, and increasingly, an intermediate service. Our ability to simply identify -- l*et al*one analyse -- these changes is seriously constrained by data availability and the imperfect methodological and conceptual approaches.

To examine its social and economic effects requires, at a minimum, data on production, prices, investment, employment, wages, turnover, skills and education, the relationship between goods and services and their trade, technological and quality improvements, the size of firms and the evolution of sectors over time. And as enterprises become increasingly global, trade between affiliates, transfer pricing and multi-national market share can be added to our data wish lists.

This paper will cover three broad areas:

1. An overview of primary sources of official data in the United States

- the US Census Bureau's expansion of economic statistics, with increased emphasis on the service sector;

- the strategic review of the Bureau of Economic Analysis' Economic Accounts;

- the Bureau of Labor Statistics data on employment, wages, occupations, price indices and productivity.

2. Problems with the data, and issues that need illuminating

- All of our statistics have deficiencies, but none more than our service sector data, that suffer from all too well-known limitations in conceptual analysis, classification and collection methodologies. Information technology is inextricably intertwined with the service and exhibits all of the problems most frequently encountered when analysing this sector. These include problems of comparability, inadequate measures of output, heterogeneity, quality changes in price indices, and availability of employment data from small employers.

- As the service sector increasingly merges with manufacturing and agriculture it creates new linkages between existing industries, and entirely new industries (tele-healthcare?) that our data fail to reflect. Traditional measures of economic output -- especially at the macro level -- fail to capture the increasing proportion of services and information inputs in the value added content of goods (e.g. research, design, accounting, distribution).

- The productivity paradox exhibited by the service sector reflects all of the data problems: sales figures are deflated, however prices do not reflect increases in quality, better customisation to individual needs, greater choice etc. Traditional measures of productivity no longer make sense when efficiency improvements may show up as quicker operations, or lower output. Innovative use of proxies, such as air miles travelled, require data from other sources.

- The translation from professional to consumer mass markets complicates the jobs picture. How do we trace the impact on employment, given that we cannot distinguish between producer services and consumer services, yet we would suspect that there are differential employment effects in services to enterprises and service firms supplying consumers. What are the implications for the ways in which employment statistics are collected?

- Information technology and telecommunications have a global reach and will continue to be dominated by large multinational companies with the resources to invest in risky new technologies and industries. The rapid increase of international electronic trading of new information products and services will require new and more ingenious methods of tracking such exchanges of unknown origin. We will also need to look at the effects of mergers and acquisitions, franchising, licensing, royalties, regulation, and so on.

3. Other data sources:

All of which suggests that we will need to look at micro level data, and therefore that existing official data sources must be supplemented by special surveys, private data, and case studies. For example, the U.K. has employed "Delphi" survey methods in its recent technology foresight reviews. This will lead to other problems such as inconsistencies in definitions used and different rages of coverage.

The work of the OECD is therefore crucial in promoting international standards, systems of classification, to improve quality and international comparability, and to provide international fora in which to discuss these issues and pursue common solutions.

HOW THE IT/TELECOMMUNICATIONS AFFECT THE ECONOMY

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Summary of the paper

The growing awareness of the changing role of telecommunications in the economy raises a set of fundamental questions. Although technological dynamics are generally considered as the major causes for the restructuring of the telecommunication sector, an analysis of this transformation process focusing only on the technological would be misleading in trying to conceptualise the broader societal characteristics of the telecommunication sector. At least three factors can be regarded as a prominent causes of the transformation of the sector: *institutional dynamics*, changing the market structure from a monopoly to a competitive market; *demand dynamics*, stemming for an increased awareness of users about the strategic importance of these infrastructures; *new economic relationships* characterising the vertical and horizontal structure of the telecommunication sector. We analyse the main implications of these changes, in *a new micro-economic perspective*, regarding, on the one hand, the theory of telephone demand, and on the other hand, the new marketing and competitive strategies suppliers have to put in place in view of the technological, institutional and market dynamics the sector is facing; and in *a new macro-economic perspective*, considering the use of telecommunication as strategic input in production, assuring productivity gains and, as a consequence, economic growth.

The main elements discussed in the paper are as follows.

The micro-economic level: market and competition effects of IT/Telecom's industry organisation

Direct and indirect consumption network externalities and compatibility among systems determine the more complex "market system competition": how expectations, co-ordination, and compatibility affect three basic clusters of decisions, *i.e.* technology adoption, product selection, compatibility/standardisation.

Technology adoption decisions

Here we discuss the direct/indirect network effects and their consequences for market size equilibrium.

Direct network effect and market size equilibrium

The demand for a telecommunication network is a typical function of both its price, and the expected size of the network. The presence of adoption effects profoundly affects market behaviour and performance. Since social marginal benefits exceed private marginal benefits the equilibrium size is smaller than the socially optimal network size, and the perfectly competitive equilibrium is not efficient.

Moreover, because of the positive-feedback nature of these networks, even adoption externalities that are small at the individual level can lead to large social welfare losses.

Indirect network effect and price/market size equilibrium

The concept of indirect network effect is best discussed for *hardware/software systems*, the typical system market where one consumer's adoption decision (to buy the system or not) has no impact on the other consumers, given the prices and varieties of software available. In the market equilibrium it is likely that inefficiencies explained in *static hardware/software* models are attributable to traditional market power, not to network effects. Adoption externalities come about indirectly, through the impact of one consumer's adoption decision on the future variety or prices of components.

Product selection decisions

Direct and indirect effect have welfare implications. One interesting question is how to decentralise the welfare maximising solution in the presence of network externalities. Clearly, the welfare maximising solution can be implemented through perfect price discrimination, but typically such discrimination is unfeasible. Subsidisation can be a remedy. The ownership structure can help internalisation, but monopoly ownership will not reach full efficiency. Direct users transactions or joint ownership may also help.

Compatibility

In this section of the paper, the social benefits and costs of compatibility, as well as the effects of compatibility on price competition, quality and innovation are considered. The analysis of social benefits and costs of compatibility is the basis to examine the private and social incentives to achieve "horizontal" compatibility (between two comparable rival systems) and "vertical" compatibility (between successive generations of similar technology).

Does compatibility intensify price competition ?

For systems that are incompatible, the locus of competition shifts from the overall package (including the network size) to the specific cost and performance characteristics of each component individually. This general principle implies that if one firm has a distinctly superior overall package, including its products offering, its installed base and its reputation, that firm is likely to prefer incompatibility. However, if each firm has a superior component, firms may prefer compatibility and may spend resources to achieve it. We then discuss if *profits and prices are higher in a regime of full compatibility.*

Does compatibility lower quality ?

The standard literature of "mix and match" model assumes that the utility from a component is added to the utility of complementary component and then is accrued. However, in some network, including telecommunications, the utility of the composite good is not the sum of the respective qualities. Thus, significant quality co-ordination problems arise in a network with fragmented ownership.

Do network systems retard innovation ?

Some theoretical models focus on the *excess inertia* phenomenon, *i.e.* when users tend to stick with an established technology in a system market even though joint adoption of a new but incompatible

technology would be more efficient (because of the switching costs). But the opposite can also happen: the market may be biased in favour of a new, superior but incompatible technology (*insufficient friction)*.

The micro-economic level: the theory of telephone demand

Until the 1980's, most existing studies of telephone demand were guided by the general canons of neo-classical demand theory, but the standard statement that demand depends upon price and income is of limited usefulness. The telephone and the network to which it belongs possess a number of singular features that must be taken into account in modelling demand. Following Taylor's (1994) approach to the telephone demand, we briefly discuss the distinction between demand for access to the telephone system and demand for use of the system once access is obtained; the interdependency of the preferences across subscribers; option demand and the variety of shape and forms of telephone calls.

The macro-economic level: IT/Telecom effects on the national economic performance

The current "upswing" of the interest in innovation in economic growth theory can also be linked to the major technological changes taking place in the telecommunications industry, which have an effect on the nature of the service provided by this sector. During the second part of the 1980s a vast literature has dealt with the role of telecommunications in economic growth in which this sector appears to be a prime cause of the transformation of the economic system and the "competitive weapons" of the 1990s (Antonelli, 1992).

Since a strong link exists between the economics of telecommunication networks and growth, we overview the most important theories which explain this link.

EMPLOYMENT ISSUES AND OPPORTUNITIES IN THE INFORMATION SOCIETY

by Alain Dumort
Economic and Strategic Aspect Analyses and Forecasts

Introduction

Work being undertaken by the European Union, the OECD, and the holding of G7 summit meetings devoted to employment (Detroit) and to the Information Society (Brussels) are important signals pointing to the fact that unemployment has moved to the very top of the international political agenda. Globalisation and rapid technological progress mean that all economies of the world, especially those most developed, are faced with the tremendous challenge of adapting their economic and social organisation to profound structural changes.

As technological progress gathers pace, particularly in the field of advanced communications, it is essential that Europe embraces the concept of information infrastructures and builds inter connectable networks to fully exploit all the economic potential of its Single Market.

The impact of these advanced networks, services and Telematics applications on employment is much disputed and is still open to debate. Indeed it is difficult to forecast or even produce reliable figures. Many other driving forces enabling job creation are at stake: *e.g.* strategies of enterprises to convert technical innovation into competitive advantage to compete on global markets, flexibility of the labour market, macro-economics policy. Moreover, information and communication technologies (ICT) lead to the introduction of new work patterns. The jobs effects will depend on the capacity of organisations and enterprises to face to structural changes required. Overall driving forces improving the job intensity of economic growth has been highlighted both by the Commission[4] and the OECD[5].

One thing is certain, however, competitive advantages now lie in the use of advanced and networked ICT to support flexible business organisations. The information infrastructure will provide a vital support for the economic and social structures of the emerging information society, opening up new business and jobs opportunities in all sectors. If Europe does not speed ahead with the implementation of interconnected information infrastructure and the appropriate regulatory framework, as well as with investment in human resources, the issue in industrial competitiveness and on employment will get worse.

I. Key Issues

Productivity, Growth and Employment: lessons from the past

Growth is largely attributable to technical change which gives rise to new products, services and production techniques generating a virtuous circle of high labour productivity, income, demand, output and employment growth.

OECD and European Commission studies have shown that productivity growth related to the use and diffusion of advanced technologies, in particular ICT, is a driving force to competitiveness, through reduced costs and increased market shares. Ceteris paribus, in a favourable macro-economics environment, the combination of productivity gains, product development and income elasticity's gives

rise to jobs creation in a number of industries and sectors[6]. Higher productivity tend also to lead to higher wage for workers using ICT[7]. However, information technology systems have largely been implemented as stand-alone equipment supporting automatisation of processes particularly in manufacturing. This has led to job rationalisation and losses in the absence of accompanying product innovation and increase in the use of networked services.

Technical change has always involved a process of job destruction and skills obsolescence in some sectors. It has put pressure on the existing social structures, and has given rise to changes in the international division of labour. However, the experience of previous waves of technical change and economic cycles has been that job loss (in agriculture and industry) has been more than compensated by a parallel process of job creation in new sectors (services).

Towards the Information Society: Do the economic models of the past still apply?

The modern world economy of today is *competitive, globalised* and increasingly *knowledge-based*. Having first been applied to agriculture, then to industry, the logic of productivity has been extended to the *services* sector. Dramatic increase of productivity related to the use of ICT can therefore be expected in these services leading to labour, especially lower skill, redundancy.

The processes of *job compensation and net creation*, though, has neither been instantaneous nor convenient to the existing labour force with respect to location, sector or skill requirements.

Question 1: Can job creation in new information-related services more than compensate job reduction, through ICT-based innovation processes?
Question 2: In a globalised and knowledge-based economy, how can the employment of European lower-skill people be improved?

Underlying this transformation is the technological *convergence* between information and communication services which paves the way for new services and the introduction of multimedia application, transforming the prospects for every industry and service in the world. ICT will both contribute towards the building of an essential element of that optimal environment, the *information infrastructures,* and be engendered by it.

Since its introduction, ICT has not had a decisive impact on the *organisation* of firms, but rather on production. However, the new services and applications carried on the advanced communications infrastructure are expected not only to further change production techniques, but especially to transform work organisation and consumer behaviour patterns.

Evidence from case studies in a number of countries and sectors show that the use of advanced communication services can contribute significantly to job creation and to improvement in the quality of work[8]. These services are directly promoting the move towards a networked economy, including SMEs, which generates economies of scale (reducing costs and enlarging markets) and economies of scope (new products and services development).

Perspectives of the liberalisation of the telecommunication sector in Europe and impacts on employment

The liberalisation/harmonisation of the telecommunications sector establishes an important step to the achievement of an Internal Market in Europe. In the telecommunications sector, the necessary

legislation is finally due to be passed in the period till 1998 - both for in services and infrastructure. The inevitable adjustment of production capacities is going to tend to lower the sectorial level of employment, through increased labour productivity, but open at the same time new possibilities for growth and employment, by the development of new information and communication-related services, and by externalities associated to investment in communication networks.

Indeed, the liberalisation of the telecommunication market will boost the emergence of new markets related to the information society. Competition will increase quality, efficiency and diversity of services whilst decreasing tariffs. Lower prices fuel the opening-up of new markets contributing to create.

The analysis of employment trends accompanying and resulting from the liberalisation of the telecommunication sector is a major concern for the European Commission.

Question 3: In what sectors and occupations, and to what extent, is employment likely to grow?

Question 4: What can be done to stimulate these areas of growth?

An ambitious study has been launched to provide the Commission with prospects for the evaluation of impact on employment in the short, medium and long term (2005). Direct as well as indirect job effects, at the sectorial and macro-economics levels, will be considered. Results expected by mid-1996 will help the Commission in defining measures of social accompaniment for workers affected by the structural adjustment of the telecommunications sector and in establishing guidelines for Community policy to foster development of telematic markets.

At sectorial level, however, the emergence of new entrants on the telecommunication markets will probably not compensate the trend of job losses within traditional operators[9]. Even if the new entrants in the UK have permitted the creation of 20 000 jobs, the new service providers are also faced with the adjustment constraints of their production capacity, thanks to digitalisation of networks[10]. However, a recent study on the telecommunications sector in Finland[11] indicates that the fall in the employment related to the operation of networks, owing to the restructuring process, was more than compensated by the boom in the equipment industry (*e.g.* mobile) over the period 1987-1994.

The impact on employment is likely to be a shift in certain jobs from the telecommunications industry to the business services sector. In Finland, for example, the growth in value-added network service provision has kept at 20-25 per cent per year, according to the above study.

Moreover, the *impact of liberalisation of the markets in Europe will not be identical in regions and countries,* since the process will take very different forms in different countries, according to strategies of operators and existing infrastructures (*e.g.* cable penetration five times higher in Germany than in France) and services. These combined factors contribute to the threshold of profitability of services and there, the opportunity for new entrants to compete.

Logics of job creation, destruction and displacement

Figure 2 gives an overview of the interdependence of driving factors of ICT on employment, thanks to the characteristics of the regulatory framework, the economic environment, competitive market conditions and the labour market.

New Services, New job opportunities

Though studies suggest that only a minority of new jobs will be created in the ICT industries and services themselves, significant job creation effects are likely to be felt in many other service industries.

A wide range of new ICT-based commercial services and multimedia applications will help stimulate production output and create new job and business opportunities in all sectors of the economy, including the public sector, and at all *levels* (particularly *SME*s) by making information available to all.

The development of services has directly and indirectly created employment among services providers. The most dynamic market segments have given rise to largest job creation, such as mobile phone (40 000 job creations estimated for Germany), satellite services and value-added services. It has also been estimated that the French video-text system Minitel has directly and indirectly created 30-35 000 jobs over the last ten years.

It is also expected that by the year 2000, more than 15 per cent of publishing and information services will be electronics-based in Europe. Multimedia databases and information processing services will create entirely new opportunities in the information and education market place. Many of the new emerging demand areas have been generated by SMEs through local and regional networks.

A number of reports addressed to government have focused on measuring externalities on growth of information infrastructures. Findings, based on various and often not self-explanatory methodological framework, conclude on a particular high rate of potential return for investment.

- One dollar invested on networks (including services, applications and contents) could give rise to 1.6 dollar in GDP12.

- Two recent French studies confirm long-term "industrialising" effects on information infrastructures; according to the Théry report13, one French franc of turnover in the telecommunications networks could generate about three francs in the related services. On e of the conclusions of the other report to the Ministry of Industry on the teleservices market in France14 is that the number of jobs directly and indirectly created by all new services could rise to between 170 000 and 370 000 according to the scenarios, though many jobs will replace traditional ones.

One should also draw attention to the prospect of changes in *consumption patterns.* ICT and information infrastructures are expected to open up new service markets to the benefits of productivity. Consumers would benefit from lower prices (increasing *purchasing power*) as well as increased quality and efficiency of the supply of these services. This is particularly true of three broad areas linked to basic social needs (education and continuous training, health services and cultural/entertainment services), in which there exists significant growth potential.

Today, many of these services remain in the *public sector* under the control of the State. The quality of public services is declining drastically as governments have to make severe cuts under the increasing pressure of budgetary constraints. Information infrastructures and ICT-based services will provide an opportunity to release the increasing financial burden that public services impose on State budgets and enable the tremendous growth and employment potential of these under-exploited areas to be realised. These areas include university/school courses, distribution of catalogues (museum) or information services to enterprises and individuals (employment agencies).

These new ICT-based services as well as other telematics services (*e.g.* telemaintenance, remote traffic control) require broad expertise that will be recognised on international markets, particularly with respect to new business opportunities opened up in Eastern European countries;

Towards economic and social re-organisation

In order to exploit the job creation potential generated by ICT, Europe's society and economy must go through a period of far-reaching re-organisation. Indeed, a flexible labour force and work organisation coinciding with competitiveness in emerging markets constitute the essential foundation for achieving both *sustainable* employment and maintaining a constantly high rate of job creation.

Competitive pressure and technological change have given rise to flexibility in the location of production, in working hours and work organisation *within* firms and countries. However, inertia in existing labour structures means that it is difficult to introduce flexibility even when there is a will to do so. *ICT has a role to play in this process* by helping the introduction of new work patterns (*e.g.* teleworking, self-employment, flexitime).

II. Creating the optimal environment for turning growth in information infrastructure into jobs

The successful application and diffusion of ICT-based services depends upon levels of investment in telecommunications infrastructure and services, in human resources and in the *management of change* (techniques as well as organisation) within enterprises. Competition will exert downward pressure on costs and tariffs (*i.e.* cheaper use of ISDN, leased lines...), through productivity gains and economies of scale and scope.

The appropriate management strategies and organisational structures are key drivers for a successful organisation to be able to increase the quantity and quality of work available.

As the world economy goes through a period of restructuring, and new services emerge only slowly, measures have to be taken to accelerate and facilitate the transition to a more efficient communications system with a view to maximising the employment intensity of European economic growth.

The role that *public policy* has to play in the process of structural adjustment is to implement measures which can act as catalysts for change, remove obstacles, facilitate experiments with new technologies, and promote learning and knowledge through education and training. The objective of facilitating adaptation to industrial transformations and to the evolution of the production system constitute a new mission for the Community through the Social Fund.

Removal of Obstacles to Competition on the European markets

The regulatory landscape should be adapted to the new requirements of globalised economic competition and technological innovation. For the telecommunications sector this involves opening up new business opportunities for non-traditional operators.

The interconnectability of trans-border communication infrastructures and the interoperability of applications and services (standardisation agreements) must be ensured, as well as the availability of these services to all potential users.

Issues on security legislation such as intellectual property rights, security of systems, data privacy should be clarified.

Removal of Financial Obstacles and reducing market failures

Public authorities, and the European Union in particular, can play a catalytic role by helping to generate a critical mass of demand and investment in certain application fields, where the prospect for commercial viability may be judged to be uncertain or slow to take off. This could be the case for application of collective interest in areas such as education, healthcare, culture. In the context, the investment threshold for the rapid introduction of innovative ICT-based services and applications should be reduced, particularly for SMEs (*i.e.* through interest rebates, loan guarantees).

The Commission is proposing a decision to the Council of Ministers and to the European Parliament on a series of guidelines for trans-European telecommunication networks. Priority is placed on stimulating the implementation of user-driven applications of collective interest, as they underpin the deployment of networks.

Adjustment of Labour Market Rules

Adjustment and mutual recognition of the legal framework should be achieved so that employees who are willing to work differently (part-time, home working, teleworking, etc.) do not lose social protection or suffer a downgrading of employment conditions.

The transfer of employment from one sector to another should be eased through mutual recognition of qualifications and skills.

Training and Awareness

Work skills should be continually upgraded and uprated to keep up with the latest technology, new techniques and new working practices (increase information and computer literacy, develop new attitudes to work and aptitude for life-long learning).

Employees' and managers' understanding, organisational capabilities and confidence in new work patterns and in new services production and demand should be developed.

The diffusion of best practices in the use of new ICT-based services should be encouraged. Stimulation by example should be tested through the direct commitment of public organisations.

ANNEX

TURNING GROWTH IN INFORMATION INFRASTRUCTURE INTO JOBS

From vicious to virtuous circle using advanced communications

	vicious circle	**virtuous circle**
product	- conceived as hardware and logic	- conceived as knowledge and intelligence
technology	- stand-alone information technology hardware and software - making the machine more efficient - inward looking: island of automation	- trans-organisational advanced communications services - releasing the potential of the brain - outward looking: complex networked trading relationships
organisation	- downsizing - de-layering, but otherwise structures and hierarchies often unchanged though slimmer - machine like	- retaining jobs or upsizing - de-layering accompanied by transformation and de-centralisation to become flexible and virtual - *brain-like*
work processes	- emphasis on process at expense of product innovation - automation, speeding up, rationalisation of existing processes - processes stop at boundary of organisation	- emphasis on both process and product innovation - developing new processes and thereby new types of activity - processes cross organisational boundaries
workforce	- machine-tending - repetitive tasks - single role (specialists) - limited initiative, alienation - once-off training and de-skilling	- as a creative part of the brain - flexible, multi-tasks - range of roles (generalists-specialists) - wide initiative, responsibility, teamwork, empowerment - continuous training and up-skilling
competitiveness	- reducing labour costs - speeding up and making existing processes more efficient based upon labour rationalising benefits of information technology hardware and software	- reducing costs of other inputs include. co-ordination and transaction costs - flexibility and developing new processes, products and new business opportunities based on creative use of human capital using advanced communications services

CANADIAN STATISTICS ON THE INFORMATION SOCIETY

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Statistics Canada

1. Introduction

This note presents some of the data sources at Statistics Canada which are relevant to the Information Society. It describes plans to provide more information in the short term and looks at longer term needs.

Data on the information society include measures of the use of information products by people and the economic activities of firms that use and produce information products. There are extensive statistics on education, health and social issues, census data, demographic and intercensal studies and family expenditure. Business and trade statistics are collected and analysed in the context of the Canadian System of National Accounts (SNA) which provides measures of value added, capital formation, income and expenditure and trade, as well as input-output estimates, by industry and by region. There are also measures of employment, unemployment and labour income by industry and region.

As new information products enter the economy, they cause economic and social change and introduce gaps in the on-going measurement programmes of the statistical agency. As a result, measurement programmes have to adapt and change to provide the information necessary to address social issues and to provide adequate information to the SNA. This evolution of the measurement programme is neither new, nor peculiar to the information economy. It is part of an on-going review process.

The mechanisms for change vary with industry and with social issue and they can be initiated by clients, by regulatory agencies, and by the agency itself, or in collaboration with interest groups. An example of a client initiated measurement is the recent survey of demand for telecommunication services, carried out for the Department of Industry and analysed and published [1] jointly with Statistics Canada. Surveys of radio and television, and of cable television, conducted by Statistics Canada, are revised each year in consultation with the Department of Industry and the regulator, the Canadian Radio-Television and Telecommunications Commission (CRTC). This consortium reduces the burden on respondents by combining the statistical survey questionnaire and the annual return required by the CRTC into one document. Finally, in the broader area of service industries, of which telecommunication services is an example, survey development and revision is conducted in close collaboration with the Voorburg Group.

The Voorburg Group is a group of statisticians, mainly from national statistical offices, concerned with developing the Central Product Classification for service industries and with the development of model surveys, which are put forward as vehicles for testing draft lists of service commodities. This work is carried our for the United Nations Statistical Commission and a published example of it is the model survey for computer services [2]. There is also a model survey on telecommunications services under consideration by the Group [3].

In the longer term, there are questions about how a statistical agency should look at the information society and the information economy in particular, including the social and economic impacts of change. This raises questions of the role of a national statistical agency in the provision of data on the

information society and the relative importance of official statistics, private sector surveys, and surveys of policy ministries.

2. Data Sources Now Available

A selection of data currently available at Statistics Canada which could be used to describe the information economy is listed in the Appendix. The selection is illustrative rather than exhaustive, and concentrates on information and telecommunication industries. For a full list of printed and electronic sources reference should be made to the Statistics Canada Catalogue [4]. Statistics Canada information is also available on the Internet (Gopher: talon.statcan.ca, World Wide Web: http://www/statcan.ca).

A very recent release from the General Social Survey provides characteristics of people who use computers in the workplace [5].

3. Plans for Development

The telecommunication services industry is used to provide an example of development plans. All surveys at Statistics Canada are reviewed regularly and there are initiatives to fill gaps in measures of education, health and service industries. To keep response burden to a minimum, administrative sources are used wherever possible to provide statistical estimates. These sources include trade records, income tax returns, payroll deduction returns, and the records of the goods and services tax (GST). The introduction of a single business number (SBN) may provide additional means to use administrative data to reduce the burden of surveys.

3.1 The Voorburg Model Survey

The Voorburg model survey of telecommunications provides an example of new information which could be collected from Canadian providers of telephone services, including resellers and providers of cellular service. This survey is still under review by the Voorburg Group and its implementation in Canada would require extensive consultation with industry, with the regulator, CRTC, and with Industry Canada. None the less the model survey provides guidelines for the development of the existing surveys of providers of telephone services.

3.2 Resellers and Cellular Service Providers

An immediate initiative is to survey those firms which purchase and resell capacity for transmission on the telephone system and those which provide cellular telephony. These surveys are supplements to the existing Telephone Statistics Survey and they will provide preliminary data on these economic activities for the years 1993 and 1994.

3.3 Price Indices

As part of the Statistics Canada programme to improve service industry statistics, new price indices are being developed for the telecommunication industry. While these are intrinsically interesting, they will also permit improved deflation of the output of the industry and the consequent estimation of real growth and productivity.

3.4 Standard Industrial Classification (SIC)

The way in which statistics are collected, analysed and published depends upon the industrial classification as well as the commodity classification. The Canadian, US and Mexican industrial classifications are to be revised by 1997 and the work of revision of the SICs is being undertaken through an international collaboration. As a result, the structure for broadcasting and telecommunications in the North American Industrial Classification System (NAICS) will change for the structure now used in the Canadian 1980 SIC [6].

4. Future Needs

In the future, the collection and analysis of data on the information society will have to take into account a number of economic and social factors. The economic effects of deregulation, leading to convergence of broadcasters and carriers, the cultural impact of widely available programming transmitted by satellite, the economic and social impact of the Canadian Information Highway on health care, education, and government services, as well as its role as an electronic market place.

The statistical system, which is well able to measure financial transactions of firms, classified by industry and commodity, and to count and classify people, will have to turn to more innovative measures of information flows among firms and between firms and people. One of the key emerging issues in describing economic and social activity, is that propensity of firms to introduce new or improved products and processes to maintain their competitiveness. As well as measuring the propensity of firms to innovate, there is also a need to understand how the system of innovation, which involves all sectors of the society, is able to capture ideas and convert them to wealth and jobs. Not only is this information necessary for a single country, but it must be produced in such a way that the information is internationally comparable, if policy makers are to benefit from these measures.

If measurements are to be made of national systems of innovation, there is a need for a conceptual framework within which to fit the information gathered and to add value to the analysis of the set of measures of economic and social activity. In producing and implementing such a framework, there is a clear role for a statistical agency, although it could not be done without extensive consultations with interested groups and clients. A statistical agency provides a business register to support surveys and the linkage of data from different surveys and the SNA provides a context in which to develop satellite accounts for groups of industries which have a common purpose, such as those involved in the information society.

The statistical measures discussed so far have all been of activity external to the firm. There is also the issue of information workers and activities that take place within the firm. However, measures of own-account production and use of information services can be quite burdensome and depend critically on accounting practices. If resources are limited, measurement of own-account activities should wait until there is a clearer picture of economic and social activity outside of the firm, described within a conceptual framework.

With or without a conceptual framework, there is an interest in measures of use and planned use of telecommunication services [1]. These indicators of demand, which vary by industry and by service offered, are different from the various performance indicators collected and published for the service providers [7]. Demand indicators, which have long been used for manufacturing technologies [8-10], are now attracting a following among policy makers and, with increasing deregulation and improved measurement, they are likely to become a permanent policy tool.

5. Conclusions

The measurement of the information society is complex, if inputs to economic and social activities are to be linked to outcomes and if the measurements are to be useful for developing policy. These measurements must also be developed and analysed in close collaboration with the users of the data, and, ideally, in collaboration with statisticians from other countries, if the results are to be internationally comparable. For this to happen, there must be a conceptual framework for the measurements which provides a system within which to do analysis.

Only in a statistical agency, or agencies, will the infrastructure be found to support such an undertaking, and if new and innovative measures are to be made, there will have to be investment in that infrastructure. However, that requires a long term commitment, both nationally and internationally, and the co-operation of data providers and data users.

There will still be the need for immediate measurements to satisfy a particular need of a policy ministry, or a regulator, and these can be satisfied by *ad hoc* surveys and reports. There is also a place for measures of technical information of use to the industry concerned that are better made and marketed commercially. However, the question remains of the long term role of the statistical agency in illuminating the problems and opportunities of the information society.

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APPENDIX—SELECTED DATA SOURCES FOR INFORMATION TECHNOLOGIES AND TELECOMMUNICATION SERVICES

Catalogue No.	Title
Service Producing Industries	
Telecommunications	
56-002	Telephone Statistics, Monthly
56-203	Telephone Statistics
Broadcasting	
56-205	Cable Television, Annual
56-204	Radio and Television Broadcasting
Computer Software and Electronic Information Services	
63-222	Software Development and Computer Service Industry
Goods Producing Industries	
Telecommunication Equipment	
43-250	Electrical and Electronic Products Industries
Economy-Wide Sources	
Research and Development	
88-202	Industrial Research and Development
88-204	Federal Scientific Activities
Capital Expenditure	
61-205	Private and Public Investment in Canada

Catalogue No.	Title continued...
Prices	
62-001	The Consumer Price Index
62-555	Family Expenditure in Canada, Irregular

Economy-Wide Sources

Employment and Earnings	
72-002	Employment, Earnings and Hours, Monthly
72-005	Estimates of Labour Income, quarterly
Labour Force	
71-220	Labour Force Annual Averages
Trade in Goods and Services	
65-001	Summary of International Trade, Monthly
67-203	Canada's International Transactions in Services

Integrated Data

Gross Domestic Product	
15-001	Gross Domestic Product by Industry, Monthly
Income and Expenditure	
13-201	National Income and Expenditure Accounts
Input-Output	
15-201	The Input-Output Structure of the Canadian Economy

THE DEMAND-SIDE APPROACH TO INFORMATION TECHNOLOGY

Shane Greenstein
University of California, Berkeley

What factors shape the design and execution of econometric studies of buyer behaviour? This talk will emphasise two themes, one falling under the label "commercialisation," and the other, "selective eclecticism". After framing the relevant issues, I will then devote equal time to both themes. Please excuse the self-promotion, but this talk will illustrate these themes with examples from "The Competitive Crash in Large Scale Computing," a study that Tim Bresnahan and I finished this fall. It is based on a large survey of roughly ten thousand large system users in the United States. We study the decline in demand for mainframe computers in response to the diffusion of client/server technology. (For copies, please contact either CEPRE, Stanford, CA, 415-725-1874, or NBER, Cambridge, MA, 617-868-3900).

Defining "the demand for computing"

First, what do studies of the demand for computing actually study? For my money, the "demand for computing" means the demand for all computing platforms, large and small. To be sure, PCs are likely to be the most important sector in the future, but most casual observers misunderstand the scale of importance. Throughout most of the late 1980s and early 1990s, the sales revenue associated with PCs was just over a third of the sales revenue for computing equipment in the United States. Even the broadest definitions of microprocessor based systems, encompassing both PCs and workstations (as defined by the Computer) Manufacturing Business and Equipment Association) will still result in less than half the revenue associated with computing equipment today in the United States. If we examine stocks of computing equipment -- leaving aside traditional economic issues associated with measuring the value of a stock of capital -- larger systems are also equally important. While mainframes and minicomputers have declined over the last decade, they are no dead. For reasons explained below, these conclusions are not likely to change soon.

Second, who are we studying? The most important users are business organisations in the United States. Business use of computing continues to define the largest part of the market and virtually every business enterprise buys something from the computing market. Banking and finance are the most computing-intensive sectors, though many sectors of manufacturing , wholesaling and retailing, transportation, and other services are now not far behind in computer intensity.

There are some obvious and not-so-obvious reasons behind the ubiquity of computing in business. Computing applications on mainframes, minicomputers and micros influence every facet of a typical office. Enterprises use computing for simple administrative work like report writing, for more complex tasks such as co-ordinating inventories or for operating internal control systems, and for very complex tasks such as executing financial transactions or processing real-time transactions with small delay. These are essential functions in virtually every modern and efficient economic enterprise -- more

on these functions and what they entail below. (In addition, there are factory floor applications, which are another animal, largely unstudied by economists, clearly important to manufacturing, and which I will hardly mention again in this talk.)

Third, why study the "demand for computing?" There is a simple reason and a complex reason. The simple reason is that without understanding demand it is impossible to understand dynamic developments in this industry. For example, why do buyers adopt one technology, but not another ? How much impact does new technical developments have on the buyers and users and why? How has computing technology altered the skillset needed for while white collar work? So far so good, but still too simple a reason to study demand. A more complex reason is that economists already know quite a bit about changes in supply conditions and about changes in prices. But this is not enough. Though we have learned from and will continue to learn from this research about supply or research about prices, even with the aid of hedonic price indices, we also fail to illuminate many issues. The principal gap is that we will fail to fully understand difference between buyers in any given year or changes in buyers over time. Changes in demand over time, variation in demand across a set of users in any given year, or substitution elasticities between ostensibly competitive products lay behind most studies of productivity growth, diffusion of new technology, returns from investment in information technology, or restructuring of administrative work around information technology, to name a few important topics.

Fourth and finally, how to study the "demand for computing?" Generally, economic analysis is a data-intensive exercise. It necessarily involves collecting data about individual computer users and organisations and their behaviour. The interesting and difficult part involves organising this data, sorting it, asking the right question, and analysing the data under different hypotheses about economic behaviour. Though these steps may seem obvious, virtually every economist who has ever measured the demand for computing -- and I am as guilty of this as anyone -- has measured the demand for computing equipment in a hardware-centric sense. That is, economic studies of the demand for computing usually become studies of the demand for the *computing equipment.* While measuring the demand for hardware is not the ideal thing to do, it is still quite difficult, more feasible than any alternative, and nonetheless, quite informative.

Selective eclecticism for understanding organisations

New computing technology changes rapidly, so computing designs change rapidly, so every few years buyers find themselves in from of a new set of choices. This is interesting for one reason. When an organisation makes a major computing equipment acquisition it puts much of its routines at risk, potentially revisiting an enterprise's core strategy for structuring operations. To appreciate this statement requires facts, theories, and lessons from a *selective eclectic* variety of sources.

To begin with, it helps to understand how users use computer equipment in practice. Effective use of modern computing equipment involves networks, which means communication equipment and networking technologies, old and new software, and large doses of human intervention. The networks are called local-area networks and wide-area networks, but these often involve private and public communication lines, private and public switches, and in the last few years, client-servers architectures -- though no two engineers seem to agree on exactly what that means yet. More broadly construed, computing infrastructure involves everything from wireless communication devices, to microprocessors embedded in the switches, to thousands of miles of copper and fibre cables. On the human side, effective use of computing technology means countless hours of training, learning, maintenance, and frequent restructuring of important and minor routines. On the software refining and retrofitting old software.

Why worry about all the details? Getting new equipment potentially alters every facet of an organisation, its operations, its staffing, and its final product, and it has consequences for many potential expenses far beyond the actual purchase of the equipment. Though generalisations are incautious, for most computing, the yearly expenses associated with staff, software programming, maintenance and support usually exceed the hardware expenses by several orders of magnitude. Moreover, computing functions and communicating functions shape the way an enterprise operates, how it co-ordinates its business, the products and application and outputs, tend to incur very different magnitudes of adjustment costs. For batch-oriented back-office functions or critical-function real-time applications.

These details are complex and my experience has been that they arise in a variety of ways when analysing computer demand. Economists must ask a selective eclectic variety of questions about the interaction of organisations and technology: How do users employ their systems? Who provided the hardware and the software? Does the user retain large in-house programming and large maintenance staff for upgrading systems? Do the dominant applications require centralised management and control or do many dozens of users experiment in an air of decentralised management? And so on.

The adjective *selective* is there for a reason. This is not an argument that all the economists and applied econometrician who study the demand for computing need to become obsessed with infinite detail or take courses in the management of computing systems or their marketing. Open ended or purposeless question-asking or fact-finding about so much detail is generally useless. However, the label *eclectic* is there for a reason too. Careful institutional work is not yet part of the standard econometrics canon. However, a few evenings curled up with an information systems management book and several very good person-to-person interviews with actual information system managers will be useful for most research on computing demand. The more important point is that without such idiosyncratic knowledge, one runs the risk of being irrelevant -- *i.e.* a selective eclectic knowledge base is essential for asking the right question about computing markets, accurately explaining what happens in computing markets, and for interpreting the information contained in statistical estimates. All this is not difficult for most economic researchers; most good researchers do this anyway, just quietly.

Time for an example to show where some eclectic knowledge helps. In the early 1990s business stayed with their legacy systems in droves, surprisingly unwilling to move to a new client-server platform. This seems to make little sense at first blush because the new systems ostensibly had higher technical benefits across a wide set of uses. One big theme running throughout Bresnahan and Greenstein's study of large scale computing users is that one needs to understand both benefits and cost s at the organisational level. Many users knew about the potential benefits of client server, but were also painfully aware of the costs. In particular, abandoning legacy large systems came with larger internal adjustment costs than technologists and engineers anticipated or cared to admit in the trade press.

"Internal" is the important point. The costs of adjusting are "internal" to organisations when no market exists for costs incurred, but instead depend on organisational incentives for inducing employees to bear those (often hidden) expenses. Tim and I came to appreciate that the management of large systems explained many difference across users. The only types of users who largely moved to client-server were engineers and academics, who tend to have decentralised organisations, and lower and more dispersed internal adjustment costs, but make up only a small fraction of total demand. Many big-system users did not change at all and knew from personal experience that the trade-press and hype were seriously wrong. Thus, the user specific data helped explain why the aggregate market demand shifted downward, but much less than predicted by those in the majority of the trade-press who predicted (and are still predicting) a revolution in computing technology.

Commercialisation processes and competition

It is a bit of simplification to say that every new technology diffuses in a complex competitive environment. More to the point, virtually every demand study, irrespective of its goals, has to explain why new technology does not diffuse immediately. On a general level slow diffusion is not surprising, but its explanation illuminates a core issue in the demand for computing.

The appearance of a new technology offering lower costs or superior capability rarely leads to instant replacement of the old technology. After all, users may be reluctant to retire computing capital that continued to offer a flow of useful services, even if technical change apparently depreciates the market value of those services. What is more surprising is that the old computing technology continues to sell and viably compete long after the introduction of the new. Sellers of the old technology may find their competitive circumstances changed, but react quite naturally with new pricing or new technology strategies. Buyers may also delay their purchase of the new technology until anticipated price/performance improvements appear. Often buyers need to become informed or to make other investments to take advantage of "enabling" technologies. The larger point is that the pace of adoption of the new technology, the pace of retirement of the old, depends on all the factors that shape the competition between old and new. These market-based factors get the label *commercialisation*.

Though it may sound didactic for an economist to emphasise the importance of market processes, it is nonetheless true that understanding commercialisation processes is one key to understanding computer demand. parts of this research agenda encompass traditional economics questions about the influence of competition on vendor and buyer behaviour -- how the number of firms, the concentration of suppliers, or the degree of technical uncertainty influences the price of final products, the elasticities of substitution between old and new products or different varieties of products, market shares of new designs, the average vintage of the installed base of computing capital, the product life cycles of new designs, and so on.

Parts of the agenda also encompass a desire to understand less traditional issues. Does the degree of closeness between vendor-buyer influence the pace of adoption of new technology by making the buyer resistant to new technology from new vendors? Why do computing platforms tend to be dominant by small number of technical standards, and do these incumbent standards lockout new applications that require incompatible standards? Do users adopt new technology more willingly in markets with unified technical leadership than those with divided technical leadership? Does the purchase of a new technology come with expectations about the possibilities for future change and advance -- if those expectations change, how do they shape behaviour in predicable ways? And so on.

Time for another example to show commercialisation processes at work (or in this case, to show that a particular market force did not influence outcomes as much as many thought). Bresnahan and Greenstein investigated whether a user's ties to its manufacturer made a user more resistant to new technology. While stories on this issue abound, there is little systematic statistical investigation of it. One can easily wee why this is an important question, since a single firm provides roughly two thirds (by number of boxes) of all large general purpose systems in the United States. To put one version of this hypothesis bluntly, IBM had few proprietary rights in the most widely used client-server solutions, so were they holding up the diffusion of the technology with the customers with whom they had the closest ties?

It turns out that the question is difficult to pose in practice because the market structure for complete computer systems is so complicated. Hardware vendors provide software services and maintenance, some even provide customised services. A large third party software industry for large

systems also exists, some if it is available on multiple platforms and some if it is not. Many users do their own programming of system tools, but buy packaged application software from their vendor. And on and on. The main point here is that to construct the hypothesis properly we had to understand how this market operated at a significant level of detail.

Just to finish the example, the overriding finding is that no matter how you cut it IBM is taking a big hit to sales from traditional customers. More specifically, ties to vendors do not matter as much as internal adjustment costs. The one possible exception to this finding occurs among large system users who buy IBM proprietary communication technology, often hardware and software products that are complementary to large databases and a large user-base -- these buyers tended to resist abandoning mainframes and start moving to client-server. However, these buyers seemed to be unrepresentative, in a special category all their own. It was not obvious that the tie to a vendor was as essential as the adjustment costs or the inability of the new technology to yet satisfy a particular type of user's needs. I might add, in closing, that it is also not clear how long these set of users will act this way. The most we can say is "probably for a few years," which in this industry is practically forever.

In closing, econometric studies of computing markets require "selective eclecticism" and "commercialisation." These factors are not unique to a particular technology choice or episode in computing. There arise in every buyer decision and technology choice. Therefore, these factors should be there in every study of computing demand. This is not an argument that these factors are substitutes for good econometric work. Instead, it is an argument that they are a necessary complement to most micro-economic studies of computing demand.

VALUATION AND REGULATION OF NEW SERVICES IN TELECOMMUNICATIONS

Summary of Paper by Jerry Hausman and Tim Tardiff
MIT

We answer the question in this paper of how to value the introduction of new services in telecommunications. Much public discussion has centred on the evolving "information super highway" as well as the many new services which may be offered as high capacity fibre optic transmission networks are extended into the telecommunication infrastructure. This increased transmission capacity will allow many more channels of entertainment, high speed access to information, as well as two way interactive services.

How can society establish the value of these new services and increased choices? This question has potentially important economic consequences and equally important public policy implications. Because of the network structure of telecommunications, public policy has always played a large role in the production and regulation of telecommunications. By demonstrating how to value new telecommunications services, we allow for a more reasoned approach to the necessary benefit-cost calculations which can help guide public investment in telecommunications infrastructure and also to evaluate the effects of regulation.

The methodology we apply to value new telecommunications services is the method first introduced by the Nobel prize winning economist, Sir J.R. Hicks (1940). J. Hausman (1991) has recently used this methodology to value new varieties of consumer goods. The basic idea of the economic approach to value new goods or services is to realise that in their absence, consumers are unable to purchase them, no matter how much they would like to buy them. Thus, in some sense, the price of the new good or service might as well be infinite since the new good cannot be purchased at any price. At this virtual price demand is zero so that a "virtual equilibrium" exists between demand and supply (which is zero). Estimation of the virtual price along with the expenditure function (demand curve) for the new good or service gives the economic value. The actual price of the new service will usually be well below the virtual price which sets demand to zero. The difference in price is the fundamental gain in value, also called consumers surplus, from the new service. This economic approach uses market demand to value new goods and services since the market establishes what consumers are willing to pay for the new good or service.

We examine the consumer welfare gains from the introduction of voice messaging services by telephone companies in the US beginning in 1990. For 1994 we estimate the consumer value from these services to be about $5.4 billion. Thus, very large gains to consumer welfare can arise from the introduction of new telecommunications services.

However, regulatory delay in the introduction of new telecommunications services can lead to large consumer welfare losses. The approximate 10 year delay from regulation in the introduction of voice messaging services cost consumers in the tens of billion of dollars. Similarly, we apply our methodology to the cost of regulatory delay in the introduction of cellular telephone and estimate the cost to consumers

to be closer to $100 billion. Thus, the cost of regulatory delay in the introduction of new telecommunications services can be extremely high.

We then compare these lost benefits to the potential consumer welfare losses which might occur if competitors were correct that regulated services might be used to cross subsidise new services. We find the potential losses to consumers to be relatively small by comparison. For example, even if say 25 per cent of the costs of voice messaging services were improperly shifted to basic exchange access services, the loss to consumers would be less than 0.01 per cent of the gain in consumer welfare from voice messaging. Furthermore, since exchange access is priced below its (incremental) cost in the US, adverse economic efficiency consequences would not occur. Thus, our conclusion is that regulatory delay potentially costs consumers tens of billions of dollars per year. With the potential for new services rapidly increasing due to the rapidly increasing functionality and rapidly decreasing cost of computing power and memory, the costs of this regulatory delay are becoming larger than they were in the past. Policy makers should take these costs of lost consumer benefits into account. Otherwise public policy is being "unfair" to consumers as regulators attempt to create a regulatory framework which somehow makes competition "fair" to competing firms.

EMPLOYMENT ISSUES AND OPPORTUNITIES IN THE INFORMATION SOCIETY

Werner Herrmann
Adaptation to Industrial Change

1 Introduction: the problem is structural

Europe has lagged behind other industrialised regions in terms of investment, innnovativeness and growth. It is also under pressure from emerging industrialised economies, which have strong competitiveness based on high productivity, lower costs and high levels of innovativeness.

At the heart of Europe's disappointing performance lie a number of structural problems.

i) inappropriate macro-economic frameworks (with insufficient stability in monetary politics)

ii) an insufficiently open economy (within Europe and globally)

iii) the need for a more efficient economic structure (over-regulation in some quarters has stifled change and innovativeness)

iv) inadequate co-ordination and co-operation on innovation

v) social welfare and taxation systems often suppress job creation.

Unemployment in Europe has been firmly identified as stemming from the lower rate of growth and the lower employment intensity of growth which stem from such structural problems. In particular, there is a need for reform of and innovation in European:

i) educational and training systems - to develop lifelong learning

ii) labour markets and work contracts - to promote flexibility and responsiveness

iii) social security and taxation - to lower the barriers to job creation

However, part of structural challenge which Europe faces is related to the rapid adoption of new technologies, which are promoting a deep seated change in the fundamental nature of economic and social life. Of importance here are new technologies such as biotechnology and eco-technologies as well as, of course, information and communication technologies.

These new technologies represent possibilities for:

i) major new industries in their own right in which Europe has to seek to gain a competitive position

ii) possibly even larger new technology-based industries, such as knowledge intensive services, which will emerge as the new technologies diffuse throughout the economy;

iii) the potential for productivity enhancing innovation in existing industries which could give many of them a new lease of life, perhaps through innovations and quality upgrades which could create new markets;

iv) but also the high likelihood of structural shifts in the economy which reduce the markets for existing industry, occupations and skills.

The challenge, therefore, is to achieve a structural transformation of the economy, which will lay the ground for greater competitiveness and growth with the aim of generating wealth and employment for Europeans.

There is a recognised need, therefore, for innovation at a structural level in the European economy in order to make it possible to reap the gains of the potential of innovations at the technical level. This is the essence of the European approach to the Information Society.

Technological innovation and promotion of new services based on ICTs will not be enough. In order to move ahead into an Information Society it is seen that far reaching changes in the systems of education, ICT-regulation and innovation and employment are necessary.

The Commissions developing concept of the Information Society

The Commission has long been active in the area of developing ICTs and analysing the effects on Employment.

EC has for a long time supported the development of ICTs through R&D framework policies. In the past, these have sometimes been seen as too far from the real needs of Europeans, but with each stage of development the projects supported have come closer to the real socio-economic context. Thus they are becoming a laboratory for simulating change and co-operation in European innovation.

The Commission has also, since the 1980s, been supporting research and developing into the areas of ICT and employment on an on-going basis. This continues today with studies of telework, the effects on health workers of new ICTs in hospitals, the employment consequences of liberalisation in telecommunications, regional cohesion and advanced communication technologies and so on.

However, the recession of the early 1990s gave such efforts a new stimulus. The urgency of the unemployment crisis gave a high level of importance to achieving structural change in the European economy and the potential role of ICTs in formulating a solution. It was necessary to find a framework for concerted action on the way that we approach ICTs, had not really existed before. Thus, whilst in the past we have been far from inactive, we are now able to programme for our efforts so that they have more direct effect.

Sequence of action:

1	White Book	Dec	93
2	Bangemann Report	May	94
3	Corfu Conclusion	June	94
4	Action Plan	Jul	94
5	The Essen Conclusions	Dec	94
6	Establishment of High Level Expert Group	Feb	95
7	Establishment of the Information Society	Jul	95
8	Report of the High Level Group	Nov	95/May 96
9	Action plan on Employment and Social Effects of the Information Society	end	96

Underlying these activities the aim of the Commission in this area has been to:

act rapidly
act positively in order to promote change
to encourage flexible responses
to discuss and debate on a wide basis (we do not pretend to have all the answers)
to commit ourselves to an action plan in this area

The active steps we are taking

We are aware that it is necessary to move ahead very quickly, and that there is impatience for the wheels of public policy making to begin to turn. It simply would not be good enough to say we must always wait until there is a definitive picture, because policy making helps to form the picture!

Thus, I can give you a flavour outline some of the approaches we are taking in order to help to promote adaptation to the IS in the employment area.

a) ESF Training initiatives

- Improving the training environment (training trainers, new methods of training delivery, support for new curricula, etc.)

- IT training for specific groups (researchers, IT professionals in short supply, skilled workers needing skill upgrading, the long term unemployed and those potentially excluded from the Information Society labour market)

- Measures aimed at people in specific types of organisations (SMEs, business start-up, public sector)

- Measures to support rural/remote areas (technology outreach centres, mobile technology transfer centres, tele-education materials)

b) Regional - local partnerships (Regional Information Society)

- the support of local partnership building initiatives to create regional level action plans for the information society and to undertake the development of user needs focused pilot demonstrations

c) Adapt

- Providing training, counselling and guidance to help organisations identify innovation opportunities and to implement them optimally

- Anticipation, networking and new employment opportunities -- to analyse the labour market and to develop new employment initiatives

- Adaptation of the labour market agencies and training systems

d) Eures

- a computer system for signalling and filling job vacancies across the whole of Europe. This system can be seen as the first step towards much more efficient labour markets.

***e)* Employment observatory (MISSEP)**

- the development of comparable labour policy information between national employment services so that the situation in one country can be analysed in relation to the rest of Europe. This should allow us to identify emerging practice and to increase the ability of one country to learn from the experiences of another.

f) Formulation of policy on legal structures

- we have been sponsoring studies into the development of teleworking. To examine what are the implications of new forms of work for our existing approaches to labour protection. Can the old systems stand up? In what ways we have to find new approaches in order to encourage change?

At the moment these changes, however, do not represent a co-ordinated approach to the Information Society. They are just our first attempts to grapple with the range of issues at stake.

The IS and jobs: particular challenges

We know that whilst our current approach contains many of the elements of a solution, we are not there yet. That is one of the fundamental reasons why we have established a High Level Expert Group on the Social and Societal Aspects of the Information Society.

Because the unemployment crisis is caused by structural problems we have to find structural responses.

I can best explain my point through an examination of our approach to the establishment of our high level group on the social and societal aspects of the information society. We asked them to consider 6 key themes.

The Six Themes of HLEG:

Quantitative and qualitative implications for employment :

1. Changing working conditions and work organisations
2. Cohesion
3. Education and training
4. Health
5. Labour markets

If we take the first theme. For policy makers terms the key question is how can we increase employment. However, this is a simple problem with no simple answer. For instance, we know that the nature of employment is changing in relation to the Information Society.

The content of work is changing -- with a shift towards greater demands for analytical skills, the ability to communicate, the ability to work in teams and above all the ability to continue to learn throughout a working life. Thus, the answer to the first theme straight away requires us to consider the issues of how work is organised (the second theme) and the access people have to training systems (our fourth theme) in order to ensure their position in the labour market. But, the mobility of workers also depends upon the effective operation of labour markets (our sixth theme). Increasingly, people are seeking answers to the problems of unemployment and effective labour markets by examining the scope for co-ordination and partnership at the regional level (our third theme).

The fact that there is a great deal of interaction between these different themes, however, does not imply to us that we have selected the themes badly -- although that of course is a possibility! But that there is a great deal of interaction between the different types of problem which we face. Solutions which examine just the employment problem, or just the issues of technological unemployment are, in our view, unlikely to make a deep impact on the structural problems which we face.

Thus, whilst we have to make practical steps (which means quite timid and careful steps) towards changing the structure of the European economy. We have still to keep in mind the big picture -- the fact that the Information Society represents more than just:

1. a new set of technologies;
2. a number emerging industrial and service industries;
3. the possibility to achieve productivity gains through process innovation.

If we remember Solow's productivity paradox (an idea that st*ill seems to have some potency)*

Why does all this investment in computer technology not show up in the productivity performance?

The answers are widely thought to be the increasing pace of competitive pressure on the one hand, and, on the other hand, the fact that technological innovation has to often not be accompanied by social innovation.

We could imagine a policy version of the productivity paradox

Why is all the investment in policy programmes not able to keep pace with the rate at which unemployment seems to grow?

Again, one answer is that the pace of industrial restructuring, globalisation and technological change seems to be driving change along at a ferocious rate. But also, we might propose the idea that our approaches are too piecemeal. Education and training policy is not calibrated against employment and industrial policy. Technology policy does not reflect industrial development realities or educational capacity, and so on. This clearly points towards the need for the development of coherent and integrated policy frameworks.

Thus, there is the danger that the process is not carried out in a comprehensive manner so that the full benefits are not accrued to Europe.

In the context of the Information Society, and elsewhere, we must avoid the risk that the process of change be seen as:

1. solely driven by market forces;
2. undermining social solidarity;
3. too concentrated upon gain tomorrow, and neglecting the real problems of pain today
4. focused upon rationalisation of structures, and especially public support where direct public action is necessary.

In particular, for instance, we have the massive problem of finding practical solutions to the issues such as:

1. high rates of obsolescence of the existing skills stock (especially amongst male manual workers, but increasingly amongst white collar workers);
2. the risks and dangers facing the flexibilised labour force, whether they be externalised workers, teleworkers or simply ones subject to very flexible work contracts;
3. the problems of defining and funding lifelong training systems;
4. finding new ways to encourage innovation and entrepreneurship;
5. making sure that the Information Society is an inclusive society, in which there is a positive and progressive place for people who are disabled and disadvantaged, people with lower levels of skill and learning capacity, and for people who are discriminated against on grounds of gender or race.

Such a mix of problems has in the past been met mostly in reactive mode with passive support for potentially excluded people whilst stressing the independent development of training in order to build capacity. In proactive mode there has been a tendency to legislate or directly intervening by engaging in developmental process (infrastructure investments, public ownership and so on).

Our new policy frameworks stress the need for change orientated policy:

1. active support of individuals and organisations to help them to innovate and adapt;
2. better information to help us to spot danger areas or opportunities and to anticipate and support change;
3. reinforcing the efficiency of service delivery, by streamlining and making life easier for people and businesses.

What a co-ordinated package of such measures to address the Information Society would look like we cannot yet say. But we are working towards more co-ordinated action.

With the help of the advisory bodies which we have established, we hope to pick up, and persuade all sides in the labour market, and governments world-wide, to move forward on this issue of the IS in a way which has a proper balance between economic and technological dynamism in order to create good and fulfilling jobs.

INFRASTRUCTURE, UNEMPLOYMENT, AND ECONOMIC GROWTH THE MACRO POLICY ENVIRONMENT OF "INFORMATION SOCIETY" INVESTMENTS

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Remarks prepared for the OECD Workshop on "The Economics of the Information Society," University of Toronto, June 28 and 29, 1995

The Macro Policy Environment and the General Role of Infrastructure

The countries of the OECD have, as a whole, experienced rising rates of unemployment, a slowdown in the growth of real wages, and a growing disparity between the wages of workers with different levels of skill or amounts of education. These problems are more severe in some OECD countries than others, but they are pervasive. And, they have created a policy environment in which the "jobs" issue has assumed a central importance.

The rise of the "jobs" issue has inevitably generated a derived demand for policy solutions. Unfortunately, the usual tool kit of appropriate policy responses is almost empty. The traditional use of demand-side stimulus through deficit spending, and the use of supply-side fiscal incentives to promote investment, simply piles more public debt on a stock that is regarded by many (particularly among inflation-fighters in central banks) as already excessive. Indeed, in many countries, a major macro policy goal is to attack the public debt problem by tightening fiscal policy, not loosening it further. Much the same can be said of "industrial" or "incomes" policies, which often lead to disguised unemployment and costly public subsidies.

A more conservative solution is to follow fiscal and monetary restraint, while at the same time promoting productive efficiency in the market place by privatisation, deregulation, and liberalisation of international trade. This does not run afoul of the deficit problem, but has other difficulties. Restructuring to achieve productive efficiency may cause severe dislocations in the short and intermediate run, and thus worsen the problem of unemployment and stagnant wages among the very low-income workers that the policy seeks to help. This problem is exacerbated by the rigid labour markets of many OECD countries.

With all these problems, one solution to the "jobs" problem virtually jumps out of the policy makers' tool kit. This is the proposal to increase the demand for labour by raising the marginal productivity of the work force through increased spending on public infrastructure capital (roads, etc.) and human capital (worker training, education). This new "Public-Investment Economics" is primarily focused on social-overhead types of investment, *i.e.*, those categories of investment that form a background for direct investment in the private sector. This new policy would, in effect, attempt to "pick winners" among different types of social-overhead investments, instead of trying to pick winners among

different industries with an "industrial policy." However, unlike the old industrial policy, the new policy would largely complement the working of the market place rather than act as a substitute for it.

The attractiveness of this approach to the jobs issue is obvious. It attacks the problem of low wages and unemployment by making workers more productive, without increasing the net public debt—infrastructure investment financed by debt creates an asset on the national balance sheet that offsets that debt—and without direct interference with the private sector.

These attractions are buttressed by studies which purport to show that the return to infrastructure investment is much larger than the corresponding return to business fixed investment—as much as 70 per cent *per annum* in one study by David Aschauer, and much greater in some other studies (up to 200 per cent!). According to Robert Reich, writing in the February 1991 issue of the *Atlantic* magazine, "His [Aschauer's] calculations imply that a one-time increase of $10 billion in the stock of public capital would result in a **permanent** increase of $7 billion in annual [US] GNP." Aschauer's results are sufficiently large that they can explain as much as two-thirds of the productivity slowdown in the 1970s and 1980s.

In an era of slow wage growth and high unemployment, any investment policy that promises better economic performance is welcome. Any policy that promises an immediate, massive, and nearly costless improvement is an invitation to immediate action. This invitation has been accepted in the US during the presidential campaign of candidate Bill Clinton (*Invest In America*). Other governments have reassessed their public investment policy with a view toward increased spending, and a European Commission White Paper called for a greatly increased infrastructure commitment.

Skeptics have challenged the magnitude of these estimates, noting both econometric and intuitive problems (example: a 70 per cent annual rate of return on a $1 million infrastructure project compounded over a 30 project life yields almost $5 trillion). Recent research, which corrects for some of the obvious statistical problems of the earlier literature, has tended to find a much smaller rate of return to infrastructure investment. For example, my own research on the role of infrastructure in low and middle income countries yields estimates that are one-quarter to one-fifth smaller than the original Aschauer estimates. This is in line with the return to private fixed investment, and suggests that there is no massive under-investment in infrastructure facilities. A similar result is reported in the recent research of Nadiri and Mamaneus. However, even with more modest rates of return, infrastructure investment may offer an attractive policy option for raising the marginal product of labour.

Implications of the Macro Policy Environment for IT Investments

Someone who is interested in information technology or in the telecommunications industry, and who has approached the subject from the standpoint of industrial organisation, may well wonder about the relevance of the macro-infrastructure literature. The IT and telecommunications sectors are not exclusively, or even primarily, a public sector function. Indeed, they are increasingly (throughout the world) a private sector function.

However, IT and telecommunications are very much part of the infrastructure discussion. When pressed for examples of the kind of investment envisioned by infrastructure advocates, telecommunications and advanced IT are often cited. This is partly due to necessity. A second Interstate Highway System in the US does not excite much interest; indeed, environmental legislation has virtually blocked construction of roads in those areas where congestion is the greatest. The possibilities offered by an "information super-highway" seem much more attractive.

There are also good reasons for viewing IT investments as an integral part of a national infrastructure investment strategy. Telecommunications and associated IT services are often provided through networks which require large investments to establish, and which may throw off important externalities. For these reasons, this sector traditionally has been treated as part of the "infrastructure hypersector" in development economics (viz. the recent *World Development Report* by the World Bank), and analysed as social overhead capital. This seems all the more appropriate for developed economies, since the information super-highway is often cited as an alternative to conventional infrastructure systems like highways and air travel. In any event, any macro assessment of "the Economics of the Information Society"—the subject of this workshop—needs to acknowledge this "infrastructure" policy environment.

Some Remarks on the Empirics of IT Infrastructure

It is one thing to acknowledge the role of telecommunications and IT investments in the larger infrastructure debate. It is another to translate this debate into operational policies for telecommunications and IT technology *per se*. Indeed, there is a risk that a general enthusiasm for infrastructure investment as the solution to the jobs problem will substitute for hard analysis, not stimulate it. The looseness of concepts like "the information super highway" is evidence that this is a danger that should not be underrated. Moreover, rates of return to "infrastructure" based on historical studies of roads, canals, electricity generation, etc., are not particularly helpful in determining the potential returns—inclusive of spillover externalities—to new IT investments.

This said, it is also important to recognise that "hard" analysis of individual IT investments -- at the project or industry level of detail -- may miss important economic benefits. Many have argued that such "micro" studies are flawed because they are unlikely to recognise the spillovers associated with new technologies or networks. Thus, while micro (or industry) studies might capture the benefits from a particular project that accrue to a particular industry or region, it may well miss the benefits that accrue elsewhere. This suggests that "hard" micro-industry studies should be complemented with corresponding macro studies.

To do this properly, the linkages between macro, meso, and micro effects need to be developed in a more persuasive form that is currently the case. My own research on this kind of linkage (for the World Bank) has convinced me that this is an extremely difficult and complex task. The complexity arises, to a large extent, from the fact that most infrastructure capital comes in the form of large, jointly used, networks of interlocking investments (roads and highways, telephone and telegraph, gas and electricity distribution, sewers and water distribution). Unlike private investment in plant and equipment, the productivity of any one piece of the network depends on the size **and** configuration of the entire network of investments. For example, the value of linking points A and B depends on whether or not there are already links between point A and C, and between B and C. If these already exist, a direct link may shorten the access time between A and B, but it is unlikely to have the same impact as an entirely new link. Moreover, the value of a new link depends on its effects on the links with other points, as when a new link between A and B alters the value of the existing A-C and B-C links.

This network feature of public infrastructure helps explain why there is such a large payoff to new infrastructure systems, and why this payoff diminishes as the network expands. The first network links constructed tend to be mutually complementary (and may be complementary with other inputs), and can thus have a very large payoff. But, the potential for large complementarities becomes exhausted at some level of network development and subsequent additions are (increasingly) substitutes for existing capacity. As this happens, the impact of infrastructure on economic growth becomes progressively weaker.

Most empirical macro work of infrastructure has ignored these network effects. I have worked on a computable general equilibrium model in an attempt to simulate the consequences of this neglect, and have found that they are potentially serious. Indeed, the macro approach may give a very misleading result precisely because it ignores the joint-use nature of infrastructure networks. For example, studies that find a high rate of return on average may greatly overstate the return to marginal investments. Also, the jointness (or public good) aspect of networks may lead to a misinterpretation of the results of econometric studies. This is a gap that must be addressed in building up the empirical foundations of IT economics.

The possible network features of IT-telecommunications investments are not the only potential source of misspecification. Many IT innovations are embodied in the design of new capital goods, and when new, technically superior goods, appear on the market, there is a problem of how to count them *vis-à-vis* the less productive goods they supplant. Current opinion is divided on this issue: some opt for adjusting downward the price of new technically superior goods, and thus increase the implied "quantity" to reflect the improvement in quality, others argue against such an adjustment. My recent work -- reflected in my background paper for this workshop -- suggests that neither view is necessarily correct, and that a new parameter must be added to the analysis: the fraction of the improved quality that is paid for by additional resource cost.

One final remark is in order. Even if all these problems are solved, and it is established that IT investments have strong growth externalities, the "jobs" objective of the New Public Investment Economics may be frustrated. It is increasingly recognised that the adoption of new technologies -- particularly IT technologies -- may augment only the marginal product of high-wage, high-skill workers. Low-wage, low-skill workers may, in fact, be supplanted in high paying jobs, reinforcing the very effect that the jobs policy sought to ameliorate.

PROSPECTS OF NEW AND GROWTH MARKETS IMPLICATING WITH ADVANCED INFORMATION TECHNOLOGY

Yumio Imamura

1 Overview

The current recession started in 1991 is imposing the Japanese industrial society for structural changes, which Japan has never experienced. My report will discuss the following:

Conversion of industrial structure that Japan plans to take, the scale of new markets and labour opportunities created by the conversion, and expectation for information and telecommunications technologies. My report is based on the recommendations of Subcommittee on Advanced Information and Telecommunications in the Economy Council (advisory group for Prime Minister) and Subcommittee for Long-Range Issues of the Industrial Structure Council (advisory group for Minister of International Trade and Industry). It also refers the White Paper on Labour published by the Ministry of Labour. The growth rate of Japanese GDP has slowed down since 1990 and became negative in 1993.

Economic recovery is being delayed by the financial institutions' $B!! (Blong: standing for bad debt caused by the excessive investment on real estates during the economic boom between 1985 and 1991. Extreme appreciation of yen against US dollar due to trade surplus of more than 100 billion dollars is also lagging the recovery. The complete unemployment ratio gradually increased from a bottom of 2.0 per cent in 1991 and reached at a record 3.5 per cent in the first quarter of 1995 (according to the statistics of Japanese Ministry of Labour, complete unemployment ratio is the percentage of the completely unemployed in labour population, over 15 years old).

In the world economy, economic activities have globalised and national borders become less important. The level of Asian industrialisation has advanced rapidly and American manufacturing has revitalised. All of these factors force Japan to compete in the dynamic global environment.

Japanese manufactures have been moving their manufacturing facilities overseas, especially to developing countries. This international division of manufacturing should be beneficial from a global perspective because it will bring the employment opportunity in those countries. However, the excessive hollowing out $B!! (Bphenomenon will weaken the Japanese assistance and become obstacles for the world economic development. It also may restrain Japanese assistance to developing countries, like ODA (Official Development Assistance) activities. In June 1994, the Subcommittee for Long-Range Issues of the Industrial Structure Council made a recommendation for the drastic conversion of Industrial structure by restructuring the current market and developing new and growth markets.

The recommendation forecasts the future of twelve new and growth markets including housing, information and telecommunications. According to the recommendation, these markets will represent 210 trillion yen (approximately 2,500 billion dollars) and create 11 million jobs by 2000. By 2010, these markets will represent 350 trillion yen (approximately 4,100 billion dollars) and create 13.7 million jobs. In order to create the job opportunities, it is necessary to convert the employment structure in the scale of several million jobs over a decade. It also calls for changes in the Japanese industrial system such as deregulation and reduction of the price gap between Japan and other nations.

Focusing on the improvement of productivity and creation of new industry, various measures are taken to develop new and growth markets. Among them, much expectation is placed on information and telecommunications technologies, such as data highway networks, CALS (Continuous Acquisition and Life-cycle Support), EDI (Electric Data interchange), multimedia, and databases. Furthermore, improvement in creativity and productivity of white collar workers is necessary. To achieve this objective, a number of companies are developing an infrastructure to communicate within and outside the company using PC and networks.

2 Implication with Advanced Utilisation of Information and Telecommunication

Technologies and its Benefits

Subcommittee on Advanced Information and Telecommunications Society in the Economy Council announced the interim report on the measures for advanced utilisation of information and telecommunications technologies in June 1995. The interim report is introduced below.

Development of advanced information and telecommunications society will substantially reduce restrictions of time and locations for information exchange and making deals, which had been done by telephone and face-to-face meetings, through accessing databases all over the world and communicating via e-mail. It will also improve efficiency of all the corporate activities such as production, distribution, development and administration through promotion of advanced graphic processing technologies and sharing information within the organisation. First, CALS and EDI are regarded as the promising change for production and distribution systems utilising information and telecommunications technologies.

Secondly, in the area of developing new products, in addition to the current modelling and computer-aided simulation, virtual reality technologies will help development of attractive products by reflecting the opinions of users who virtually have seen and used the products. Thirdly, in the planning and management department, by sharing the information necessary for decision making among all the concerned people, the prompt decision making becomes possible.

In the current stagnant Japanese economy, Japanese industry is required to make efforts to improve the management efficiency through restructuring as well as to develop the new industry under the healthy competitive market while coping with decline of the work force due to the society composed largely of elderly people and low birth-rate. Advancement of information and telecommunication is a solution for these challenges.

In a process of realising the advanced information and telecommunications society, the information and telecommunications market is enlarged and diversified. The new industries and employment opportunities are created. The demand is increased with the stimulating consumers purchasing desire by providing new product information and entertainment information. In addition, not only does the productivity improvement revitalise the economy, but realises the relaxed affluent life by reducing working hours. It is necessary to recognise that advancement and application of information and telecommunication technologies will bring the world-wide historical changes that are equivalent to the Industrial Revolution. Based on this recognition, in order to realise the affluent life and vital economy, various stakeholders in a business community should participate in establishing the advanced information and telecommunication society by taking leadership and actively making efforts for changes rather than passively responding to the changes that advanced information and telecommunication technologies bring.

NEW WAYS TO WORK, AND NEW JOBS IN THE INFORMATION SOCIETY

Peter Johnston
European Commission

In the second half of the 1990s, Europe faces an extremely difficult period for economic growth and industrial change. Over 18 million Europeans are unemployed. In addition, the current economic recession is not just cyclical. Industry and commerce throughout the world is in a period of rapid structural change: A change towards globalisation of production and marketing, but also to the "de-materialisation" of production. In the "information Society", organisations must master information and communication technologies, new business organisations and new working methods.

In his presentation to the Heads of State at the European Summit in June 1993[15], the President of the European Commission highlighted the importance of rapid development of new frameworks for co-operation between businesses in Europe; of the development of performant trans-European transport and telecommunications infrastructures, and the creation of a common "information space "within which decentralised economic activity can develop through interactions between small businesses. He stressed the need to create a European network o training facilities for new skills and to encourage distance working. In December 1993, the Commission presented a White Paper on growth, competitiveness and employment[16]. In it, telework is identified as one of 8 strategic developments in which investment should be stimulated. In June 1994, Heads of State in Corfu endorsed the report of a group of senior industrialists, chaired by Mr. Bangemann on "Europe and the Global Information Society". Telework development is the top priority application in that report.

This presentation summarises the policies and actions taken at European level in connection with work in the information society. It focuses on the stimulation of new ways to work over advanced information infrastructures, notably telework. The executive summaries of relevant analyses carried out in 1994/5 for DG XIII of the European Commission are annexed.

1. The transformation to an information society is already well underway

Through rapid technological progress, our society will evolve during the next five to ten years towards a "society of information" or a "society of knowledge". Human knowledge will constitute not only a new economic resource, but also a structural element of our society.

The repercussions of these innovations will be felt in more than just the technological sphere.

The industrial revolution gave a premium to concentration and centralisation of production. The transition to an information economy is reversing the trend. Competitive advantage now lies in the use of telecommunications and information technologies to support much more flexible and de-centralised business organisations.

2. The nature of work is already changing

Under the pressure of new competition, organisations and the way they employ people are changing. Re-engineering, downsizing, empowerment, flattening of hierarchies, networking of

self-directed teams, total quality management, part-time working and teleworking are all part of the same inevitable process of re-adjustment to a new environment -- that of the post-industrial information society.

Even as the economy recovery gathers strength, the drive to reduce fixed costs, improve productivity, increase flexibility and improve quality of services will continue to dictate corporate decisions on employment. Restructuring and use of flexible working patterns have become imperatives for large employers.

3. Changes in working practices can be beneficial, if properly managed

The new interest in telework is not "technology push". It reflects a popular demand for more flexibility and control by individuals over their time and work commitments. At a European level, over 40 per cent of business organisations in the five largest countries of the EU have expressed interest in telework and over 50 per cent of the general population is attracted by some of its advantages: *for employees*: greater flexibility in their allocation of time and energies, lower housing and commuting costs, and a better quality of life; *for society*: less congestion in major cities, less environment damage, greater flexibility in labour markets, and a better distribution of tax revenues to support public services and infrastructures.

However, the development of these more flexible working patterns will only be possible with the removal of legal and regulatory constraints, particularly those that inhibit trans-border telework within the European Union. Measures that would enable the creation of "virtual businesses" with fully integrated activities distributed throughout the European Union will be a necessary part of a second phase of consolidation of the European internal market.

4. Greater flexibility in employment is central to EU policies for growth, competitiveness and employment

The central theme of the Commission's white paper on growth, competitiveness and employment is the ever growing crisis of unemployment in Europe. Only about 60 per cent of the working age population is in paid employment and increasing numbers of the under-25s and over-50s are excluded from the social interactions and economic benefits of regular employment.

The solutions to the problems of unemployment and social exclusion will neither be simple nor fast. The structural changes in society through which we are living will take many years yet. However, the key message in the Commission's white paper is that there *are* strategies, which if pursued jointly by the member states and institutions of the European Union, can offer a return to fuller employment. With acceleration and co-ordination of the transition to a more decentralised "information society", new, more flexible, forms of work can offer both greater competitiveness to European businesses and a better quality of life to Europe’s citizens.

A number of basic ideas underlie this belief in the ultimate benefits of this transition: most notably that the "limits to growth" in information service economies are far from reached. The intellectual resources of the human population are nowhere near fully exploited; productive resources and demand expand as people are freed from the tasks of producing the basic necessities of life. The production of, and the demand for information can continue to expand without significant environmental impact.

However, to exploit the full potential of new information and communication systems, while at the same time we address the problems of unemployment, we will need more flexibility -- in hours worked, and in who does what, where and when. We also need to look for ways to reduce the threshold cost for provision of new types of services, to open new markets for small businesses, and to reduce the threshold cost of bringing people back into regular employment.

Better and new uses of advanced communications and the promotion of new flexible working patterns are key ways of addressing these issues.

5. The foundations for a better understanding of work in the information society have already been laid

In 1994, the European Union contributed to three major analyses:

- a general reflection on underlying economic and social changes and the need to re-define the concepts of work in an information society; a document from this activity entitled "*Rethinking Work*" was published in the context of the European Assembly on New Ways to Work in the Reichstag, Berlin, November 1994. It is being updated in preparation for a second European Assembly in Rome in November 1995;

- a more structured assessment of employment trends related to use of advanced communications has been carried out on behalf of DGXIII by TeleDanmark, working together with Institute for Technology Assessment (Vienna) and the Programme of Research on Engineering Science and Technology (UK). The summary of the final report and recommendations is in Annex I;

- a third set of analyses and assessments has addressed legal, organisational and management issues of telework, notably in the context of trans-border employment within the European Union. The summary of conclusions and recommendations is in Annex II.

6. Next Steps: Clarifying New Employment Models and Sectors for Better Targeted Technology Development, Training and Business Development Initiatives

Coherent national and European policies and initiatives for employment growth require a clearer and shared understanding of the technology and infrastructure developments that will enable new jobs to be created and sustained in the information society. These jobs will require new skills, not just in using technologies and communication systems, but in management and innovation. Our education and training systems must adapt to these new shills requirements very quickly. The skills in the 10-30 age-group today will be the foundation of our prosperity in 2000-2020.

In partnership with the member States, the European Commission is launching a new set of European RTD actions and structural policy initiatives in 1995. The "Advanced Communications" and "Telematics Applications" RTD programmes and the "ADAPT" initiative under the European Social Fund will be the frameworks for further analysis, research, experimentation, trials and information exchange.

Broader co-operation in the framework of OECD and G& initiatives will be supported where there are common interests.

CONCLUSIONS FROM "THE OUTPUT CONTRIBUTIONS OF COMPUTER CAPITAL AND LABOR: A FIRM-LEVEL ANALYSIS," *ECONOMICS OF INNOVATION AND NEW TECHNOLOGY* 3, FORTHCOMING 1995

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The magnitude, and even the sign, of the impact of computers on output and productivity has been the subject of considerable debate. Some business analysts have asserted that the return on investment in information technology has generally been low, and perhaps even negative. A few econometric studies have provided support for this claim. But a number of others have found that the output contribution of computers is positive and statistically significant, and may even be quite large. These studies have supported the hypothesis that computer investment yields positive returns, but they have not provided valid tests of the hypothesis that computer investment (like R&D investment) yields *excess* returns -- preceding the large increase in the use of computers, and some were based on the manufacturing sector, which is a relatively small user of computers. Although labour costs account for over 40 per cent of IS budgets, only one previous study has examined the role of IS labour as well as IS capital.

I have examined the output contributions of IS capital and IS labour at the firm level during the period 1988-91 throughout the business sector, using two different sources of data on these inputs. I began by establishing some basic facts about the allocation of information technology resources. Expenditure on information systems tends to be about 2.7 per cent of total revenue, and the share of IS employment in total employment is about 3.1 per cent. Since the wage rate of IS employees is much higher (on the order of 3 times as high) as that of other workers, the share of IS labour cost in total labour cost is higher, perhaps as high as 10 per cent.

The mean value in the used equipment market of sample firms' computer capital as a per cent of their net tangible assets was 1.5 per cent. But because computers have a much higher depreciation rate, and much lower (in fact, negative) rate of asset price appreciation, that other capital, the rental-to asset-price ratio is expected to be six times as high for computers as it is for other assets. This implies that the share of computers in capital (rental) income is similar to the share of computers in labour income, about 10 per cent. The sample mean ratio of non-labour IS expenditures to total investment (about 13 per cent during 1988-91) is consistent with this.

The data suggest that accurate measurement of the replacement cost of computer assets seems to be much more difficult than measurement of IS budgets and employment: the correlation between IS capital values contained in the two surveys is much lower than the correlation between the IS budget and employment values. They also suggest that the Informationweek IS capital date, which are based on an extremely detailed underlying survey and which this study is the first to analyse, are more reliable than the Computerworld estimates.

I estimated production functions in which only capital was disaggregated into IS and non-IS components, only labour was disaggregated, and both inputs were disaggregated. Noise in the computer capital data not withstanding, the hypothesis of zero returns to computer capital was always decisively rejected by the data. In fact, the estimates indicated that there are substantial "excess returns" to investment in computer capital: its elasticity was 2.6 - 3.7 times as large as we would expect to observe if there were zero excess returns (*i.e.*, if the marginal rate of substitution between IS and non-IS capital were equal to the ration of their rental rates).

RESEARCH IN PROGRESS BASED ON LONGITUDINAL FIRM- AND ESTABLISHMENT-LEVEL DATA FROM COMPUTER INTELLIGENCE INFOCORP, US CENSUS BUREAU, AND US BUREAU OF LABOR STATISTICS

The evidence described above was based on firm-level data for several hundred firms in both the manufacturing and service sectors. The analysis was essentially cross-sectional ("between firms") rather than longitudinal ("within firms") due to lack of consistent time-series data on IS inputs at the firm level. We are in the process of re-examining the issue of the substitutability of IS for non-IS inputs using longitudinal data on about 35,000 service establishments from the Census Bureau's Enterprise Statistics Program. Under this program, the Census Bureau collects two kinds of reports from companies or establishments in Economic Census years (*e.g.* 1982, 1987, and 1992). The first is the Enterprise Summary Report (Form ES-9100), which provides consolidated company-level information for over 7000 firms on the following: sales, employment, payroll, assets, **expenditures on computers and peripheral data processing equipment,** other capital expenditures, and other variables. The second is the Auxiliary Establishment Report (Form ES-9200), which provides establishment-level data for over 35,000 auxiliary establishments. These are defined as "establishments whose employees are primarily engaged in general and business administration; management; research, development, and testing; warehousing; electronic data processing; and other supporting *services* performed centrally for other establishments of the same company rather than for other companies or the general public" (emphasis added). The companies that own these auxiliaries are in a variety of industries; fewer than one-third of the auxiliaries are owned by manufacturing companies. But, by definition, 100 per cent of these establishments are "service establishments": their function is to produce (a variety of) services, not goods.[17] In 1987, 2.8 million people were employed in these establishments; auxiliary establishment payroll accounted for about 16 per cent of the total payroll of companies with auxiliaries. The following is a partial list of the data included in the auxiliary establishment report: payroll, assets, **expenditures on computers and peripheral data processing equipment,** other capital expenditures, and **employment, classified by the following eight functions**: L_1: **Electronic data processing** (include programming and systems design); L_2: Administrative and managerial; L_3: Office and clerical; L_4: Research, development, and testing; L_5: Warehousing; L_6: Sales directly to customers; L_7: Sales support; L_8: Other. These data will enable us to obtain estimates of the effect of information technology on labour demand (hence productivity) that are more reliable, more detailed, and less subject to potential biases than our previous estimates.

I am also embarking on a project entitled **The Impact of Information Technology on Productivity in the Federal Government.** This project will attempt to provide important new evidence about the impact of information technology on productivity by linking together two unique sources of organisation-level data bout the federal government. The first data source is the Federal Productivity Measurement Program conducted by the US Bureau of Labor Statistics (BLS) since 1967. BLS "measures the efficiency (productivity of individual Federal Government organisations" by collecting output indicators and employment and compensation data from 276 organisations within 60 Federal agencies. BLS does not publish the organisation-level data; instead, it groups the organisations into 28 functions that reflect common government activities, and publishes function-level productivity data. I seek to become a Special Sworn Employee of BLS so that I may have access to the organisation-level data.

The BLS data on output and employment, by organisation, will be linked to detailed longitudinal data on information technology utilisation provided by a private marketing research company, Computer Intelligence Infocorp (CII). Since at least 1987, CII has collected data on an annual basis from about 5700 Federal government sites on a number of aspects of information technology utilisation, including the

total purchase value of all information systems, total MIPS, disk and take drives, number of mainframe and minicomputers, and the number of PCs and terminals. CII has agreed to provide me with these data, which can be aggregated to the organisation level for linkage to the BLS data.

BROADBAND TO THE HOME: EVOLUTION SCENARIOS FOR AUSTRALIA

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Summary

This paper reports the results of research undertaken by the Communications Future Project (CFP) of the Australian Bureau of Transport and Communications Economics to develop likely evolution scenarios for broadband residential networks in Australia over the coming decade. The research involved developing a spreadsheet based model to examine the economic viability of providing different services on a range of delivery platforms over the coming decade. Household spending patterns and likely costs for different platforms in particular were analysed. From the results some conclusions are drawn on likely policy issues for government on competition and equity.

Introduction

Throughout 1994, Australians asked when pay TV would finally reach our shores. Since the launch of pay TV in January 1995, that question is likely to become: "Is the information superhighway just around the corner?"

The CFP has tackled this question by examining ways that the new pay TV networks (which are essentially one-way) are likely to evolve towards two-way, fully interactive broadband service provision.

The research was based on the premise that while the promise of digital convergence is revolutionary, its introduction will be evolutionary -- with the implication that a careful examination of current forces for change would help in anticipating future developments.

The main aim of the project was to assist the Australian Government in its current review of the more competitive communications regulatory regime it put in place in 1991-92. It is clearly important that any review is based on the most realistic possible assessment of the market environment, ant the forces that are likely to help shape it in the next decade.

The network evolution approach

The approach essentially involved developing a structured framework for comparing the costs of technologically feasible future networks with the revenues they might reasonably be expected to earn. A model linking net present values) NPV at a 15 per cent discount rate) of revenues and costs was used to identify likely evolutionary pathways for residential networks. Because it utilises a high level approach, the model precludes examination of specific business ventures. Nevertheless, the model was used to provide insights into the following sorts of questions:

- What factors will most strongly influence the timing and extent of cable network roll-out from urban areas to rural and remote regions?

- Can two broadband network roll-outs be commercially justified in some regions?

Since a prime interest of the study was to examine the rollout of services from urban areas to more remote parts of Australia, a geographic classification of five areas was used. These areas were based largely on household density (a key cost determinant, particularly for cable platforms because the cost of laying cable in remote areas would be very much greater than in urban areas). The classification wan inner urban, outer urban, provincial towns, rural, and remote.

The timeframe for the analysis was 1995 to 2005. This was divided into three market phases, corresponding in the short-term, to the rollout of cable and wireless pay TV networks (1995-1997), in the medium-term, the introduction of interactive services (1997-2000) and, in the long-term, the introduction of switched broadband communicative services (2000-2005).

Four technology platforms were considered, namely:

- direct broadcast satellite, DBS;

- multipoint distribution system, MDS;

- hybrid optic fibre coaxial cable, HFC; and

- asymmetric digital subscriber line, ADSL.

Revenue estimates

To model demand for the new services, the CFP examined Australian Bureau of Statistics (ABS) household expenditure data, and defined four demand scenarios based on those bundles of services whose delivery will become technologically feasible as network technology evolves. The data were used to derive estimates of the upper bound of spending available for allocation to networked services on the basis of substitutability (that is, the "contestable" expenditure).

The contestability analysis suggested that the expenditure pool for pay TV services is currently around $50 per month in metropolitan areas (on the basis of current spending on home entertainment media like VCRs) but less than two-thirds of this elsewhere in Australia. This is shown in Table 1.

Table 1. Maximum monthly contestable expenditure estimates by demand scenario and market area

Demand Scenario	Inner urban	Outer urban	Provincial cities	Rural	Remote
1. Pay TV	50	61	35	32	32
2. Interactive home recreation	66	74	62	61	59
3. Interactive home transactions	18	22	16	16	15
4. Communicative home video	65	73	62	62	60

Source: BTCE (1994a).

Although the four sets of expenditure estimates offered a useful input to the modelling exercise in a form that could be aligned with cost estimates, the contestability approach could not indicate how many households are likely to subscribe to the services over time. So, to model revenue growth over time, both revenue and cost variables were linked to an S-shaped diffusion curve which is characteristic of commercially-successful products. This diffusion curve is typified by a slow initial take-up by "early adopters", followed by a period of rapid diffusion into the mass market, followed by slow approach towards a market saturation level, which in the case of VCRs (the product whose growth parameters were used in the CFP model) could be around 90 per cent.

This diffusion curve is fundamental to the modelling process, since the mathematical function that generates this curve is linked to both cost and revenue variables, hence changes in both supply and demand over time, and in different market areas, can be simulated.

The cost and revenue streams for a particular demand scenario are themselves functions of many input variables. Costs are a function of:

- starting time of the roll-out of the platform and its rate;
- number of households taking up the service (diffusion rate);
- market size of each area;
- rate of change of both the number of households in each market and the infrastructure component costs; and
- cost-scale factors for each market area.

Revenues are a function of:

- rate of service diffusion;
- connection, subscription, usage and transaction-based charges;
- type of service (distributive, centralised interactive or communicative);
- rate of "churn" of subscribing households, *i.e.* assumed to be 15 per cent; and
- levels of revenue contribution from advertisers.

While the contestable expenditure approach sought to address the question of where the money might come from in the household budget to pay for new networked services, a separate analysis of individuals' time use patterns addressed the parallel question of where the time would come from for people to use the proposed new services. The results suggested that those with the most time available to consume these services tend to be those whose labour market status means that they have lower incomes (for example, retired or unemployed people). This "time rich, cash poor" group which is likely to seek new ways of spending time on entertainment services was noted to be larger than the "time poor, cash rich" group of higher income managers and professionals, who might be more interested in ways of saving time and becoming more productive through use of networked information services.

In general, the expenditure and time-use analyses both point to large uncertainties in estimating the rate of growth of services which have not previously been available in networked form, such as home shopping and telecommuting. In these cases, widespread market take-up would require significant social and behavioural changes, which would be unlikely to be rapid.

Cost estimates

Estimates were made not only of the costs of connecting households using each delivery platform but also a range of other costs involved in providing networked services (that is, operating and maintenance costs, management and advertising costs, and very significantly, program costs).

The cost to connect all Australian households to the new services would be huge. Specifically, the likely costs of a hybrid optic fibre coaxial cable (HFC) network to deliver services to all Australian households (including customer premises equipment) were found to be as follows:

- $25 billion for the initial distributive network;
- around $5 billion for an upgrade of the network to deliver centralised interactive services (such as video on demand; and
- around $11 billion for a further network upgrade to provide limited communicative services (such as video telephony).

For the HFC network, the bulk of the cost (60 per cent) was found to relate to rural and remote households (which comprise only 30 per cent of households).

Costs for the other three platform networks would be less than those for HFC but nevertheless would also be substantial.

Model results

An HFC network is not likely to be economic, even in high-density urban areas, if based on pay TV revenue alone. Given the huge costs involved to cover rural and remote areas, a roll-out to these areas would be extremely uneconomic.

DBS and MDS are likely to be able to provide profitable pay TV services in urban and some provincial areas, but the modelling indicates that if a cable network was rolled out in some areas, these other platforms would be reduced in these areas and, in the longer term, they would probably serve only niche markets.

ADSL would not be economic, but could serve an interim function for Telstra in serving outer urban areas in the period before HFC is rolled out to these areas.

Results of sensitivity tests on a number of the variables used in the model suggest that the results were most sensitive to penetration level assumptions: the initial take-up level, the final saturation level and the growth rate of the curve, particularly in the earlier years. The above results were based on the assumption of an initial penetration level of 5 per cent. For the HFC rollout, an initial penetration level of 25 per cent with an ultimate saturation level of 62 per cent would be required to yield a more promising economic outlook.

These penetration rates are much higher than achieved for pay TV services in other countries, which suggests that for HFC to be successful there probably will need to be a very large 'pent-up' demand.

Even though an HFC network is shown to be uneconomic if based on pay TV revenue alone, nevertheless the model's results indicate the revenues would cover more than 80 per cent of costs and that an increase in revenue of 20 per cent would yield a more positive economic picture, even with an initial 5 per cent take-up rate.

Telephony revenue and network evolution

It may be feasible in the near future for HFC to carry both telephony and video signals. The economics of such an integrated network would be different for Australia's incumbent local telephony provider, Telstra, than for a new entrant as Telstra already receives basically all local telephony revenue as well as the bulk of current trunk and international call revenue.

Telstra's strategic imperative would thus be to retain its telephony revenue. For new entrants the major attractions will be the prospect of additional revenue plus less reliance on Telstra for interconnection. Because of these different strategic positions the two situations were examined separately.

In the case of other carriers, on the assumption that 70 per cent of pay TV subscribers would also take telephony, and assuming a 20 per cent discount on current telephony charges (as indicated by some over-seas experiences), the additional telephony revenue looks likely to make cable rollout viable. Thus while neither pay TV or telephony alone look likely to offer sufficient revenues, combined provision would do so.

It is therefore feasible that a dual HFC rollout in inner urban areas could be economic, given reasonably high penetration rates (for example, an initial take-up of around 20 per cent for each of two providers).

Simple calculations indicate that even if other carriers take telephony revenue from Telstra, then so long as Telstra can avoid the loss of even a quite small proportion of telephony revenue (for example 3 per cent) in inner urban areas by laying an HFC cable, it would probably be economic to do so.

If Telstra were to roll out HFC cable for strategic reasons related to protection of its telephony revenues, then a rollout by more than one carrier might still be viable with slightly lower penetration rates than those modelled (for example, a 20 per cent initial penetration rate).

Conclusions

The modelling indicated that for urban areas, at least in the short term, a number of different delivery platforms could potentially serve the Australian pay TV market. In addition, the strategic role of telephony revenues points to the possibility of a rollout by more than one carrier in some densely-settled urban areas.

Modelling results also show that interactive services such as video-on-demand are unlikely to be widespread even in inner urban areas until around the end of the decade. Two-way, fully communicative broadband services are likely only towards the end of the ten year forecast period.

For non-metropolitan parts of Australia, the huge costs involved mean that HFC networks are unlikely to be rolled out for many years. In addition, the result suggest that some people in rural Australia would be unlikely to receive services on a purely commercial basis, even via wireless networks, for many years. Centralised interactive and communicative services are very unlikely within the forecast period.

In the foreseeable future, therefore, only homes in inner urban areas have the prospect of a fully communicative network, or what is widely termed the 'information superhighway'. this finding suggests that issues related to new forms of 'information poverty' are likely to arise in the community in the coming decade.

Equity, particularly access to the new information services for those living outside urban areas, will be a concern. while terms such as the 'information rich, information poor society' are useful in focusing public debate, the outcomes of extensive new communications networks will be affected by more than just access to new technology (for example, the ability of people to use networked information and in particular the degree to which people not in the primary labour market will have access to ongoing training, will be crucial). Nevertheless, lack of network access for those living in rural and remote areas clearly has the potential for exacerbating existing urban-rural divisions. The cost will be an important factor.

However, the cost to Government of subsidising access to a cable network for rural and remote communities could amount to over $1 billion per year. This compares with the current USO cost estimate for standard telephony of between $100 million and $200 million per year.

The BTCE research points to the difficulty of defining a new universal service obligation which might supersede the current obligation to provide a standard telephony service; cost considerations aside, there is no obvious successor. In addition it would be difficult to identify the benefits.

What is clear, though, is that a growing range of consumer issues is likely to arise, including privacy, consumer protection and the special access needs of disadvantaged groups.

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Estimating demand for new networked services to the home

Public debate on new networked services has tended to focus on 'supply-side' issues (*i.e.* the technologies and their costs). In order to take a genuinely economic approach to examining network evolution, the scale of demand also needs to be estimated to help form a picture of where the money might come from in the household budget to pay for new networked services.

This approach proved problematic for the BTCE. Not only are the factors affecting demand for new services complex and uncertain, but significant demographic information such as gender and occupation are not available in a form suitable for inclusion in the model. A specific problem was that cost estimates were necessarily at the household, rather than individual level, so for example, although the demand for interactive video games might be expected to be strongest among the key market sector for today's computer games (*i.e.* males aged 15-24 years), households generally consist of several people, each of whom has distinctive demand patterns. Also, evidence that household size and composition are hanging in most developed countries confirmed that it would be difficult to estimate how any single market sector's demand would translate into per-household revenues.

Qualitative input to the demand scenarios was therefore also sought, as an adjunct to the modelling exercise. This supplementary information was based on analysis of data on daily time allocations by different demographic groups to activities which might be affected by networked service delivery (*e.g.* current time allocation to free-to-air television viewing, which might be available for pay TV viewing).

Joint consideration of expenditure and time use data for each scenario highlighted the distinctive demand patterns which might emerge for people classified broadly as 'time rich, cash poor' (*e.g.* those who are unemployed or retired) and those who are 'time poor, cash rich' (*e.g.* those in managerial or professional occupations). In BTCE (1994a) it is noted that entertainment is likely to be the major service application for the 'time rich, cash poor' who might be expected to welcome new ways of spending time. Information services, possibly offering new ways of saving time, are also likely to meet with demand, but from the smaller group of 'time poor, cash rich' individuals.

THE RELATIVE MATURITY OF ICT TECHNICAL AND INSTITUTIONAL SYSTEMS

SESSION 1: HOW DOES IT/TELECOMS AFFECT THE ECONOMY - THEORY

Professor Robin Mansell

22 June 1995

The relative maturity of ICT Technical and institutional systems

In a bid to move toward greater analytical precision studies of the impact of innovations in information and communication technologies (ICTs) tended to separate technology users from producers. and technological systems development from the economic (and social and political) context[18]. At the aggregate level, for example, investment in the telecommunication infrastructure can be shown to be closely associated with economic growth. At a more disaggregated level, investment in information technology hardware and software can be shown to be associated with gains in productivity.

The expected gains have taken considerable time to even begin to be reflected in the statistical evidence. Modelling exercises that have sought to establish the centrality of the ICT revolution and its importance for economic growth generally have assumed that: a) the technical 'substructure' (*i.e.* networks, computer processing power, software functionality) is being used to capacity; b) that external barriers (*i.e.* policy and regulatory constraints) do not impinge on market performance; and c) that capabilities in relevant producer and user communities are well matched and change in tandem with technological capabilities[19].

These assumptions have been necessary in order to make use of available empirical evidence. However, they have been challenged by less formal -- though still empirically grounded -- research on the factors affecting the innovation process and the diffusion and use of advanced ICTs. Such factors include the familiar issues of learning by organisations, mismatches in skills and competences, and uneven economic resources available for investment in technologies and in human capital.

The label, appreciative theory, is used to describe analytical frameworks that involve theorising, but which remain relatively close to empirical data[20]. Such theories encompass certain bounded aspects of the economic experience of innovation in ICTs. Appreciative theories are explicitly partial. They lay claim, neither to the predicative power of formal theory, nor to the simplistic assumptions about human behaviour that are necessary attributes of formalism. However, they do provide a basis for linking issues that need investigation if new light is to be shed on the complex system represented by the production and consumption of ICTs.

Theoretical understanding of the impact of advanced ICTs on the economy could be deepened if we begin to build frameworks that break down dualisms between the 'economic' and the 'social' impacts and the 'technical' and the 'non-technical' factors that contribute to change. There is also a need for more rigorous empirical studies aimed at developing indicators and benchmarks (ideally on a comparative basis as between firms/sectors/countries) that will allow us to pinpoint how and why the experience of the ICT revolution is as variable and uneven as it is. This kind of work needs to be both historical and prospective.

It calls for much more than new case studies of technical and institutional (organisational) change. It calls for a fundamental rethinking of how we model the key interfaces between technical systems and the market place; how we expect dynamically changing technical systems and markets to coincide to capture the potential benefits of advanced ICTs; and how we measure (using a mixture of quantitative and qualitative evidence) the extent to which there are departures from the expected synchronicity of technical and institutional systems.

The following proposes a starting point for thinking about these theoretical issues and points to the empirical data that would need to be generated.[21].

Theoretical departures

There is a growing body of evidence suggesting that it is only when a particular conjuncture of technical design features, investment, and organisational change comes about that the potential of advanced ICTs is realised. In addition, there is evidence that leads and lags in technical innovations and their commercialisation, investment in tangible and intangible resources, and learning on the part of both public and private organisations, results in 'mismatches' which, in turn, prevent the benefits of innovations from being appropriated by users and the economy as a whole.

The literature on economics of technical change offers three *departure* points for the analysis of the relative synchronicity and asynchronicity of these features of the economy.

- First, it points to the importance of the life cycles of technology: this literature has concentrated heavily on the manufacturing sector and, where life cycle analysis has been extended to services, the results of research in manufacturing sectors have been challenged.

- Second, the economics of technical change literature points to the critical importance of diachronic (time dependent) systems and the need to investigate how and why the subcomponents of technologies do not develop in a consistent or linear fashion.

- Third, this same literature emphasises the need to examine the economics of technical *and* institutional change.

The life cycle concept, the recognition of the importance of time in the appropriation of the potential benefits of technical change, and of the importance of institutional issues offer pointers to a theoretical framework to tackle questions about the economic impact of advanced ICTs. For example:

- The concept of life cycles can be applied to organisations as well as to technologies. There are large literatures on the life cycles of organisational change and the factors contributing to the 'births and deaths' of firms and public sector institutions. Some of it is located in the literature on the political processes and policy analysis.

- There is yet another literature that focuses on the time dependency of technological 'lock-in' effects which arise not only in the case of standardisation issues, but also more generally in the emergence of designs or architectures of advanced technical systems. consideration of the time element is also present in the literature on policy formation and implementation. Here the assessment of the impact of policy measures is linked not so much to the formal expression of policies or regulations in legislation, directives and standards, but to the implementation and enforcement of actions.

- The economics of technical change has looked closely at firm level change, *i.e.* the changing competencies, skills and structures of organisations and at the structural characteristics of markets.

  These same concepts are relevant to public institutions that influence supply and demand in the marketplace, *i.e.* regulatory agencies, national, regional and international policy organisations, etc.

Taking there three conceptual elements as a departure point, the relevant theoretical questions regarding the impact of advanced ICTs on the economy are:

- What is the relative maturity of the life cycles technical systems (including services), supplier and user systems of innovation?

- What is the timing of changes in each of these areas? What are the leading and lagging systems and why?

- What are the key institutionalised systems and their relative maturity in the private sector, *e.g.* strategic, business processes, training features, etc.?

- What are the key institutionalised systems and their relative maturity in the public sector, *e.g.* implementation and enforcement of policies, regulations, data protection codes, etc.?

Our analytical tools are inadequate to apply this approach to the generate insights at the macro level. However, at a disaggregated level, this perspective suggests comparative research on the life cycles of specific advanced ICT services and technologies and selected firms/sectors and public institutions. It requires that as much attention be given to issues on the user (demand) side as to the producer (supply) side. Finally, it requires that analysis focus on the intersection between technical innovation and institutional capabilities and how this varies over time.

This approach creates a significant challenge for empirical work. It requires the development and testing of new indices and benchmarks of relevant changes in technologies and institutions. Some work is underway in specific areas but we have no means of coherently linking the indices that are available in a way that addresses key factors that affect whether the benefits of advanced ICTs are appropriated. Such metrics might, for example, include:

- metrics for technical capacity utilisation: hardware, software and underlying network substructures;

- metrics for human capital capabilities: training, skills, (competencies) at the firm and sectoral level;

- metrics for policy/regulatory capacities (implementation and enforcement).

If we do not begin to generate new datasets and indicators in an imaginative way, we are likely to confront new incarnations of the productivity paradox as technical innovation continues and the employment consequences will remain illusive.

REMARKS PREPARED FOR THE OECD WORKSHOP ON "THE ECONOMICS OF THE INFORMATION SOCIETY," UNIVERSITY OF TORONTO, 28-29 JUNE 1995

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Summary

In 1992, a report by the Economic Strategy Institute indicated that the accelerated introduction of high-speed telecommunications could boost US economic growth by 4 per cent to 6 per cent over the following 15 years. A subsequent study by Teknibank (now Databank Consulting) was directed, among other things, at applying the methodology of that study to the European situation. The obtained results suggest that a similar effect could be generated in Europe, but a strong stimulation for both infrastructure implementation and usage innovation will be needed to match the 6 per cent growth increment predicted for the US.

It has been also found that this boost to business competitiveness and economic growth will be strongest in the more industrially developed regions of Europe (Germany, France, United Kingdom), where advanced communications multiply the efficiency/effectiveness of sophisticated information systems, unless specific measures are taken to promote the redistribution of "office work" within the EC.

The final results of the study show an incremental output growth, due to the introduction of broadband communications, of the GDP of the European Community from 1993 to 2008 of 2.7 per cent for the neutral scenario, 4 per cent for the proactive scenario and 6 per cent for the accelerated scenario. This growth is incremental, that is, it must be added to the effective GDP growth in the same period. Translating such percentage rates in monetary terms, this means that at 1990 ECU (dollars), the increased cumulative growth may be evaluated as:

European Community GDP cumulative incremental growth, 1993-2008

--	Neutral Scenario	+2.7 per cent	129 Billions Ecu (160 Billions $)
--	Proactive Scenario	+4.0 per cent	190 Billions Ecu (235 Billions $)
--	Accelerated Scenario	+6.0 per cent	285 Billions Ecu (353 Billions $)

This kind of analysis involves more or less implicit assumptions about the link between productivity gains at micro-economics level and the resulting output growth, which is somewhat difficult to be dealt with. To assume a one-to-one correspondence between these two variables (as in Cohen's 1992 study for the US) would mean to assume a constant level of employment. We choose instead to analyse

the relationship between productivity gains and sectoral economic growth in European economies in the past 15 years, which resulted often minor than 1, reflecting a slow decrease of employment especially in manufacturing industries. Therefore we estimated different ratios for different sectors and countries by which productivity gains are translated into economic growth. It must not be forgotten, though, that the relation between productivity increases and output growth implies a corresponding relation between output growth and employment growth. In order to achieve employment growth, other labour market conditions must be appropriate and sectoral rates of growth must be higher than the corresponding increases in productivity. In this respect it has to be noted that the productivity gains identified in our study almost all lie in the area of "office work." The service sector will, therefore, be the main beneficiary of effective use of advanced communications but, conversely, employment in office work will come under strongest pressures if productivity gains outpace growth.

Actually, it is since the 1960's that the 12 EC countries have shown an increase of occupied population markedly lower than the other OECD countries, even if this did not prevent them from achieving GDP growth rates higher than US. At the same time, the relative importance of employment (although not of output) in industry has also decreased, down from nearly 40 per cent of OECD employment in 1970 to under 30 per cent in 1992. The counterpart has been a continual rise in the importance of employment in the service sectors.

In other words, the dynamics of productivity growth has been for the whole period particularly high, second only to the Japanese one. Actually American economists have been until recently very much worried about the "productivity slowdown" which seemed to have entrapped their development perspectives.

Among the various explanations proposed for this phenomenon, two seem particularly relevant (even if not exclusive, because the phenomenon is so complex that it would be wrong to adopt deterministic explanations).

The first one, relevant in the first half of the considered period, refers to the 'latecomers advantage," that is the advantage exploited by countries (such as Italy) living a mainly export-led economic growth, based on the import of technology (under the form of machinery and components import and/or licensed production—or simply imitation). In this way these countries achieved the same productivity increases gained by countries at the forefront of technological innovation, but in a shorter time.

The second explanation, more recent in its formulation and because of the facts it takes into account, refers to the relative weight of high or low-tech sectors in the different economies. According to this interpretation, in mature (low-tech) sectors technological innovation affects mainly production processes (typically labour-saving), while in new, high tech sectors it affects mainly product innovation. The different dynamics of demand in the two macrosectors, mainly of substitution for mature sectors while fast growing in high tech sectors, plus the difficulty to measure productivity increases in new and services sectors, combine to explain a diverging pattern in job creation. In the case of mature sectors, there will be strong productivity increases and low job creations, and exactly the opposite for high tech sectors. National economies with a strong prevalence of mature sectors (as it is often the case in the EC) will be affected by this dynamics.

Undoubtedly, technological change continues to alter the nature of jobs. The biggest OECD countries, with their large domestic markets, have generally had the biggest share of employment in high-tech manufacturing. But the rapidly growing international market for new technology products makes high-tech production feasible even for small countries. Thus not only Japan, but also some smaller

countries (notably Ireland, Australia, Finland and Norway) have been particularly successful in strengthening their competitiveness in high-tech industries (right side of the chart). Many other European countries have a relatively poor record in shifting to high-tech exports. The only large EC country that strengthened its comparative advantage significantly in high-tech products, the United Kingdom, did so not by increasing its market share for high-technology commodities, but through a large loss of market share for low and medium-tech products in the early 1980's.

Unemployment in the EC is not only higher, it presents different characteristics also in terms of duration of the average period of unemployment. In the EC there is a larger share of long-period unemployed. In this kind of survey, long-term unemployment is defined statistically as the number of unemployed who, at the moment of the survey, have been without a job for at least one year, as a share on the total number of unemployed. The starting point is approximated by the ratio of the number of unemployed for less than a month on the occupied population aged between 15 and 63.

The EC countries are in a worse situation than the other industrialised countries. Their labour market is characterised by a high rigidity, meaning that it is relatively unlikely to lose one's job, but it is also relatively unlikely to find another one in a short period. This is exactly opposite to the situation in the USA, where in 1993 (with the recovery well under way) a survey found that nearly 20 per cent of American workers thought they were likely to lose their jobs over the coming 12 months, and another 20 per cent expected to be laid off temporarily: but the average length of unemployment is much shorter. In the late 1980's, 2 per cent of Americans became newly unemployed each month, while only 0.4 per cent of Europeans did.

The rigidity of the European labour market, combined with the macro-economics restraints which prevent European countries from using the public sector as a source of jobs, is at the root of the structural unemployment problem above analysed, even it is not the only cause.

The overcoming of these rigidities would require profound changes in the legislative system and in the traditions ruling the conditions of work in the European countries, affecting also industrial relations and welfare systems.

The existence of minimum wages has been criticised because they restrict the adaptability of wages to the productive contribution at the lower end of the wage scale. Workers whose estimated contribution to output is less than the minimum wage equivalent have no chance of regular employment. Especially the entry into the labour market by newcomers will probably be impeded. An appropriate reform could contribute to the solutions of these problems.

THE COLLAPSE IN DEMAND FOR THE UNSKILLED: WHAT CAN BE DONE?

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Introduction

In the United States, the poor are getting poorer. In Germany,, by contrast, the poor are getting richer. Britain is in between. The rich, on the other hand, are getting richer in all three countries.

Across the OECD, changes in technology and trade patterns have led to a significant decline in the demand for workers without skills. This fact is at least partly responsible for the wage changes described above. So we are left with something of a puzzle. Given that shifts in technology and trade patterns are much the same in all developed countries, how is that the lowest paid in the United States are doing so badly whereas those in Germany are doing so well? Figure 1 illustrates just how big is the gap. It appears that throughout the 1980s, the real wages of bottom decile male workers in Germany have been gaining on those in a similar position in the United States by an enormous 4 per cent per annum. In what follows, we shall address this puzzle, because an understanding of how Germany achieves this outcome may shed some light on the question of what might be done to solve the low pay problem in the United States.

Unfortunately, the solutions indicated by pursuing the comparison with Germany tend to be rather long-haul. So we must also consider what might be done in the short-run. Again, utilising evidence from other OECD countries, we investigate successively demand expansions, public employment/job creation, across-the-board switches away from payroll/income taxes towards excise taxes (VAT), and finally low-wage job subsidies, minimum wages and negative income tax systems. We begin, however, by comparing the United States with Britain and Germany.

1. United States, Britain and Germany: An Overview

The economies of the US, the U.K. and Germany are worth comparing because, while Germany has an unskilled *unemployment* problem which is no worse than that in the US, the low pay problem in Germany is more or less non-existent. For example, bottom decile US men receive about one half of the pay of bottom decile Germans on a PPP basis (see Freeman, 1995, p. 66). The male decile 9 to decile 1

earnings ratio in Germany is around 2.3 and stable be desirable to have a system in place which provides private sector jobs for low skill individuals at a reasonable wage. One way of doing this is to fix a minimum wage (for prime age adults) and then to subsidise employers in order to provide an adequate supply of jobs at this wage. The latter could involve a tapering subsidy of the kind suggested by Dreze and Malinvaud (1994).

This proposal has a number of advantages. If it is successful at creating jobs at reasonable wage levels for the unskilled, the unemployment benefit system can be structured to pressure the unemployed to take these jobs. The subsidy system is not attached to individuals, so there is no problem of labelling associated with schemes where individuals of a given type "carry" subsidies with them to employers. On the other hand, it has to be recognised that it reduces the incentive to acquire training.

Summary and Conclusions

In the United States, the poor are getting poorer whereas in Germany they are getting richer. Indeed workers in the bottom decile of the male earnings distribution in Germany earn twice as much as their equivalents in the US Yet the unemployment rate of the unskilled in Germany is much the same as in the US, as is the non-employment rate. So are there any lessons in the German experience?

First, compulsory schooling in Germany is focused on bringing *all* pupils up to an acceptable level of achievement. As a consequence, the variation in attainment among school children is substantially lower in Germany than in the US Following on from this, some 80 per cent of German youth attains either a vocational training certificate or a university degree and 19 of the remaining 20 per cent receive some *formal* post-secondary education or training. By contrast, around 31 per cent of US school leavers never receive any formal training or education after leafing school and 46 per cent gain neither a certificate nor a degree.

So the education and training system in Germany trains a far higher proportion of the work force up to a significant level of skill than in the US One of the consequences of this is that the skills of the supervisory level workers in Germany raise the productivity of unqualified workers in both manufacturing and the service sector. This enables the relatively compressed wage structure to be sustained without excessive unemployment at the bottom end.

There are obviously some lessons here for raising the pay of those at the bottom end of the US earnings distribution. However, applying them would take a very long time even if it were politically feasible. So what of the alternative demand-side policies which could be introduced over a reasonable time horizon?

There are two basic approaches, direct demand expansion or tax cuts/job subsidies. Demand expansion focused on the unskilled or job creation programmes are not very effective unless they are used for small and precisely targeted groups, such as the very long-term unemployed. Tax cuts/job subsidies hold out more hope if they can be concentrated at the bottom end of the pay distribution. Standard public finance suggests that negative income tax schemes are the most efficient for alleviating poverty. However, if it is thought desirable to focus on the provision of work, then a combination of minimum wages and job subsidies could be effective in providing reasonably paid jobs for the unskilled.

IMPACT OF THE DEVELOPMENT OF THE INFO-COMMUNICATIONS INDUSTRY ON THE ECONOMY AND EMPLOYMENT ANALYSIS USING INPUT-OUTPUT (I-O) TABLES

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1. Outline

The extension of info-communications entails the development of info-communications sector and info-communications assistance property sector, which provides computers and info-communications equipment, indispensable for industries supplying information and for info-communications activities. And it also entails the encouragement of new service industries related to info-communications. The utilisation of info-communications has a significant influence on the productivity of corporations.

The development of info-communications will not only raise the productivity of the info-communications industry but will also be a factor making changes in the industrial structure.

The Ministry of Posts and Telecommunications has developed the MPT Input-Output Model (The MPT I-O Model) and used it to find what sort of impact the development of information-oriented society would have on the industrial structure and to grasp what qualitative and quantitative changes would be brought about by the info-communications industry, which promotes the importance of information in the course of changes of industrial structure, by way of the quantitative measurement of the level of info-communications in the Japanese economy.

Several research papers on the Information Economy have been published. The MPT I-O Model's based on that of Marc Uri Porat (The Information Economy (1977)). While Porat attempted to measure level of more information-oriented society from gross value added of a nation's economic activities, the special feature of the MPT I-O Model, is that it makes an analysis from the structural aspect by observing transactions for intermediate goods.

2. MPT I-O Model

The MPT I-O Model measures the scale of info-communications industry and that of info-communications activities. So it involves two models, the MPT I-O Table and the In-house Analysis Model.

1. MPT I-O Table

The MPT I-O Table is developed to measure the scale of info-communications industry, using "Input-Output Tables for Japan" and existing statistic data. The MPT I-O Table is made up of three blocks based on the info-communications industry.

As well as measuring scale of info-communications industry, the MPT I-o Model analyses the economic effects that the goods and services produced by info-communications industry have on itself and other industries.

These blocks are divided into (1) the info-communications service sector, which provides information service to corporations and members of the public, for example Postal services, Telecommunications, Information Software. (2) the info-communications assistance property sector, which supplies the equipment (info-communications services; for example info-communications equipment manufactures computer leasing (3) the sector not related to info-communications, *i.e.* not included in (1) or (2).

A block combined (1) and (2) is defined as the info-communications sector (info-communications industry).

2. In-house Analysis Model

The In-house Analysis Model is developed to measure the scale of info-communications activities.

The info-communications activities in the market is the activity of the info-communications service sector measured by using the MPT I-O Table.

The in-house activity to produce info-communications service (hereafter referred to as "in-house info-communications activity"), which produce for self-consumption and does not appear in the market, exists in the info-communications assistance property sector and the sector not related to info-communications.

The In-house Analysis Model examines the in-house info-communications activity separately from the activity of the sector, which is measured by the MPT I-O Model.

The costs for in-house info-communications activity are the costs for info-communications services for the research and development, data processing and management in intra-company and intra-Government production activity. These costs consist of (1) the amount provided by info-communications service sector as an industry, (2) rental and maintenance costs for computers and other equipment, electronic charges, (3) compensation of employees who engaged in info-communications activity and (4) depreciation of fixed capital used for info-communications activity.

Using the In-house Analysis Model, we measure the extent of "informatisation" of industrial activity by analysing (1) the scale of in-house info-communications activity; (2) trends in info-communications expenditure in each industry; and (3) the ratio between in-house activity and external procurement in this info-communications expenditure.

3. Analysis using the MPT I-O Model (Japan)

1. Analysis of the changes of the industrial structure using MPT I-O Model

Analysing the changes of the industrial structure from 1985 to 1990 using the MPT I-O Model, during the 5-year period real domestic product of info-communications industry (1985 prices) increased at high pace by 1.7 time, from 55 trillion yen (1985) to 96 trillion yen (1990). So the real domestic product share of the info-communications industry to all industries raise 2.8 points.

The intermediate demand for info-communications industry increased by 1.9 times during the 5-year period, from 33 trillion yen (1985) to 62 trillion yen (1990). So the total amount of intermediate demand for the info-communications industry to all industries rose from 9.7 to 13.2 per cent.

The amount of final demand for the info-communications service industry rose slightly, but that of the info-communications assistance property industry increased by 1.7 times during the 5-year period, from 18 trillion yen (1985) to 29 trillion yen (1990).

The amount of info-communications activity estimated by real gross value added (1985 prices), info-communication activity in the market (info-communications service sector) increased from 14 trillion yen (1985) to 22 trillion yen (1990) and in-house info-communications activity increased from 38 trillion yen (1985) to 54 trillion yen (1990), so the total amount of the info-communications activity increased from 53 trillion yen (1985) to 76 trillion yen (1990).

The share of the in-house info-communications activity to all the info-communications activity is about 70 per cent.

In the period, the average annual growth rate of the Japanese economy was 4.6 per cent, but that of the info-communications activity showed higher growth rate 7.6 per cent, so the share of the info-communications activity to all economy rose from 16.0 per cent to 18.9 per cent

2. The effects of structural changes in both demand and supply side on economic growth and induced employment change

Using the MPT I-O Model, the effects on economic growth and employment caused by the change of the demand structure in the info-communications sector and the change of the supply side structure by the development of production technology in the info-communications sector, in the 5-year period from 1985 to 1990 was measured by the method of factors decomposition analysis.

(a) Analysing value added on the MPT I-O Model, the contribution ratio of the info-communications sector to the economic growth rate from changes in the demand and supply structure from 1985 to 1990 was 17.5 per cent.

(b) During the 5-year period from 1985 to 1990, the number of people employed in Japan increased by 5.51 million from 46.09 million to 51.59 million, an average annual growth rate of 2.3 per cent. However, owing to changes in the demand-supply structure of the info-communications sector increased the total number of employees by 1.05 million.

The info-communications sector thus played a major role in economic growth and employment, and the development of info-communications in Japan is expected to be a key factor in promoting economic growth and creating employment in the future.

4. Comparative analysis of the US and Japan using the MPT I-O Table

Using the framework of the MPT I-O Table, a comparison was made between the US info-communications industry and that of Japan, using I-O tables for the US in 1987 and Japan in 1985 and 1990.

In making a common I-O table for the US and Japan, sectors have been combined where scopes and concepts do not conform with each other. Japanese sector settings have been made to conform with

those of the US. In the sectors between the table of the US and that of Japan, there were some differences in the treatment of consumption expenditure outside household, royalties, public administration, public services, education and research. Japanese prices have been expressed in real terms based on 1990 prices and converted to dollars through a purchasing power parity in 1987. As no figure could be found for the number of employed in the US in 1987, this was taken as the average of the figures for 1986 and 1988 in "Employment and Earnings".

1. Value added of info-communications industry and value added inducement coefficient

The value added of info-communications sector in the US is 335 billion dollars (1987) and that of Japan is 142 billion dollars (1990). The value added share to all industries held by the info-communications industry in the US is 7.4 per cent which is almost the same as that of Japan is 6.7 per cent

2. The number of employees in the info-communications industry, employee input coefficient and employment inducement coefficient

The number of employees of info-communications sector in the US is 6.88 million and Japan is 3.06 million, but the share of the number of employees of the info-communications industry in all industries is almost the same, 6.1 per cent in the US and 5.8 per cent in Japan.

The employee input coefficient, which indicates volume of work inputs necessary to produce one unit of info-communications sector's products, is slightly lower both in the US and Japan compared with another industry. Especially employee input coefficient of the info-communications assistance property sector of Japan is 6.85, which is lower than that of another property sector (8.14) means the labour productivity of the sector is high.

Regarding the employee input coefficient for the telecommunications industry in Japan, with the liberalisation of the telecommunications carriers in 1985, the entry of new telecommunications carriers created employment. However, with the restructuring of existing telecommunications carriers, the employee input coefficient was cut back drastically which cancelled out the increase in employment and caused a drop in the employment coefficient.

In the period, demand for the info-communications assistance property sector's products has increased rapidly. But the increase of the demand for labour of the sector was not so high.

Using the employment inducement coefficient, which indicates volume of work inputs necessary directly and indirectly to produce one unit of need, that of the info-communications sector in the US is 21.02 and that of Japan is 21.40, and that of the sector is not related to info-communications in the US is 22.72 and Japan is 21.71. Those of the US are similar to those of Japan. The employment inducement coefficient of the info-communications sector is similar to the sector not related to the info-communications.

As for the info-communications sector, the absorption of employment (the employee input coefficient) is not so strong, but the indirect employment inducement to another industry (the employment inducement coefficient) caused by the increase of the needs of the sector is high, so the employment inducement effect of the sector is as high as that of the sector not related to info-communications, whose absorption of employment is strong.

5. Analysing the development of the info-communications technology and forecast on the future economy (using MPT I-O Model)

I explained the outline of the analysis using the MPT I-O Model.

Also I analysed commonly the US info-communications industry based on the MPT I-O Model which was slightly modified.

I think the MPT I-O Model has some advantages to analyse the changes of each industry for the innovation of info-communications technology. Because it has more detailed sectors in info-communications industry.

It will be important and significant to analyse each I-O table of OECD countries by common framework based on the MPT I-O Model, which will be clear how the information will change the industrial structure in future.

As for forecast for the future, it will be important to forecast on the final demand structure and the state of industrial technology in each industry.

On the I-O table, input coefficient indicates "production technology". Specially to forecast the production technology in future, we must grasp correctly the change of info-communications technology which will promote the change of industrial structure.

1. Forecast on the future info-communications technology

It will be difficult to forecast on the input coefficient which indicates production technology based on the trends of past. In each OECD country, it will be better to research the development and the extension of info-communications technology through interviews.

Using the common framework based on the MPT I-O Model which will be also modified by introducing the forecast on the changes of production technology, it will be worth while OECD countries will make I-O model of the same future year.

At that time, we'll adopt the same input coefficient of info-communications sectors which will be the most advanced ones, because the info-communications technology will be spilled over to each country.

2. Forecast on the final demand

As for the forecasting of the final demand in each country for the future, it will be done using the extrapolation of trend based on the Macro-econometric model.

And in the component ratio of the final demand sectors, we will consider the increase of the demand of the investment caused by the construction of the info-communications infrastructure.

Using the common future technology (1) and the future final demand estimated by the Macro-econometric model (2), we can grasp the scale of the economy and the component ratio of the industries. And perhaps we will be able to estimate the economic influence by the development of the info-communications in each OECD country, and the difference caused from the structure of the industry in each country.

SUMMARY OF DISCUSSION TOPICS FOR OECD WORKSHOP JUNE 28-29, 1995

Pasi Rutanen
Ambassador to OECD, Government of Finland

The speakers of the last session are supposed to make concluding remarks on the preceding sessions to "synthesise the debate". In addition to this Ambassador Rutanen will make comments on:

-- the OECD Ministerial Communiqué of 24 May 1995 and the role of the Organisation in the GIS/GII;

-- education and the uptake of new information society;

-- promise for job creation; policy recommendations and the G-7 Halifax Summit of 16 June 1995;

-- the Asia-Pacific Information Infrastructure; Seoul Declaration of 30 May 1995 and Action Plan/Joint Statement on social implications and human resources development;

-- the OECD/KISDI joint conference in Seoul 26-28 April, 1995; the chairmen's summary on information technologies in socio-economic development;

-- the integration of developing countries into the GIS;

-- the process of social transformation that will engender modern information "intelprises" as players in the "wisdom game"; netizens" as new social class; the "post-illiterates" and the "symbolic analysts".

On the OECD discussion, Ambassador Rutanen will make the following remarks:

The OECD Ministerial Meeting on 23 and 24 May 1995 was looking for a strategy that would improve our ability to adjust and compete in a globalised world. Ministers undertook better education and training (including lifelong learning) as part of their strategy.

One of the major focuses was OECD member countries' quest for knowledge-based societies, including the Organisation's work on the Global Information Society-Global Information Infrastructure.

The Communiqué had a short paragraph on the GIS/GII. In the discussions the advanced GIS countries (Canada and Finland) were outlining the following tasks for the OECD:

-- further define the content, shared objectives, commonality of purpose and common vision of the GII/GIS;

-- continue examining the economic effects and policy issues raised by the development of information infrastructures and services and by national information initiatives and strategies undertaken;

-- evaluate the impacts on job destruction, creation and re-orientation of employment;

-- continue OECD's leadership role in the promotion of information security, in order to protect privacy and financial transactions, and to enforce intellectual property rights;

-- work on educational needs connected with the development of information society, including life-long learning and the training of teachers;

-- define the roles of governments in outlining common principles and appropriate regulatory reforms/regimes/frameworks, and in enhancing harmonisation of standards of Member countries aimed at encouraging competition an private sector investment in the GII/GIS;

-- initiate work for international understanding/agreements/arrangements to lay a framework for international electronic commerce;

-- explore ways of safeguarding universal service, also ensuring that the developing economies are not excluded from GII/GIS.

The challenge of knowledge-based economy has been discussed with growing intensity also in the context of *unemployment*. Large portions of our populations are threatened to be left out of this new economy. The ones who can ride the wave of the change g*et al*l the benefits. This was behind the Ministers' request in the communiqué to examine the possibility of developing standards and indicators for human capital investment.

It is essential that the new sets of indicators or the economics of the GIS are not developed in a vacuum, -- that they are policy-relevant and comprehensible to the political decision-makers and to the general public. The information in the knowledge-based society belongs to everyone.

IT SPILLOVERS AND PRODUCTIVITY GROWTH: AN EMPIRICAL APPLICATION TO FRANCE

Abstract of the paper by Hans van Meijl & Luc Soete
MERIT

A crucial feature of the knowledge creation process is the existence of externalities or spillover effects. The existence of such spillover effects has been shown to be crucial for the long term growth rate of an economy. Authors both of the "new" growth tradition (Romer, Helpman) as well as those with a more evolutionary perspective on technological change (Dosi, Freeman, Nelson) have stressed that the generation of these spillovers differs among sectors or among technologies. Especially, a "pervasive" cluster of new technologies (Freeman, Clark and Soete, 1982) or general purpose technology (Helpman and Trajtenberg, 1994) is expected to create important spillovers for the economy. This paper analyses the existence and magnitude of spillover effects related to the current pervasive or general purpose technology: Informational Technology (IT).

Following Griliches (1979), we first distinguish between two types of research and development (R&D) spillovers. On the one hand, externalities may occur because downstream users do not pay the full value of the input. This type of spillovers is called ***pure rent spillovers***. Rent spillovers are "embodied" in purchased goods and are measured by using the capital and intermediate inputs purchases matrix weights (Wolff and Nadiri 1993). On the other hand there exist ***knowledge spillovers***; ideas discovered in one sector which are used by research teams in other sectors[22]. Knowledge spillovers increase the productivity of the sector's own research efforts and can be either related or unrelated to good purchases. Knowledge spillovers related to good purchases can again be measured by capital and intermediate inputs purchases matrix weights. We call these ***input related knowledge spillovers***. Knowledge spillovers unrelated to good purchases or what we will call ***pure knowledge spillovers*** are considered to be dependent on the "technological" closeness of the sector. Griliches (1990) identified five possible methods to measure this technological distance. We use here the one developed by Evenson *et al.* (1988) based on he Canadian cross-classification of patents by industries of "production" and industry of "use". This so-called Yale "flow-tru" or technology flow matrix corresponds in our view most closely to a measure of the technological closeness of sectors. Previous studies which measured spillover effects examined only one of the spillovers concepts. The major contribution of this paper is the development of an analytical framework which treats these three spillover concepts: "pure rent spillovers", "input-related knowledge spillovers" and pure knowledge spillovers" at once.

The second major contribution is that these spillover concepts are being analysed for Information Technology. The magnitude of spillovers related to IT, as pervasive or general purpose technology are expected to be large. According to Freeman and Soete (1987 and 1994), Freeman and Perez (1988) and David (1992) information technology corresponds today to the major new key technology pervasive across all sectors of the economy. Investments in IT goods, for example computers, are expected to have a large influence on the productivity level in every sector. However, many empirical studies, who used the production function approach as we do in this paper, have searched for the influence of IT on productivity and have not found a statistically significant relationship[23]. In this paper we investigate this so-called IT productivity paradox by splitting the various spillover effects into IT and non-IT spillovers.

We use mainly French INSEE input-output and sectoral data covering the period 1977-92. The reason for doing so is purely pragmatic. French input-output data are probably among the best in the world, available at a relatively high level of disaggregation, and regularly updated.

As in most other OECD countries, the IT sectors are small in economic production terms. They only represent 1,87 per cent of actual French production. However, in R&D terms they perform 26.2 per cent of total R&D (BERD). Estimation results indicate that besides internal R&D, R&D spillover effects are important for productivity growth. Especially, the spillover effects related to IT capital goods turn out to be significant and large in magnitude. While Bresnahan (1986) using a different methodology found that the spillovers from computers to the financial services were high during the 1958-1972 period, our findings, consistent with results of some other recent studies, indicate that the influence of information technology has spread in the more recent period over the whole economy. Information technology is now a truly pervasive, general purpose technology which appears to boost productivity growth across the whole economy.

NEGLECTED DIMENSIONS OF THE PRODUCTIVITY PARADOX: USERS, COMPLEMENTARITIES, AND INFRASTRUCTURE

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Recent and preliminary evidence has suggested that the ICT productivity paradox is being resolved.[24] Whether or not this evidence is extended and buttressed by additional studies, the ICT productivity paradox should be seen as a fundamental indictment of our ability to measure what matters and as a failure of the predictive (*i.e.* scientific) content of economic analysis. Stated in general terms, the ICT productivity paradox involved economic organisations (including those operating under profit incentives) investing in a specific class of intermediate goods for a prolonged period without achieving widespread improvements in their measured productivity. The element of paradox in this behaviour is what would motivate such behaviour over a sustained period.

One clue to this puzzle comes from a variant of the ICT productivity paradox, the ICT profit paradox. Why did organisations with a profit motive continue to invest in information technology even though, on average, there was no correlation between the extent of their investment and increases in their profits? Economists generally recognise that this particular "paradox" may be resolved by noting that we would expect competition to bid away excess profits from any investment (including ICT). While perhaps too facile, this explanation should also suggest a particular line of quantitative research involving the timing of adoption of ICTs and the variability in the length of the time that firms take in experiencing changing in business performance. It may generally be true that the adoption of ICTs begins as an effort to save costs that becomes transformed into a process of product differentiation that raises costs back to near the original levels. The inability to accurately measure productivity in he more highly differentiated product offerings coupled with competition that makes these offerings the norm means social welfare increases without increasing either profits or productivity. This explanation resolves the paradox, but has not been systematically established empirically.

It seems more likely that ICTs do offer productivity improvements, but that the realisation of these improvements is quite difficult. If we are to understand the impediments to realising these productivity improvements, then research in three areas should be stressed in coming years.

First, we need to better understand how users incorporate ICTs into their organisations. The literature on this area ranges from impressionistic generalities such as those offered by Beniger to very specific and somewhat didactic case studies such as those in Zuboff or more generally in the organisational literature. Perhaps the greatest promise in this area is the development of sectorally specific studies of which Flamm's article in Crandall and Flamm's study of telecommunications is a useful departure point. Flamm observed that computer costs fall more rapidly than transmission costs while switching costs(which should also benefit from the factors driving down computer prices) increase. One of the explanations offered by Flamm was that the competitive ideal may not have, after all, had that great an impact on telecommunication tariffs, a point made by Mansell in her comparative study of the new telecommunications. The key lesson I take from this discussion is that the adoption of ICTs occurs in a particular industrial context and the analysis of how users deploy, and for what purposes they deploy, ICTs

is the key determinant of what we should expect to see in the realisation of the productivity improvements. From this perspective, the natural follow up is the examination of specific tasks to which ICTs are applied and the quantitative estimation of the consequences of these uses in which I expect that product differentiation should play a much larger role in our explanations. After all, we know from theory that a monopolistically competitive world is one in which investment in capacity serves to absorb profit and a move toward monopolistic competition is likely to involve scant gains in measured productivity.

Second, the diffusion of ICTs involves a broad range of complementary developments. In practice, ICTs are components in a system of production of goods and services. For example, desk top publishing, initially a software capability in personal computers drives complementary demands for high quality printers and printing services. Desk top publishing is diffused to the extent that these complementary capabilities exist. Central to these capabilities is the existence of human skills. I does little good to have the technological capabilities if the complementary human capabilities have not been developed. Just as in the case of the organisational dimension, the development of capability can absorb substantial resources. There is no question that enormous amounts of human capital investment, both formal and informal, have been devoted to learning how to use the new ICTs. It is also clear that there are substantial variances within the labour force in the level of these skills. While computer literacy is increasingly a requisite for employment, that term may be deceptive, particularly as we talk about ever increasing levels of "user support" necessary within modern organisations. It may well be true, for example, that moderate gains in the level of knowledge, with current equipment and software standards serves to generate a greater range of problems requiring solution and "support." This problem may even be exacerbated by the dynamics of competition in the software industry where application programmes are rapidly growing more complex, perhaps outstripping all but a few users' capabilities to master their intricacies. Meaningful measures of the human capital investments associated with the diffusion of ICTs are a needed first step to help us resolve productivity issues.

Third, and last, we need to think more seriously about the infrastructures that ICTs have promised to provide in developing the "information society." There has now been a long debate about the contribution of ICT production to various measures of social welfare. Yet, it seems clear that the use of ICTs is where much of the social welfare is to be generated. The infrastructure that ICT creates is one in which the information generation and use would be getting easier over time. Is this the case? Are we approaching interoperability? Are the standards that we have for the transport of information along the global information infrastructure going to contribute or impede the public's enthusiasm for this future? What are the social losses from the absence, delay, or incompatibility among the standards for all which compliance is largely unenforced and unmonitored? The answers I would make to all of these questions would suggest that we should not get a very high grade for our efforts to construct a meaningful information infrastructure, an effort that is certainly a prerequisite to any meaningful use of the term information society. Can we do better next term?

TELECOMMUNICATIONS IN TRANSITION: UNBUNDLING, REINTEGRATION AND COMPETITION

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I. Introduction

The world economy is experiencing a technological revolution, fuelled by rapid advances in microelectronics, optics and computer science, that in the 1990s and beyond will dramatically change the way people everywhere communicate, learn, and access information and entertainment. This technological revolution has been underway for about a decade. The emergence of a fully-interactive communications network, sometimes referred to as the “Information Superhighway” is now upon us. This highway, made possible by fibre optics and the convergence of several different technologies, is capable of delivering a plethora of new interactive entertainment, informational and instructional services that are powerful and user-friendly. The transition from analogue to digital technologies, the expanding bandwidth of the enabling platform, and the shift from regulated to competitive environments have all service to make the 1990s the decade in which the Information Superhighway will be built and used. A true revolution in the delivery of entertainment, information, transactions and telecommunications services is at hand.

This paper outlines these technological changes and explores their implications for competition policy, industry structure, and business organisation. Part I introduces competition as an organisational model and discusses the existing structure of the telecommunications industry in the United States. Part II describes recent technological advances that change the conditions underlying the current regulatory structure of the telecommunications industry and challenges the effectiveness and validity of the current regulatory scheme. Part III discusses how innovation impacts what has been considered the natural monopoly of local exchange. Part IV advances five principles that should guide policy modification. Part V explores how eliminating the line-of-business restrictions created by the Modification of the Final Judgement[25] between the government and American Telephone and Telegraph Co. will accelerate competition and stimulate the development of the Information Superhighway. Ameritech's Customer First Plan is presented as a 'viable means to enhance competition, avoid redundant investment, and increase service innovations and technological advances. Part VI discusses the impact of removing interLATA restrictions.

The organisational model most capable of delivering advanced services universally and at low cost is one that relies on competition and co-operation. Competition will ensure that incentives exist to provide new services at low cost. Co-operation, governed by antitrust laws, will ensure that the various networks based on copper wires, coaxial cables, fibre optic cables, and airwaves are knit together into a “network of networks." In combination, competition and co-operation will ensure that vestigial elements of any remaining essential facilities in the local exchange business are accessible in a non-discriminatory fashion and that people can communicate anytime, anywhere, to anyone.

The United States has already moved quite some distance toward implementing this model. Since the late 1970s, the government has embraced competition as a matter of public policy for the telecommunications industry. Moreover, "the genie of competition has been set loose from the bottle and is unlikely ever to be squeezed back in." Nor should it. In the United States, if not everywhere, competition is far and away the most promising route for efficiently bringing forward the advanced telecommunications services needed to enhance global competitiveness in the decades ahead. However the existing structure prevents realisation of the benefits of integration. The predivestiture Bell companies, whatever their faults, did bring forward network innovation that kept the United States second to none in the efficient provision of telecommunications services for decades. The benefits of the former integrated system can be available today. Many of the problems of the existing system, such as declining investment, slow rates of new product innovation, and limited network innovation, can be addressed if the embargo under which the Regional Bell Operating Companies (RBOCs) are operating is lifted. When coupled with unbundling of the local exchange, removal of the interLATA restriction will create a framework that allows market forces to determine whether services are offered by an integrated or a nonintegrated entity and how different services are priced. This will leave federal and state regulators more focused on monitoring safeguards and championing innovation rather than simply standing in innovation's way. Also, inefficient investments that have sprung up purely as artefacts of regulation will fade away, as they should. Scarce investment dollars can then be steered where they need to go: not into the unnecessary duplication of facilities, but rather, into the building of advanced digital intelligent networks.

This model based on competition is by no means a pipe dream, It is the logical conclusion of the trend selected in the late 1970s and early 1980s to increasingly rely on competition rather than regulation to organise the market. The model already finds full expression in New Zealand, where the Post and Telegraph Office (PTO) provider was privatised and the market was opened to competition. The "Kiwi share" set a price cap on residential rates that moves with the rate of inflation and New Zealand's antitrust laws safeguard the interconnection rights of new entrants. Tremendous productivity improvements followed privatisation and deregulation bringing New Zealand to a leadership position in the modernisation of telecommunications infrastructure.

II. ENABLING TECHNOLOGIES

The continued rapid evolution of a number of key technologies facilitates the development and deployment of advanced broadband telecommunications services in the United States and abroad. These technologies enable voice, data, and images to be created, processed, stored, and delivered using a variety of wired and wireless technologies that were little known only a few years ago. Interactive multimedia for instance, mixes and combines a variety of communication methods, sounds, graphics, still photos, motion video, and the written and spoken word, in a computer-controlled environment. The familiar functions of the computer (manipulating data bases) and the TV set (displaying pictures) now combine to give us an expanded concept of multimedia, drawing on advanced software developments and protocols and powerful microprocessor architectures.

Some key technologies that provide the enabling platform for these new telecommunications services are:

1. *Bandwidth Explosion.* The conversion to digital systems permits expansion in the number of channels carried by a transmission media. Optical fibre also permits a dramatic increase in the bandwidth that can be transported from point to point.

2. *Enhanced Videoprocessor Power*. New RISC-based microprocessors and digital signal processors permit faster, more efficient, and thus lower cost switching. data access, and digital compression.

3. *Reductions in Memory Cost.* In recent years, the unit cost of memory has fallen dramatically, thus allowing cost -effective storage and retrieval of large libraries of digital context.

4. *Software Breakthroughs.* Software developments are putting quick, low-cost programming, access to large data bases, and inter-operability, which facilitate the integration of different types of media into multimedia products. Stored program control has dramatically improved the versatility of telecommunications products. Software breakthroughs are also permitting seamless, user-friendly operation.

5 *Wireless Modulation.* Techniques such as trunking have been developed and are now being deployed that dramatically increase the capacity of the radio spectrum for voice and data.

Many of these technological developments change the conditions that form the basis of the current regulatory structure of telecommunications, making many of those regulations obsolete. Recognising this, regulators and courts have begun to promote competition as the underlying principle for the organisation of the telecommunications industry. Some regulatory changes include additional spectrum allocations for new services such as Personal Communication Servers (PCS) and Enhanced SMR, Federal Communication Commission (FCC) co-location and open network architecture (ONA) policies, the lifting of information-services content restrictions on the RBOCs in July 1991, and a July 1992 FCC ruling permitting local exchange carrier deployment of video dialtone. Without these and other regulatory changes, the Information Superhighway would be just a dream.

Indeed, it is well to recognise that the United States no longer holds a commanding lead in telecommunications. As one observer has noted:

> "The rate of network improvement in other countries is more rapid than in the United States and we are in serious danger of falling behind. For example, both Europe and Japan have plans to have a universal broadband service available by the year 2015, with fibre connections to every subscriber"

BIOGRAPHIES OF SPEAKERS AND CHAIRS

CALVIN AVERTICK is currently General Manager at Bell Sygma, one of Canada's largest integrators.

Mr. Avertick has held a variety of positions at Bell Sygma and its parent company Bell Canada. In the Information Technology area, he has been in charge of systems development, computer hardware selection, and organisation performance groups. In the Telecommunications area, he has been involved in Regulatory and Engineering matters.

Currently he is in charge of the staff organisation for the Bell Sygma subsidiary responsible for the development of computer application systems and telecommunications methods.

Focus areas of his responsibilities particularly relevant to this workshop include I.T. Metrics (*e.g.* Performance Measurements), Intellectual Property, and Regulatory Activities.

Mr. Avertick holds a Bachelor of Electrical Engineering and a Graduate Diploma in Management from McGill University and an MBA from Concordia University.

SUSAN BALDWIN is Director of the General Broadcasting Policy Branch with Canadian Heritage.

Her responsibilities include policy formulation for the Canadian broadcasting system, including both public and private broadcasters; analysis of CRTC regulatory decisions, including licensing of pay and speciality channels; social issues such s violence in the media.

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He was the organiser of the recent KISDI-OECD joint Conference on information infrastructure: *The Vision for the New World Order*, held on April 26-28, 1995 in Seoul. Recently, he worked as the special advisor to the Korean delegation to the First APEC Ministerial Meeting on Telecommunication and Information Industry, held on May 29-30, 1995 in Seoul.

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His main macro-econometric modelling projects have included the RDX and MACE models of Canada, the INTERMOD model of the G& and world economies, and contributions to the OECD's INTERLINK and other international models. He has also participated in Project LINK and the network for empirical research in international macroeconomics based a the Brookings Institution.

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-- to analyse the factors underlying industrial change;

-- to provide forecasts of the impact of industrial change on the different economic sectors and areas affected by industrial change;

-- to develop pilot actions relating to measures to anticipate, prevent and deal with industrial change;

-- to ensure close co-operation with other Community policies relating to industrial change;

-- secretariat to the high level expert group on the Information Society.

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DAVID L. JOHNSTON is Chairman of the Federal Government's Advisory Board on the Information Highway and the Canadian Institute for Advanced Research.

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More recently, David participated in the Bureau's Communications Futures Project, a small research team that investigated likely developments in communications in Australia over the next decade.

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She is the author of many scholarly works on technical and institutional change in advanced information and communication technologies including *The New Telecommunications: A Political Economy of Network Evolution*, Sage, London, 1993; *The Management of Information and Communication Technologies: Emerging Patterns of Control*, Aslib, London, 1994 (editor/contributor); and *Standards, Innovation and Competitiveness: The Politics and Economics of Standards in Natural and Technical Environments*, Edward Elgar, Cheltenham, 1995 (co-editor/contributor).

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He is currently preparing (with R. Harris) a monograph, Unbundling and Reintegration in the *Telecommunications Industry*, for the American Enterprise Institute's program on telecommunication policy titled *Telecommunications Deregulation.* His most recent publication in telecommunications is "Telecommunications in Transition: Unbundling, Reintegration, and Competition," *Michigan Telecommunications and Technology Law Review* (95 Mich. Tel. Tech. L. Rev. 4).

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Dr. Waverman has authored numerous scholarly books.

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[8] "Employment trends related to the use of advanced communication services", study realised for the EC-DG XIII by Teledanmark, 1995

[9] Trend in job reduction in PTOs is guided by the digitalisation of networks which reduce the amount of maintenance work required.

[10] Mercury has announced the redundancy of a quarter of its staff.

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[17] As the Economist magazine pointed out recently, many people who work for goods-producing companies are essentially service employees; the distinction between the "service sector" and the rest of the economy is therefore fuzzy and may be getting fuzzier.

[18] In the present discussion, ICTs encompass IT (including hardware and software) and the telecommunication infrastructure. It also includes a variety of information and communication services that incorporate electronic information processing and electronic distribution of information.

[19] It is recognised that some work has been done to reflect these factors using hedonic price deflators, etc. but generally in Total Factor Productivity models in telecommunication there are four main components: real output (rate adjusted revenues); real capital input (opportunity cost of funds invested in plant and equipment; real labour input (labour costs adjusted for inflection and type of employees; and real non-wage expenses. Se M. Starket and J Van Pelt Jr (1995) 'Productivity Measurement and Price Cap Regulation' *Telecommunications Policy*, 19(2), 151-160.

[20] See R Nelson (1994) "The Co-evolution of Technology, Industrial Structure and Supporting Institutions", *Industrial and Corporate Change*, 3(1), 47-63.

[21] This proposal emerges out of a research programme that has been conducted over the past 8 years at SPRU on the economic and social impact of advanced ICTs. The theoretical results of this work are in R Mansell and R Silverstone (eds) *Communication by Design*, Oxford: Oxford University Press, forthcoming March 1996.

[22] Knowledge spillovers occur because a discovery in one firm/sector can provoke one in another because new ideas pop up, new avenues of research are undertaken, or previous efforts become economical to pursue or to bring to full fruition.

[23] See, *e.g.* Loveman (1994), Morrison and Berndt (1990) and Brynjolfsson 1993 (review).

[24] See the just-released special issue of *Economics of Innovation and New Technology*.

[25] Presented at the University of Michigan Conference on Competition and the Information Superhighway, Ann Arbor, Michigan, September 30, 1994. Forthcoming in *Michigan Telecommunications and Technology Law Review*. The sources contained in this article include many difficult to obtain publications that are kept on file with the author. Sources have been updated since the presentation of this article. The author is Mitsubishi Bank Professor, Haas School of Business, University of California, Berkeley, and would like to acknowledge useful discussions with Robert G. Harris and Greggory L. Rosston, who have been co-authors on related work.