STI REVIEW No. 20

SCIENCE TECHNOLOGY INDUSTRY

Special Issue on Information Infrastructures

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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

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

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FOREWORD

Prepared by the OECD Directorate for Science, Technology and Industry, the *STI Review,* published twice yearly, presents studies of interest to science, technology and industry policy makers and analysts, with particular emphasis on cross-country comparisons, quantitative descriptions of new trends and identification of recent and future policy problems. Because of the nature of OECD work, the *STI Review* explores structural and institutional change at global level as well as at regional, national and sub-national levels. Issues often focus on particular themes, such as surveys of firm-level innovation behaviour and technology-related employment problems.

This issue considers some of the key challenges raised for governments by the development of a Global Information Infrastructure (GII) and the rise of a Global Information Society (GIS). The OECD is a leading organisation in the international debate on the GII-GIS, and the papers in this publication represent ideas which the DSTI Secretariat find interesting and useful advances on some of the key issues facing policy makers. The papers cover the role of technology diffusion, the growth of the Internet market and questions of competition, firm-level organisational adaptation and employment practices, intellectual property rights and universal service. They are not meant to be definitive statements on the issues raised, but are rather designed to spark controversy, promote discussion and clarify the lines of debate.

The views expressed in this publication do not necessarily reflect those of the Organisation or of its Member countries. The *STI Review* is published on the responsibility of the Secretary-General of the OECD.

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INTRODUCTION: FOUNDATIONS OF A GLOBAL INFORMATION SOCIETY

It is now widely recognised that the development of a Global Information Infrastructure (GII) will have a profound and wide-ranging impact on economies and societies. In order to facilitate the growth of the GII – and to ensure that its development is smooth and spread throughout society in as equitable a manner as possible – governments will need to introduce regulatory reforms in a range of policy areas. In the short term, however, reforms are particularly needed in the regulation of telecommunication and broadcasting service markets.

Over the longer term, reforms will be required in a wider range of policy areas in order to stimulate the development of cheaper and new mass-market service applications – such as for on-line health care, education, entertainment and professional business services. Traditional regulations in these areas may now be outdated, inadequate or inappropriate for the development of national and international markets for those goods and services which promise to be the major benefits of the GII. The value of reforms in these areas, however, will to a large extent depend upon getting right the basic relations between markets and market players in the core telecommunication, computing and information and entertainment sectors, so that the new services which can be or are being developed are economically viable and attractive. In many ways, in fact, the crucial questions which need to be addressed by policy makers lie in general reform of the overarching framework between core infrastructure and wider applications sectors, and how specific reforms of the relations between these two groups are enacted. Satisfactory answers to these questions may thus entail investigation and rethinking of issues which traditionally have been taken for granted in industrial manufacturing societies.

For a number of years now the OECD has focused on issues concerning the liberalisation of national and international communication markets. In the last couple of years it has also begun to investigate the development of information technologies and multimedia applications and services; their impact on traditional market structures – particularly in relation to economic growth, productivity and job creation; and the implications for policy and regulatory reform of the wider impact of the GII and the new services and applications which can be carried over

it. The initial findings and policy recommendations have been presented to Ministers in a number of reports during 1996 and 1997.

The papers collected in this issue of the *STI Review* are a contribution towards extending the debate concerning these developments to a wider audience. The papers represent ideas which the DSTI Secretariat find interesting and useful advances on some of the key issues policy makers must deal with in developing the GII. However, they are not meant to be definitive statements on the issues raised, rather being designed to spark controversy, promote discussion and clarify the lines of debate. As such, the OECD Secretariat welcomes comments and replies to the issues and arguments raised in the papers.

One of the key issues concerning the interface between infrastructure and service applications is the extent to which market structures might create barriers to the diffusion of new technologies. A number of studies have shown how the key to increases in micro- and macroeconomic performance often lies not in the adoption of computing equipment by individual companies, but in their mass adoption and linking into information and communications technology (ICT) networks. Kazuyuki Motohashi tackles this issue in regard to information technology equipment, and shows that general economic diffusion is growing rapidly. The discussion illustrates some of the problems involved in measuring the impact of information and communications technologies, which is an area where the OECD Secretariat and Member countries are currently working on defining and refining statistical measurements and analytical tools. But the paper also indicates some of the methods which governments and private-sector analysts may usefully adopt towards this end.

While it is often still too early to accurately measure the growth and diffusion of new services in the same way as equipment, the growth of the Internet – with its ease of access to information produced anywhere in the world – does suggest that service development riding on the back of ICT penetration can be a rapid phenomenon. This will only be the case, however, if governments ensure that supply bottlenecks, technological innovations and market structures remain open and competitive. Louisa Gosling and Jeremy Beale outline some of the technological, market and regulatory issues faced by governments wishing to encourage the competitive growth of the Internet as a public medium of mass electronic commerce. They underline the fact that the commercialisation and technological innovation of the private sector which has lain behind the growth of the Internet needs to be sustained in order to ensure its continued development. But they also argue that governments need to ensure competitive markets which allow small and medium-sized enterprises to maintain their viability on the Internet in the face of entry by large, established players from the telecommunication, computing and information/entertainment sectors, and that regulatory reform will be needed to prevent the possibility of anti-competitive behaviour.

If the nervous system of the Global Information Infrastructure and Information Society consists of technological networks and corporate organisations, then its intelligence, thought, cultural cognisance and capacity for development are constituted by the information and entertainment services which can be or are being produced and delivered over these networks. The vitality of the whole social body are nourished and protected by government policies and regulations, information and, in particular, by intellectual property rights. While intellectual property rights are essential for the functioning of any advanced economic system, the manner in which they are organised and the role they will play may be fundamentally different in the knowledge-based Global Information Society than in the manufacturing industrial society of the past. While such rights will need to be reinforced to encourage and safeguard content creators, new means of protecting, rewarding and sharing access to content will also need to be developed. Edward Barrow considers the issues concerned with such access, and argues that new technologies allow greater protection of intellectual property. He also argues for the value of assigning such rights to individual authors as a means of ensuring dynamic content markets for Internet-based services.

The growth of new interactive and network-based multimedia services such as provided on the Internet – and particularly via its World Wide Web (or WWW) component – raises the question of the extent to which new technologies create the grounds for employment and economic growth, and on what basis this ground can be developed by companies and nurtured by governments. There is an often-expressed fear about the rapid pace of new service development, and the manner in which these developments increase competitive pressures on older industries and raise productivity without creating widespread employment.

This is a subject already being addressed within the OECD as part of its work looking at the relationship between technology, productivity and job creation (OECD, 1996, *Technology, Productivity and Job Creation*). The work there indicates that the survival of existing industries, and the development of new growth industries, depends upon organisational capabilities in the face of dramatic globalisation of competitive forces which is already occurring but which the GII further stimulates. In this regard, best policy practices by governments are those which support highly adaptable and vigorous "clusters" of a range of inputs (venture capital, skilled personnel, social and physical infrastructure) rather than those which narrowly focus on government subsidies, ownership or protectionism. But the critical question then becomes one of how can governments support this process, without trying to take over the lead role which is properly the role of the private sector?

In addressing this question, Claudio Casadio Tarabusi points to the crucial role of organisational change and learning in ensuring that structural barriers to job creation are minimised and growth optimised. He argues that ICTs have a

pervasive impact on demand for labour and operations by firms. Within this context, governments have to redirect their policies, adopting a new overall approach which he calls *Promotion of Learning (PoL)*. This consists of meshing elements of a number of different policy areas, including education and learning policies, labour-market policies, technological policies, industrial policies, macroeconomic policies and monetary policies.

Another, related, concern is the degree to which the development of new services will create new inequalities in society between information "haves" and "have-nots". Patrick Xavier looks at how the concept of universal service is being redefined in the new networked society. The concept of universal service is relatively easy to understand and appreciate in a situation where straightforward voice telephony (on the one hand) and audio-visual broadcasting (on the other hand) are *the* communication services (and provided by publicly owned or regulated monopolies). But it is less easy to deal with in a situation of highly technologically dynamic, economically competitive and commercial convergence and multiple service provision.

Xavier argues that, at a time of increasing competition and privatisation, rapid technological change and convergence, it is important that universal service objectives be determined and achieved without distortions to competitive neutrality, not only among telecommunication operators but between telecommunication and other communication suppliers. Arguments for an upgrade of universal service obligations (USOs) on behalf of uneconomic subscribers must be constrained by the need not to impose unreasonable costs on other telecommunication subscribers and create damaging uncertainty for operators and investors about the future scope of universal service.

Wherever possible the market mechanism should be allowed to play the primary role. The principle of *competitive neutrality* insists on the need to apply the principle of technological and regulatory neutrality – at least as a strategic longer-run objective. Xavier notes that, while universal service refers to the provision of service to individual households, "public access" points are designed to provide access kiosks to those without individual access, rather like public access to a public payphone instead of an individual subscribership. While in a sense arguments for public access points may seem to share the rationale of a USO-mandated provision of public payphones, the requirements are based on much broader objectives and encompass the provision of terminal equipment (computers/modems, etc.).

From an economic point of view, a number of key questions arise in relation to universal service. Are the costs outweighed by declining "externalities"? Can other forms of compensation be identified compared to the traditional general pricing and subsidy mechanisms of the past? Do increasing economies of scope encourage operators to develop new services for groups which were previously

economically marginal or unrecognised? If so, can public subsidies be reduced, or should they be re-directed?

Xavier argues that, although it may seem an expedient approach, imposing the cost of providing special support to schools, public libraries, etc., by way of subsidised provision of infrastructure and services upon telecommunication operators is contentious and open to challenge. To require that telecommunication operators bear the cost of what, in the case of schools, is essentially an educational policy programme must be recognised as a significant change in USO principles and practice. Where considered appropriate, the provision of subsidised services to schools should be paid for from the educational budget (or from general revenue).

Included as an Appendix to these articles are the policy recommendations for the Global Information Infrastructure-Global Information Society, endorsed by the Meeting of the OECD Council at Ministerial Level, 20-27 May 1997. As this series of articles indicates, however, there is still a large agenda of reform for government policy makers to consider concerning the basic outlines of the Global Information Infrastructure. As the GII grows in commercial and social influence, and a Global Information Society develops, the need for further and more far-reaching policy reforms will emerge. Imagination and ongoing debate – at both a national and international level – will be required. The OECD will continue in its efforts to advance such debate towards ends which are both economically efficient and socially equitable.

Jeremy Beale

ICT DIFFUSION AND ITS ECONOMIC IMPACT IN OECD COUNTRIES

TABLE OF CONTENTS

This article was written by Kazuyuki Motohashi, economist in the Economic Analysis and Statistics Division of the Directorate for Science, Technology and Industry, OECD.

I. INTRODUCTION

Information and communication technology (ICT) is a driving force of economic and employment growth in OECD countries. The world market for IT products, which include computer hardware, components, software and services, was estimated at US$514 billion for 1995 – 22 OECD countries contributed to about 92 per cent of that amount. Although the growth rate dropped to around 5 per cent between 1990 and 1993, it is still high compared to other sectors and shows signs of picking up in 1994.[1] Furthermore, employment in the OCA (Office, computing and accounting machinery) sector grew by almost 15 per cent during the 1980s in the OECD as a whole, in contrast to the total manufacturing sector, which lost almost 5 million jobs over the same period.

The ICT sector is important from the viewpoint of its contribution to overall economic and employment growth, but more importantly, it is a key technology in the economy as a whole, driving industry-wide performance and structural change. A rapid rate of growth for ICT production also means a significant pace of diffusion for its products. ICT diffusion can have sector-wide impacts, such as flexible manufacturing systems and sophisticated inventory control systems in the manufacturing sector and 24-hour banking services in the commercial banking sector. This article presents an overview of the input side of ICT products, and its economic impact in OECD countries.

The first section shows the sectoral diffusion of ICT goods and services based on the *OECD Input-Output Database* (OECD, 1995). Since the I/O tables present information on intermediate flows of products and services by industry, it is possible to extract the sectoral diffusion pattern of a given good – in this case, ICT-related products and services. One of the virtues of I/O tables is consistency with national accounts data, *i.e.* I/O data can be compared to other macroeconomic variables such as GDP. Some studies have analysed the macroeconomic impacts of ICT investment using national I/O data.[2] This article extends these national studies to international comparisons using the comparable I/O database compiled by the OECD.

In the second part of the article, technology diffusion embodied in ICT products is studied. The sector-wide diffusion of ICT products implies that the techno-

logical progress of ICT has a significant impact on downstream industries, and may introduce positive externalities or "innovational complementarity" (Bresnahan and Trajtenberg, 1995). One way of capturing this technology spillover process is to track the flows of embodied R&D expenditures in ICT inputs, based on the assumption that R&D investments in a given input (embodied technology in the product) are spilled over to its user sectors. This can be measured using the input-output framework originally suggested by Terleckyj (1974) and, recently, the subject of extensive work by the OECD covering 10 Member countries (Papaconstantinou *et al.*, 1996). Building on the OECD work, the focus of this paper is on ICT products. The novelty of ICT products is in their role as a nexus of technology spillover into the economy as a whole, since sophisticated electronic technologies and high-tech components such as semiconductors are integrated into a product and, because of the wide utilisation of these products, the embodied technology spreads across industries.

Finally, the article addresses the economic impacts of ICT diffusion, in particular its impacts on productivity and employment. Numerous studies have been carried out on this subject in the United States and the stylised facts demonstrate a significant impact of ICT on employment – *i.e.* a skilled labour enhancing effect – but a rather less significant impact of ICT on productivity.[3] The slowdown of economic growth in OECD countries in the late 1970s, with an explosion of ICT investments in the early 1980s, made famous Robert Solow's quip that "you can see the computer age everywhere but in the productivity statistics". Brynjolfsson (1993) puts forward four factors to explain this paradox: measurement errors, lags, distribution and mismanagement, but there is no consensus on whether the productivity paradox stems from measurement problems or from real economic effects. This article provides new evidence on these issues by analysing the effects of ICT on productivity and employment across OECD countries.

II. DEFINING ICT INTENSITY: TRENDS AND CROSS-COUNTRY COMPARISONS

The degree of ICT diffusion is often defined as the market size of computer hardware and software, telecommunication equipment and services, and other related services such as multimedia and system integration services. The OECD's *Information Technology Outlook 1997* brings together industry-source data such as those presented in Eurobit's *European Information Technology Observatory 95* and those of the International Data Corporation (IDC) to make a comparative analysis of IT use in OECD countries. The industry data often provide detailed information on the output side, such as the product mix of the information industry, but less on the input side, such as a sectoral breakdown of

ICT diffusion. In this area, input-output tables can be a useful empirical tool, in that they provide detailed information on inter-industry commodity and service flows.

In this section, the sectoral diffusion of ICT products and services is provided, based on the *OECD Input-Output Database,* which consists of comparable I/O tables for 10 OECD countries (the G7 countries plus Australia, Denmark and the Netherlands). The OECD I/O database is compiled using a common 33-sector industrial classification system, which includes three ICT-related sectors: Sector 16. *Computer and office equipment* (ISIC Rev.2. 3825); Sector 18. *Communication equipment and semiconductors* (ISIC Rev.2. 3832); and Sector 30. *Communication services* (ISIC Rev.2. 72). Most ICT products and services are included in these three sectors with the exception of package software and business services related to ICT, which are included in Sector 32. *Real estate and business services* (ISIC Rev.2. 83).[4]

Based on this classification, ICT diffusion data can be disaggregated into *i)* information technology (IT) diffusion (use of computer and office equipment); and *ii)* communication technology (CT) diffusion (use of communication equipment and services). In addition to this sectoral dimension, two concepts of ICT intensity can be defined. One is ICT expenditure intensity, *i.e.* the ratio of expenditure on ICT products and services to total production. The other is ICT capital intensity, *i.e.* the ratio of capital investment in ICT products to total investment. The economic interpretation of these two intensities is slightly different; the first reflects the degree of overall informatisation, while the second focuses on capital structure and the use of ICT investment products. In this article, the following four kinds of ICT intensity are defined:

	IT diffusion	CT diffusion
Expenditure intensity	(intermediate flow + capital flow of sector 16)/total production	(intermediate flow of sector 30 + capital flow of sector 18)/total production[5]
Capital intensity	capital flow of sector 16/total investment	capital flow of sector 18/total investment

In addition, in both cases, ICT intensity can be defined as the sum of IT intensity and CT intensity.[6]

All the intensity figures in this article are derived using the current price I/O tables, rather than the constant price tables, because of the international incompatibility of price deflators for ICT sectors. As is suggested in numerous empirical studies, output measurements for computers as well as for other durable products

are likely to be biased due to rapid changes in quality.[7] Wyckoff (1995) compares the methodological techniques used in the construction of price indices for computers in OECD countries and finds significant differences in output depending on the methodology used, *i.e.* the hedonic approach or the matched model approach. An equitable cross-country comparison of ICT intensities at constant prices is impossible if the method of deflation differs across countries.

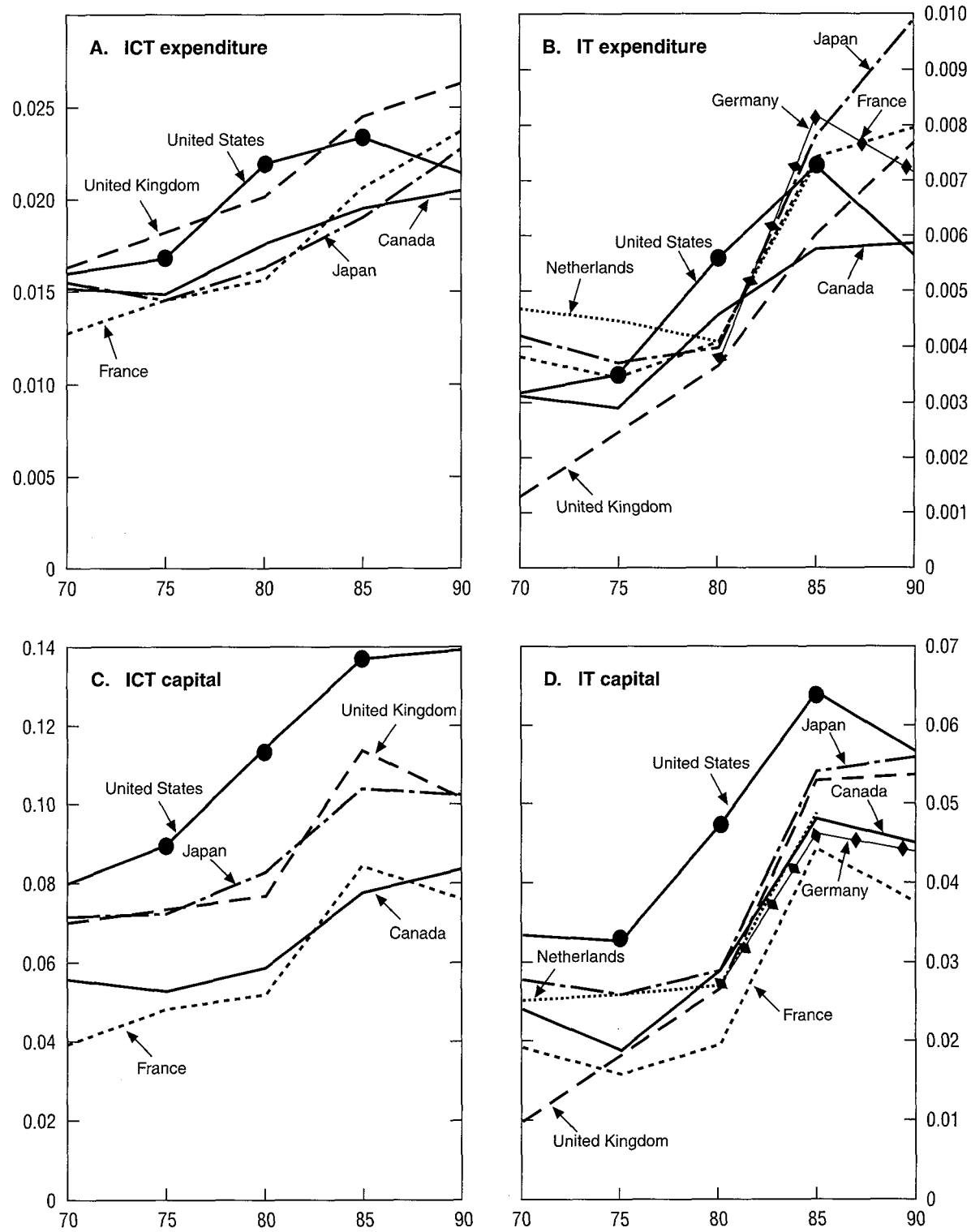
The first empirical evidence on ICT intensity for the 1970-90 period is shown in Figure 1*a*-1*d*. Expenditure intensities reflect the surge in informatisation in the late 1970s-early 1980s; this trend is more clear in IT expenditure. The sharp increase in ICT expenditure intensity can be explained by the sluggish growth rate of the overall economy during this period, in contrast to the consistent expansion of ICT diffusion. However, this trend changed after the mid-1980s. In all countries, the rate of increase of ICT intensities slowed down, and even fell in some countries such as the United States.

A similar trend over time can be found for capital intensities. However, a notable observation from Figure 1*c*-1*d* is the difference in levels of intensity by country. In 1990, about 14 per cent of US investment was in ICT capital products while this figure was only 7-8 per cent for France and Canada. Japan and the United Kingdom are situated in-between, but at levels only half that of the United States. In Japan and the United Kingdom, capital intensity rates approached that of the United States in 1990, due to a substantial drop in US capital intensity.

Figure 2*a*-2*c* shows the breakdown of ICT capital intensity for all industries into those for manufacturing and services in 1990, as well as providing a similar breakdown for IT and CT intensities. Compared to the manufacturing sector, ICT capital intensity is relatively high in the service sector, where firms do not own production equipment. Therefore, total ICT intensity is dependent on industrial structure in the sense that total ICT capital intensity tends to be higher for service-oriented economies like the United States and the United Kingdom. In this sense, the high ICT intensity of the United Kingdom can be explained by its industrial structure, while that of the United States stems from a high ICT intensity in both sectors. Other high ICT intensity countries are Canada and Japan. In addition, Germany has relatively higher IT capital intensity compared to other countries, although its ICT capital intensity is not available due to data constraints. Japan has a relatively high intensity in manufacturing for both IT and CT capital, while Canada shows high ICT capital intensity in the service sector. Germany shows a similar pattern to Japan, *i.e.* a high ICT intensity in the manufacturing sector. This observation is consistent with use of AMT (advanced manufacturing technology), *i.e.* manufacturing-oriented use of AMT in Germany and Japan *vs.* computer-oriented AMT use in the United States (OECD, 1994).

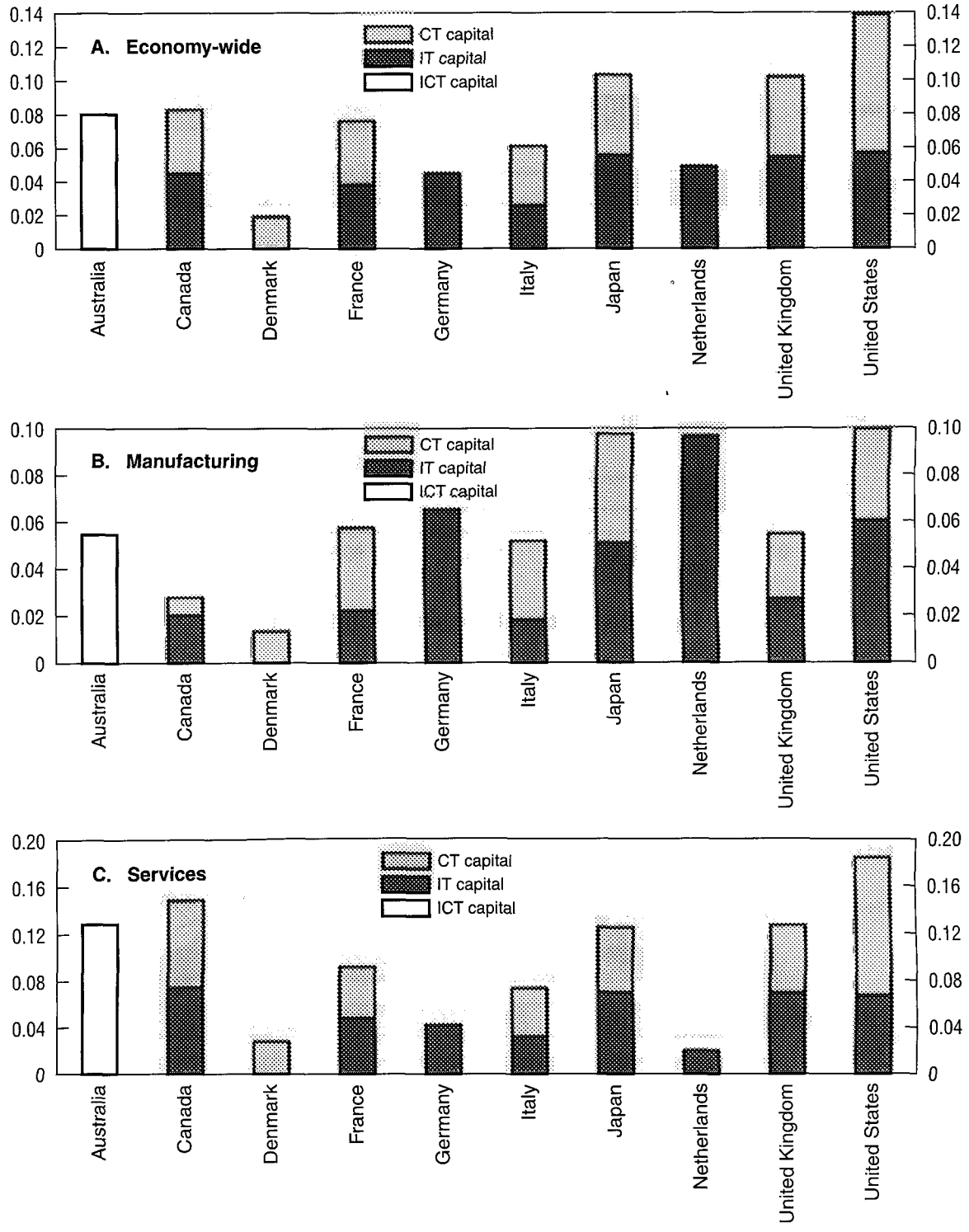
The sectoral distribution of ICT products is shown in Figure 3*a*, which supports the results of the OECD survey on IT use (OECD, 1993*b*) that ICT capital

Figure 1. **Expenditure and capital intensities**



Source: OECD Input-Output database.

Figure 2. **ICT intensities**



Note: ICT capital intensity in Australia. CT is not available in Germany and Netherlands, IT is not available in Denmark.
Source: OECD Input-Output database.

Figure 3*a*. **Sectoral ICT capital distribution**

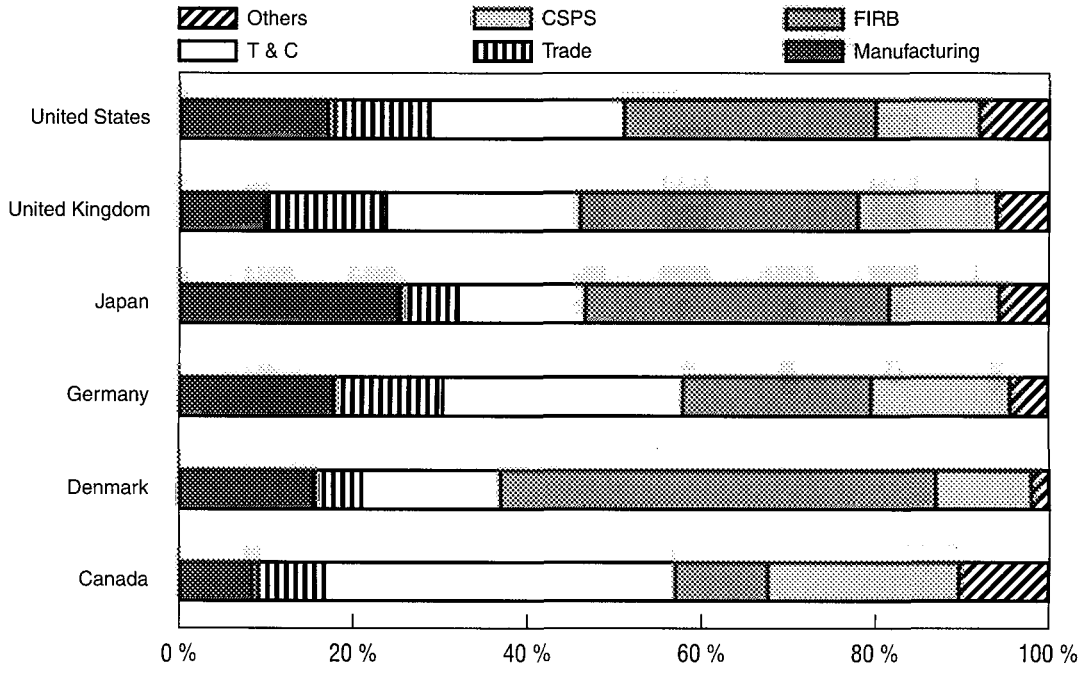
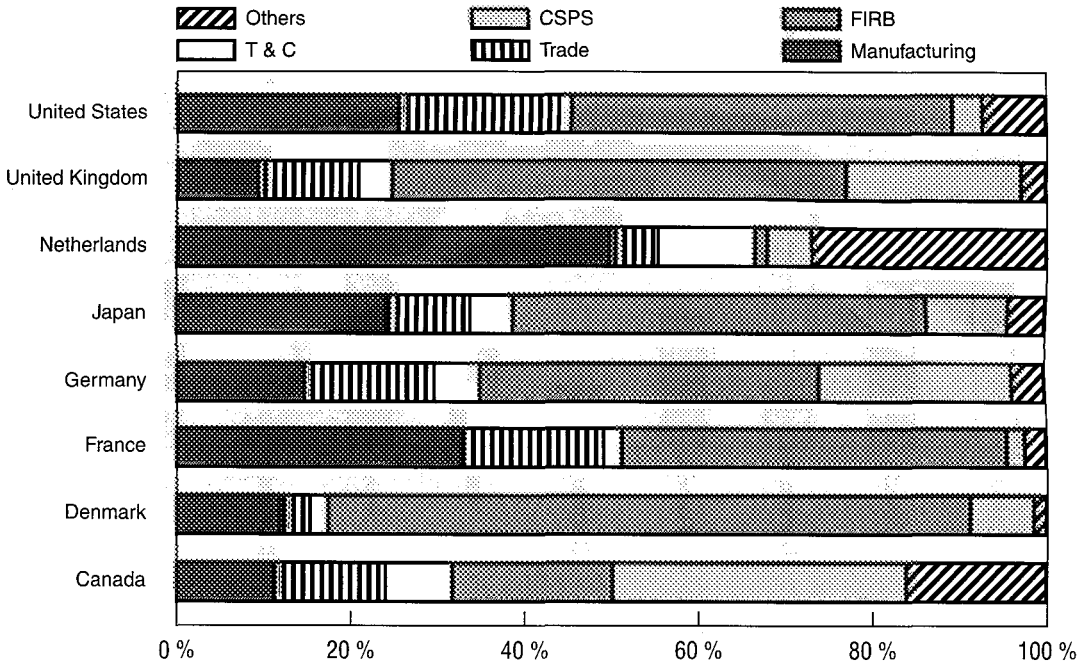


Figure 3*b*. **Sectoral IT capital distribution**



Source: OECD Input-Output database.

products are extensively used by services, especially the insurance, real estate and business service (FIRB) sector. The sectoral distribution reflects each country's industrial structure as well as the ratio of ICT capital to total capital investment of each sector. Due to structural change in the OECD countries, which are tending to become more service-oriented, the share of manufacturing is as low as 20-30 per cent, and for some countries such as the United Kingdom and Canada, as low as 10 per cent. Among service sectors, the FIRB sector has the largest share of ICT capital product investment in many countries, accounting for over 40 per cent in France and around 30 per cent in Japan, the United Kingdom and the United States. In addition, the transport and communication services (T&C) sector also has a large share, since the communication service sector is a major consumer of communication equipment.

Figure 3*b* gives the sectoral distribution for IT capital products only. Since the sectoral distribution of CT capital products is skewed towards certain specific sectors such as telecommunication service, IT capital distribution may permit a closer analysis of the diffusion of general purpose technology. In this graph, the pattern of FIRB's heavy use of IT capital is intensified. In many countries, the share of this sector is around 40 per cent. In addition, Canada, Italy and the United Kingdom share the same characteristics – the community service and personal service (CSPS) sectors play a dominant role.

In this section, the diffusion of ICT products and services is examined from both an inter-temporal and an inter-country perspective using the OECD I/O database. The comparable input-output database gives a consistent view of how the industrial structure of OECD countries has changed away from manufacturing towards an information- and communication-oriented economy. The nominal value of ICT investments shows a steady increase until 1990 in all countries, and a sharp drop in US quality-adjusted computer price indices implies further rapid increases at constant prices. In contrast, the growth of ICT capital intensities slowed down after the mid-1980s, and even dropped in some countries. Unfortunately, the OECD I/O database can only follow these trends until 1990, although there is some evidence that US IT capital intensity picked up after the US economy hit bottom in 1991 (MITI, 1996).

III. ICT INVESTMENT GOODS AS A NEXUS OF TECHNOLOGY SPILLOVER

Computers, a typical example of an ICT investment good, are a symbol of a technology-driven product and have undergone significant innovations and evolution since they were invented in the 1950s. In terms of R&D intensities (R&D expenditure over total production in a given sector), the computer industry ranks

very highly in OECD countries. At the same time, as shown in the previous section, this technology-intensive product also acts as a vehicle for economy-wide technology spillovers through its distribution throughout various industries. The introduction of computers improves the efficiency of production sites through intelligent and flexible manufacturing systems. A LAN (local area network) in the workplace changes the work methods of white-collar workers through the introduction of e-mail and file-sharing systems, while ICT contributes significantly to upgrading the quality of various services such as on-line ticket reservation systems for the airline industry and 24-hour banking systems for the financial sector.

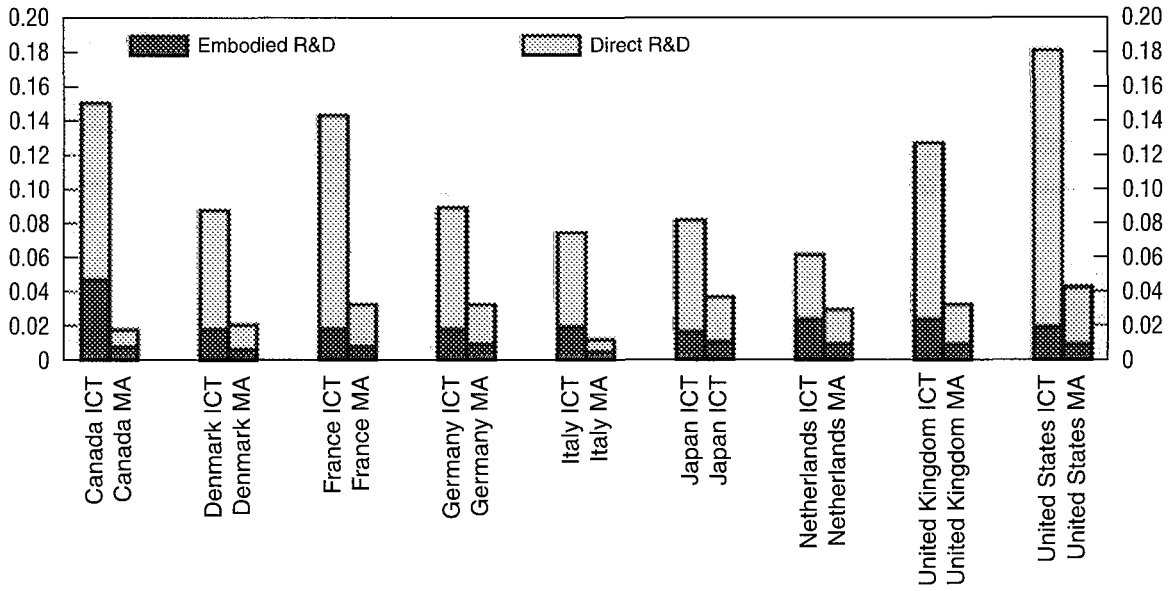
The OECD technology diffusion project for 10 countries based on the I/O database and R&D expenditure statistics defined the information and electronics industry as an IT cluster, and stressed the importance of this cluster in terms of distribution of embodied technologies (Papaconstantinou *et al.*, 1996). This study estimated technology flows based on intermediate flow and capital flow matrices from the I/O database using the assumption that direct R&D expenditure is uniformly embodied in its product or service, and is also distributed to other sectors as an input of embodied technology. This is a very strong assumption, but it has the advantage of allowing a quantitative approximation of intangible technology flows in an internationally comparable way.

In this section, we will elucidate how ICT capital goods work as a nexus of technology spillovers, following the same methodology as Papaconstantinou *et al.* (1996). In contrast to the previous OECD project which treated the IT cluster in its broadest sense, including electronic components and instruments, this study focuses on narrowly defined ICT capital goods, *i.e.* capital flows for Sector 16. *Office computer equipment* and Sector 18. *Communication equipment.* In addition, greater attention is paid to services, because service sectors generally have lower direct R&D intensities and are assumed to have larger impacts from technology embodied in ICT investment.

This section begins by reviewing the technological content of ICT sectors. Figure 4 compares the direct R&D intensity and acquired R&D intensity of ICT sectors to those of total manufacturing in nine OECD countries. In all countries, the R&D intensity of the ICT sector is significantly higher than that of total manufacturing, mainly due to differences in direct R&D intensities. However, further analysis reveals differences in acquired technology intensities as well – particularly in Canada and Italy. In fact, most of the acquired technology by ICT sector comes from the ICT sector itself, since its components are classified in the same sector. In a case study of the United States, some 55 per cent of acquired technology comes from Sector 18. *Communication equipment and semiconductors,* and 20 per cent from Sector 16. *Office computer equipment.*

As shown in the previous section, sector-wide diffusion of technology-intensive ICT capital products implies that they embody significant technology

Figure 4. **Technology intensity for ICT sectors (ICT) and manufacturing (MA)**



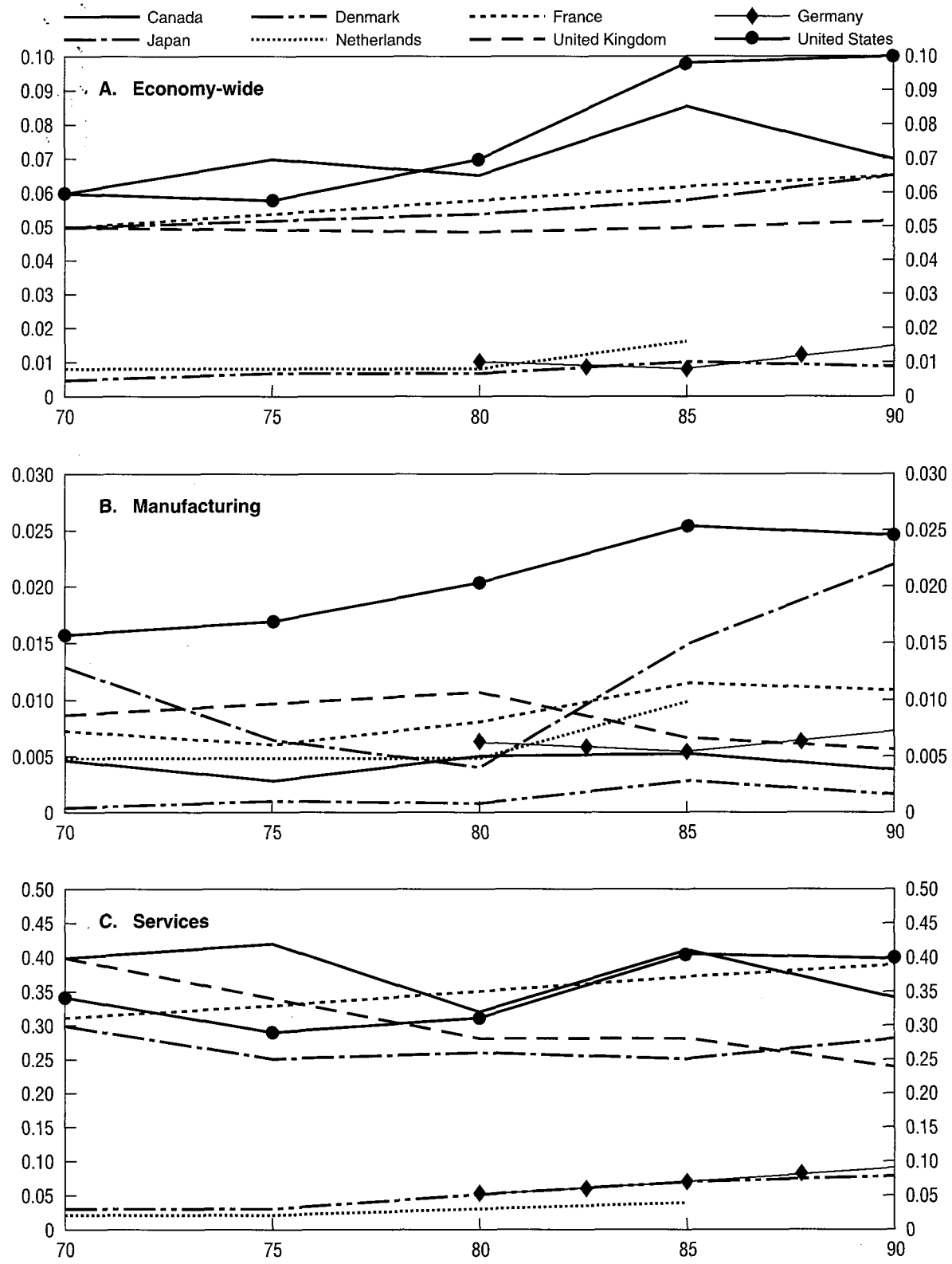
Source: OECD Secretariat estimates.

diffusion. Figure 5*a* -5*c* shows the ratio of the value of acquired technology embodied in ICT capital products to that of the total (direct R&D plus total acquired technology) for the economy as a whole, and for the manufacturing and service sectors of eight OECD countries. The general upward trend of the share of acquired technology by ICT capital goods reflects increases in the importance of ICT capital goods for overall technology spillover. In contrast to the slowdown of ICT capital intensity described in the previous section, the importance of ICT capital goods in terms of technology spillover increases even after the mid-1980s, reflecting the increasing sophistication of ICT capital products in terms of their technology content.

More detailed figures for manufacturing and services present a mixed picture, where the shares of some countries fall. In particular, the United Kingdom experiences declines in both manufacturing and services. Therefore, the overall upward trend of the economy-wide intensity can be partly explained by structural changes away from manufacturing towards the service sector, which relies heavily on acquired technology.[8]

In a cross-country comparison, the United States ranks highest for both R&D intensity of acquired technology through ICT capital goods and for the share of technology acquired through ICT capital goods in total technology. Almost 10 per

Figure 5. **Share of technology embodied in ICT capital**



Source: OECD Secretariat estimates.

cent of total technology in the United States is accounted for by that acquired through ICT capital goods, thus highlighting the importance of ICT capital for technology diffusion in this country. Canada, Japan and France follow, with Canada and France showing relatively significant amounts of ICT capital in the service sector, and Japan displaying the same result for the manufacturing sector.

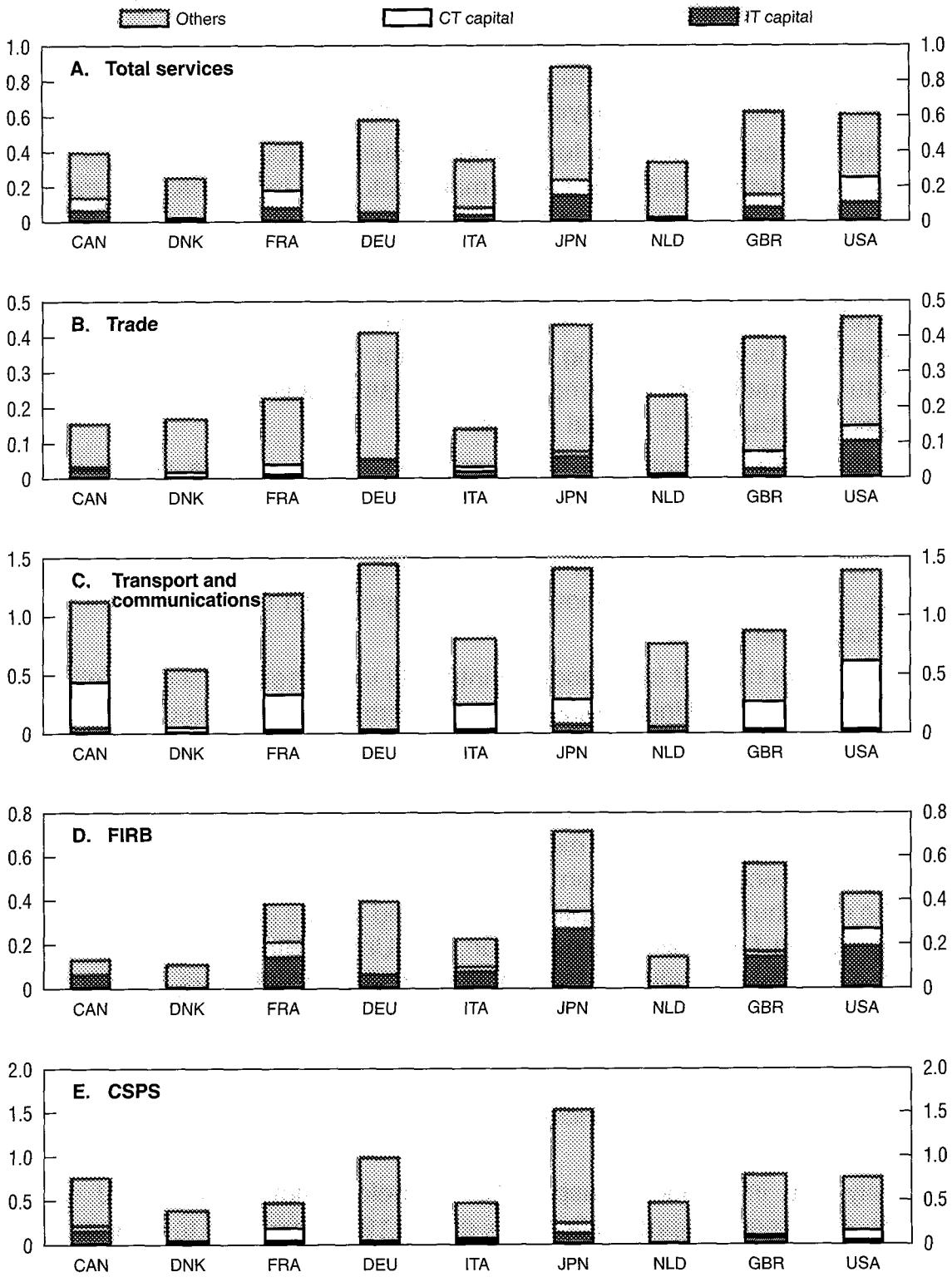
Comparing across sectors, technology acquired through ICT capital goods is important for services, but less so for manufacturing. In the case of the United States, 40 per cent of total technology in the service sector is technology embodied in ICT capital goods, while the figure is only 2 per cent for manufacturing. The reason for this is that the manufacturing sector, and especially its high-tech sectors, relies on direct R&D activities. In addition, the presence of ICT may be underestimated in manufacturing, as significant ICT elements are embodied in manufacturing machinery as components; this amount is not counted as technology acquired through ICT capital goods.

Figure 6*a*-6*e* presents the disaggregation of the service sector into ISIC Rev.2 1-digit level trade (ISIC:6), transport and communication services (T&C, ISIC:7), finance, insurance, real estate and business services (FIRB, ISIC:8), and community, social and personal services (CSPS, ISIC:9 excluding government services). In addition, it also shows the disaggregation of ICT capital into its IT and CT components.

Japan ranks highest in technology intensity in the service sector, followed by the United States, the United Kingdom and Germany. Furthermore, the non-ICT component contributes significantly to total service intensity in Japan and Germany, while a more ICT-dependent pattern can be seen in the US service sector. The ranking of countries by their technology intensities changes when individual service sectors are examined. In the trade sector, the order is as follows: the United States, Japan, Germany and the United Kingdom and, here again, the contribution of ICT capital in the United States is relatively high. In T&C, Germany comes first, followed by Japan, the United States and France. In this sector, technology embodied in communication equipment plays a dominant role, especially in the United States. In FIRB, the country ranking is Japan, the United Kingdom and the United States, and research intensity of technology acquired through ICT capital is higher in Japan than in the United States. Finally, in the case of CSPS, Japan leads, followed by Germany, the United Kingdom and the United States.

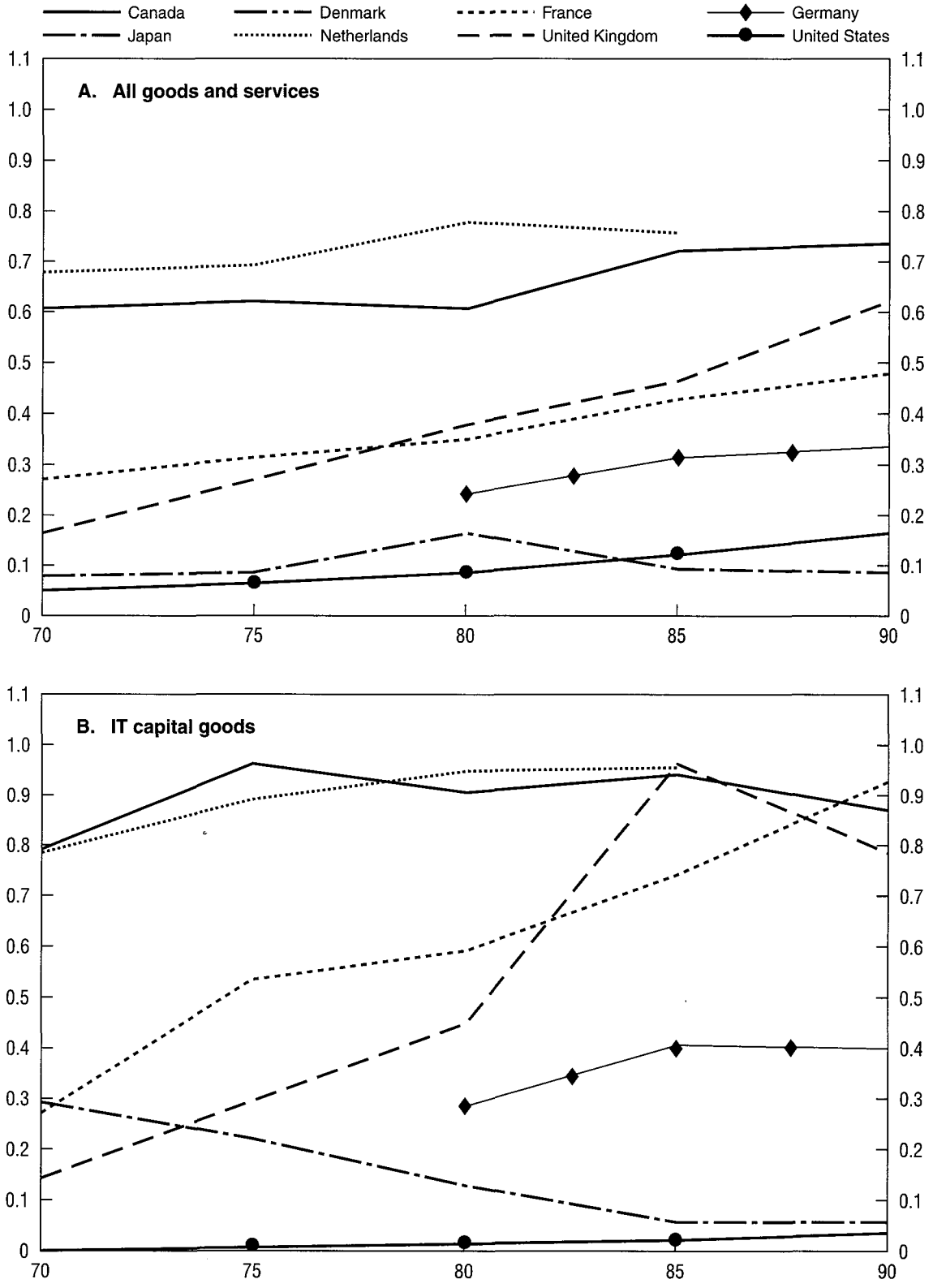
Finally, the international aspect of technology flows associated with ICT capital is discussed. Papaconstantinou *et al.* (1996) address the importance of international technology spillovers especially in small countries, and Coe and Helpman (1993) find a long-term association between international technology spillover and productivity in OECD countries. In this perspective, ICT capital goods, and especially computers, are particularly important, since production of

Figure 6. **Technology intensities**



Note: CT is not available in Germany or the Netherlands, IT is not available in Denmark.
Source: OECD Secretariat estimates.

Figure 7. **Share of import technology spillover**



Source: OECD Secretariat estimates.

these goods is geographically skewed towards the United States and Japan, which means that computers are heavily traded from these producer countries to non-producers. According to the OECD's *Information Technology Outlook 1995*, the world's top-10 information technology companies in 1993 consisted of seven US firms and three Japanese ones. Therefore, industries in non-producer countries are assumed to take significant advantage of internationally acquired technology spillovers originating in producer countries. Furthermore, the importance of the computer industry comes also from the role of multinational enterprises (MNEs). MNEs enhance international capital flows, as well as international co-operation with other firms, both of which are important in stimulating international technology spillovers.

Figure 7*a*-7*b* expresses changes in the share of internationally acquired technology in total acquired technology and in acquired technology through IT capital goods, respectively. In contrast to the general upward trend in international sourcing of overall acquired technology, that of IT capital goods shows a completely different picture depending on the country. The computer producer group (the United States, Japan and Germany) keeps stable import shares, which are significantly lower than those of the other countries. The non-computer producer group (Canada and the Netherlands) also shows a stable import share, which is close to 100 per cent. The others (France and the United Kingdom), which have shifted from producer to non-producer status over the past 20 years, have sharply raised their import shares.

The economic implications of international sourcing depend on the market conditions of the computer industry as well as on various other factors. If a market is competitive, an importing country can enjoy the technological innovations of producer countries; otherwise the price of product sophistication will be passed on to the consumer. However, global competition by large computer manufacturers tends to suggest the former case, and importing countries are thus assumed to take advantage of sophisticated technology embodied in ICT capital goods.

IV. ICT, PRODUCTIVITY AND EMPLOYMENT

Delong and Summers (1992) stress the importance of investment in equipment for a nation's economic growth, since this type of investment generates positive externalities associated with skill upgrading of managers and workers through the use of new equipment. In this sense, it is interesting to analyse in further detail the capital mix, focusing on ICT capital, since ICT capital works differently from production machinery, and calls for different skills to make it work efficiently. In addition, the importance of ICT capital is assumed to be greater for the service sector, which does not own manufacturing machinery. In other words,

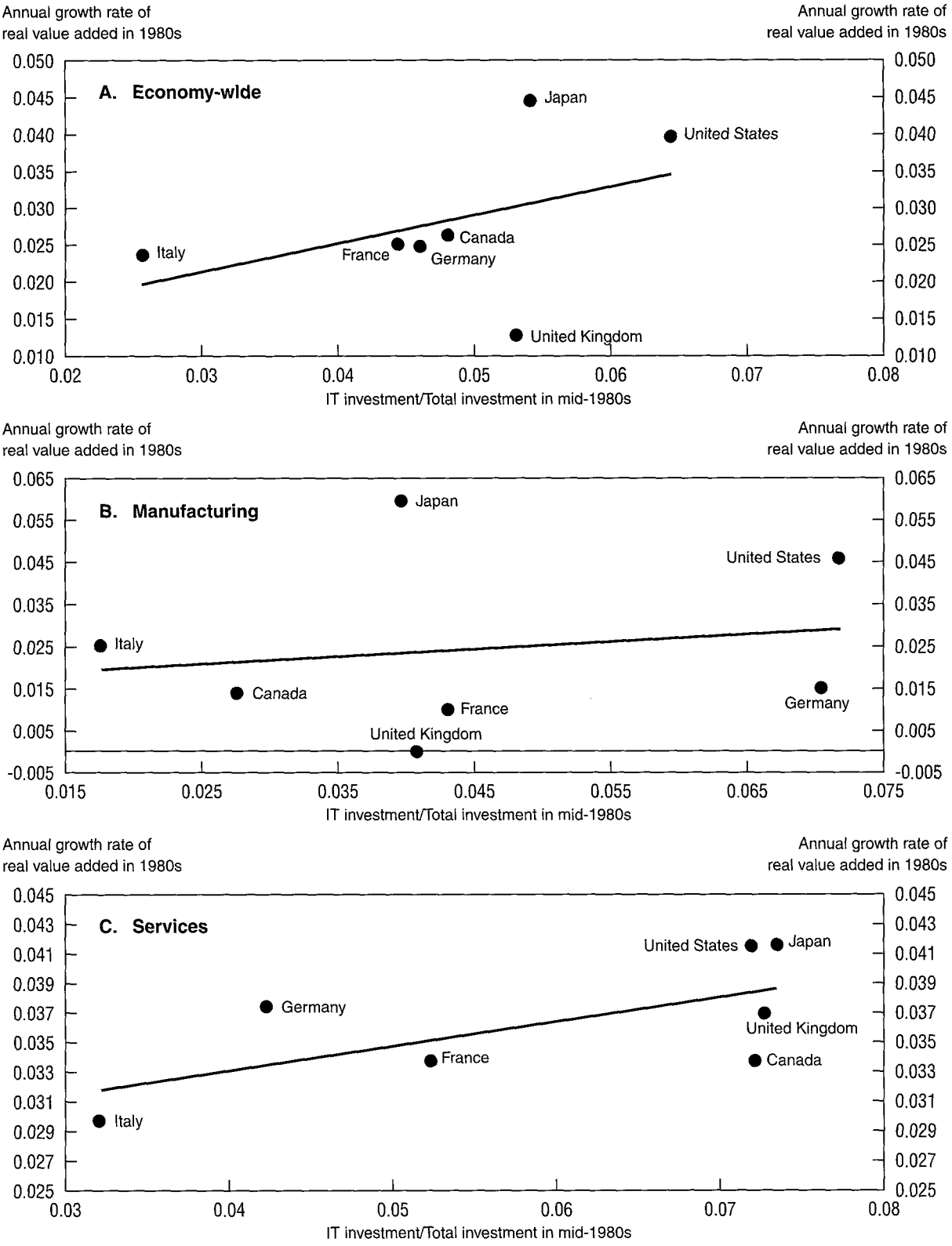
ICT capital stock is a primary source of embodied technology spillover for services. Figure 8 shows the relationship between the real value-added growth rate and IT capital intensity in the 1980s. The graph suggests that these two factors show a clearer positive correlation in the service sector.

However, sluggish labour productivity growth in services compared to manufacturing is a common characteristic of OECD countries. Various issues pertaining to this phenomenon, such as measurement problems and an institutional capacity to absorb innovative products, have been discussed by a number of researchers. Concerning differences in productivity performance in manufacturing and services, Roach (1991) stated that an inability to cut IT support staff in the service sector can be attributed to lack of international competition. In addition, measurement problems are also important, since quality improvement in services are difficult to measure. Griliches (1992) and Baily and Gordon (1988) provide case studies of measurement problems in services, including financial services, retail trade, construction and transportation. For example, in a case study of banking sector productivity, a BLS estimate will underestimate this sector's productivity because it does not take into account the quality changes brought about by branch banking (improving consumer convenience), and because it weights individual activities by labour input so that productivity-enhancing activities which require less labour input are under-represented.

In addition to relatively sluggish productivity growth in the service sector, the small contribution of computer capital to overall economic growth is another issue of "Solow's paradox". In a growth accounting framework, Oliner and Sichel (1994) estimate that between 1970 and 1992 computer capital contributed to economic growth in the United States by an annual rate of only 0.16 per cent. Although they adjusted this estimation by taking into account computer software stocks and computer-related labour inputs, it still represents a very small contribution to overall economic growth. According to their estimation, the share of computer and peripheral equipment (CPE), which is a narrower classification than office computer equipment in the STAN database, in total investment was 7.6 per cent in nominal values in 1993, whereas its share in terms of capital stock was only 2.0 per cent. This rapid growth rate does not show up directly in its share in capital stock data due to its shorter service life. As mentioned in Section II, IT capital intensity, as well as ICT capital intensity, was significantly greater in the United States than in other countries throughout the period 1970-90. In this sense, Oliner and Sichel's explanation of Solow's paradox, *i.e.* "Computers *cannot* be seen everywhere" is presumably the case for non-US countries as well.

Issues concerning rates of return on computer capital, such as whether IT capital has excess returns compared to other capital, have been also investigated, again mainly in the United States. The pioneering works by Morrison and Berndt (1991), based on aggregated data by BEA, report a modest rate of return

Figure 8. **IT intensities and economic growth**



Source: OECD Input-Output database, ANA database.

of IT capital – implying over-investment in this type of capital – while recent studies based on firm-level data, such as those by Lichtenberg (1993) and Brynjolfsson and Hitt (1995), show excess returns on IT stocks compared to non-IT stocks. In addition to differences in data, estimated period and quantitative model, these contradictory results point to the difficulties of assessing the productivity of IT capital associated with measurement problems. Measurement problems arise not only from technical issues such as quality adjustment of computer output, but also from the traditional concept of productivity. That is, a firm invests in IT capital not to maximise one-time productivity, but rather to gain a sustainable competitive advantage through responsive reactions and product-line extension to customer needs. This highlights the need to develop an innovative method for measuring the intangible and long-term value of IT investments (Brynjolfsson, 1993).

The scope of this section is to look at the IT capital, productivity and employment issues from a cross-country perspective, rather than the time series analysis used by Morrison and Berndt (1991) and Brynjoflsson and Hitt (1995) in their studies of the United States. Due to data constraints, the following analysis on productivity is carried out for only six countries, which does not allow regression analysis. However, a cross-country study of IT capital and productivity may enable a closer look at these interactions than time series analysis, as a cross-country perspective will be less susceptible to the mismeasurement problems associated with ICT product price and quality changes. In addition, analysing a long timespan (10 years in the 1980s), allows estimation bias due to time-lags between ICT investments and productivity effects to be reconciled.

To test whether IT capital stock has an excess return over non-IT capital stock, the following simple model based on a Cobb-Douglas production function is assumed:

$$\ln Y_t^i / L_t^i = \alpha + \beta_1 \ln K_t^i / L_t^i + \beta_2 \ln(IT_t^i / K_{ti}^i) + \delta_i + \varepsilon \qquad (1)$$

where, Y_t^i, L_t^i, K_t^i and IT_t^i are gross output, total labour input, total capital input and IT capital input of country *i* and at time *t*, respectively. In addition, δ is a time-invariant variable of country *i*, which captures non-IT-capital-related country-specific factors to explain its productivity level, and ε is an error term. In this model, if estimated, β_2 is positive and statistically significant, showing that there is excess return on IT capital stock.[9] However, as mentioned above, six country observations with five time points cannot give a precise estimation of this model. Therefore, the first difference of equation (1) gives:

$$\Delta \ln Y_t^i / L_t^i - \Delta\beta_1 \ln K_t^i / L_t^i = \Delta\beta_2 \ln(IT_t^i / K_{ti}^i) + \varepsilon \qquad (2)$$

Under certain conditions, the left-hand side of equation (2) gives a TFP growth rate with β_1 as the ratio of nominal capital share to that of labour. For discrete time variable *t*, (2) can be re-written as:

$$TFP^{i}_{t1} - TFP^{i}_{t0} = \Delta\beta_2(IT^{i}_{t1} / K^{i}_{t1} - IT^{i}_{t0} / K^{i}_{t0}) + \varepsilon \quad (3)$$

Finally, changes in IT capital intensity, which are used in the Section II of this article, are substituted for IT capital stock intensity in the right-hand side of equation (3).[10]

Table 1 gives the annual growth rate of TFP[11] [the left-hand side of equation (3)] and IT capital intensity [the right-hand side of equation (3)] during the 1980s in six countries. The 1980-90 period was selected because this was the period during which most significant IT capital investment was observed, and a 10-year time span is used to mitigate the problem of time lags between IT investments and productivity impacts.

Table 1. **Annual growth rate of Total Factor Productivity (TFP) and IT capital, 1980s**

	Economy-wide						
	Production	Employ-ment	**Productiv-ity**	**IT intensity**	Capital	IT share	**IT capital**
Canada	0.029	0.016	**0.012**	**0.048**	0.039	0.053	**0.092**
France	0.026	–0.003	**0.029**	**0.045**	0.025	0.068	**0.093**
Germany	0.026	0.005	**0.021**	**0.046**	0.028	0.043	**0.072**
Japan	0.042	0.012	**0.030**	**0.054**	0.055	0.071	**0.127**
United Kingdom	0.034	0.007	**0.026**	**0.053**	0.025	0.067	**0.092**
United States	0.034	0.025	**0.010**	**0.064**	0.028	0.022	**0.050**
	Manufacturing						
	Production	Employ-ment	**Productiv-ity**	**IT intensity**	Capital	IT share	**IT capital**
Canada	0.022	0.005	**0.017**	**0.029**	0.035	–0.009	**0.026**
France	0.013	–0.018	**0.031**	**0.046**	0.021	0.019	**0.040**
Germany	0.021	0.000	**0.021**	**0.075**	0.014	0.014	**0.027**
Japan	0.044	0.009	**0.034**	**0.042**	0.059	0.158	**0.218**
United Kingdom	0.012	–0.027	**0.039**	**0.043**	0.015	–0.027	**–0.012**
United States	0.033	0.004	**0.029**	**0.077**	0.021	0.007	**0.028**
	Services						
	Production	Employ-ment	**Productiv-ity**	**IT intensity**	Capital	IT share	**IT capital**
Canada	0.040	0.024	**0.016**	**0.072**	0.044	0.039	**0.083**
France	0.043	0.015	**0.028**	**0.052**	0.027	0.073	**0.099**
Germany	0.039	0.018	**0.022**	**0.042**	0.034	0.066	**0.100**
Japan	0.046	0.024	**0.022**	**0.072**	0.056	0.043	**0.098**
United Kingdom	0.063	0.030	**0.033**	**0.073**	0.029	0.088	**0.117**
United States	0.044	0.034	**0.010**	**0.074**	0.033	0.022	**0.055**

Although it is not easy to find a relationship between productivity and IT capital intensity in a sample of this size, it would seem that a positive correlation can be found in services, whereas this is not the case for the economy as a whole or in manufacturing. In contrast to manufacturing where other important sources of technology include direct R&D and R&D embodied in production machinery, IT capital is the major source of technological content in services. A clearer relationship between IT and productivity in the service sector complies with this hypothesis.

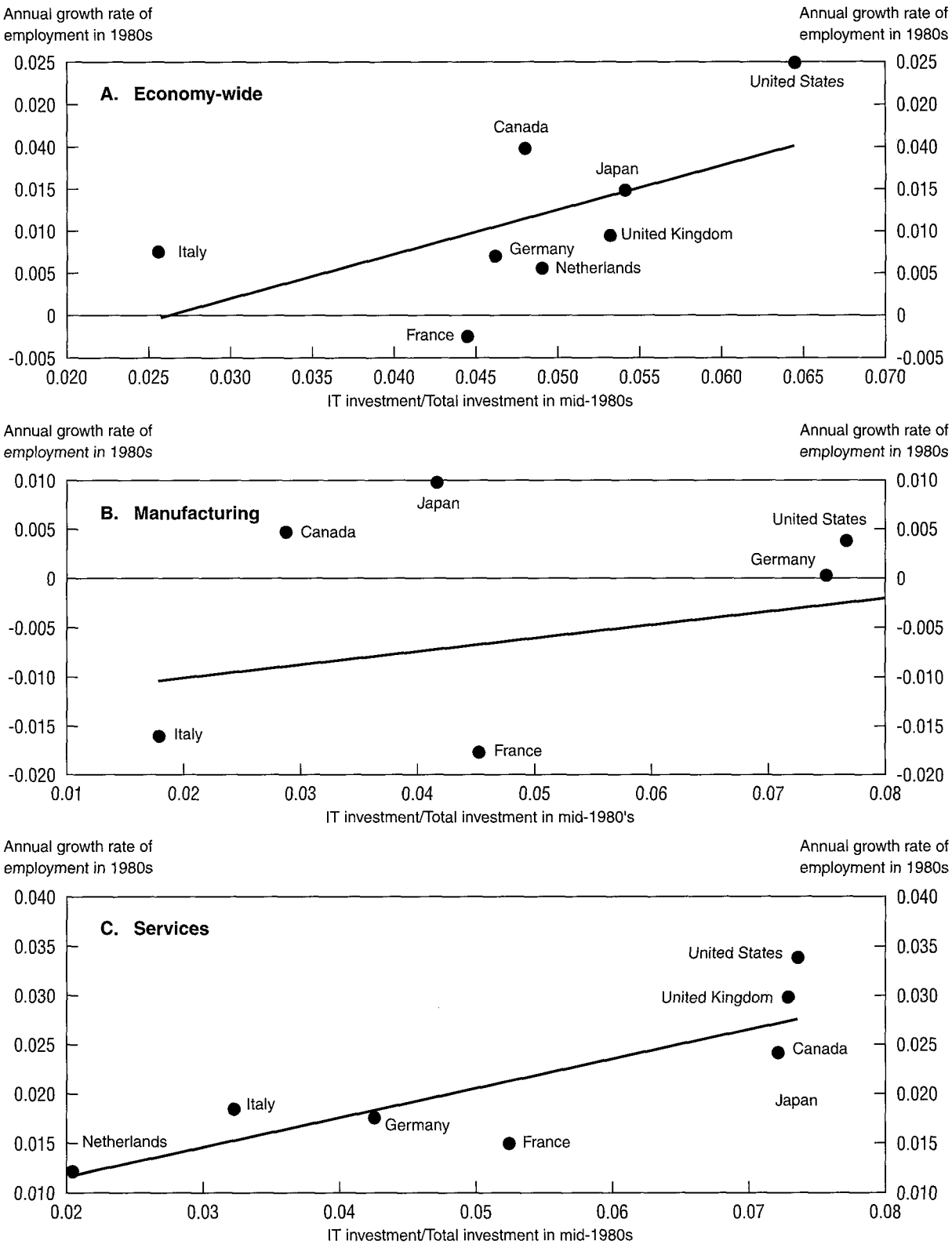
In terms of the relationship between IT and employment, this relationship is not as clear as that between IT and productivity. Technology affects employment in very indirect ways. For example, technology pushes productivity up, leading to a drop in prices. It also affects new demand and new jobs associated with market expansion. For example, Giorno *et al.* (1995) provided quantitative evidence on this process, using the OECD's macroeconomic model. However, the speed of economic adjustment to a technological shock depends on various institutional parameters in product and labour markets.

Taking into account this complexity and time lags, we have taken ICT capital intensity in the mid-1980s as a proxy of the degree of each country's commitment to ICT investment and analysed how it is correlated with job growth in the 1980s in nine OECD countries. The economy-wide picture (Figure 9*a*), shows the United States to be significantly higher than other countries for both variables; other countries show a little variation in IT capital intensity. However, when the overall picture is disaggregated into manufacturing and services, the positive correlation can be found particularly in services.

Another issue of IT and employment is the capital-skill complementarity hypothesis, which states that the demand for highly skilled labour is complementary to high-tech capital accumulation (Griliches, 1969). Following this line, Berndt *et al.* (1992) found that the share of IT capital in relation to total capital stock is negatively correlated with labour productivity, but positively correlated with white-collar intensity in US manufacturing. This finding suggests that investing in high-tech capital is labour-intensive (especially in terms of white-collar labour), rather than labour-saving. A similar study for Japan found that non-production workers are more capital complementary than production workers (Suruga, 1991).

Breaking down total employment into occupation categories opens up the possibility for further analysis of the ICT/employment relationship. IT investment is assumed to enhance demand for labour in two ways, one of which is by creating the jobs required for the proper handling of computers, *i.e.* computer engineers and software programmers. However, the share of this category in total employment is marginal. This occupation is defined at the three-digit level of the International Standard Classification of Occupations (ISCO 88) as ISCO 213: *Computing professionals* and ISCO 312: *Computing associate professionals.* The share of

Figure 9. **IT intensities and employment**



Source: OECD Input-Output database, ANA database.

ISCO 213+312 in relation to total employment in the European countries was around 1 per cent in 1994 according to OECD's *Information Technology Outlook 1995*.

While the share of employment directly related to IT is very small, the introduction of IT may also cause indirect changes in the occupation mix. In a study of Japan, Motohashi (1996) provides firm-level evidence that a firm which makes use of information networks is likely to have a higher share of non-production workers and to outsource its production activities. That is, the relative labour demand for high-skilled, white-collar workers involved in complex and wide-ranging duties using IT capital products, is becoming greater than that for blue-collar workers and low-skilled, white-collar workers, who act as support staff for decision makers. In this respect, Colecchia and Papaconstantinou (1996) present detailed observations of the change in occupation mix in OECD countries. They conclude that during the 1980s significant skill upgrading occurred in manufacturing, but to a lesser extent in services. This is not consistent with the above observation of an increase in ICT investment in the service sector. One possible explanation for this contradiction is the heterogeneity of the service sector in terms of its technological commitment. In addition, differences in labour market institutions across countries need to be taken into account in order to come up with a more precise image of the relationship between technology and skills.

V. CONCLUSION

The starting point of this article was an analysis of the issue of the economic impacts of ICT diffusion, a cross-country comparison of ICT intensity indices, the technology diffusion impacts of ICT and its association with productivity and employment growth in some OECD countries. The major findings of the study follow:

- Even after controlling for differences in industrial structure, ICT intensity shows significant variation across countries. In concrete terms, the United States presents persistently higher figures.
- In terms of the time trend of ICT intensity, a surge occurred during the period from the late 1970s to the early 1980s; the growth rate has slowed down recently. However, it should be noted that this study was carried out with current price data, since the price of IT capital is assumed to drop faster than that of other forms of capital.
- In contrast to the sluggish growth rate in ICT intensity in the 1980s, embodied R&D intensity in ICT capital increases, reflecting the increasing technology content (degree of sophistication) of ICT capital products.

- A cross-country analysis suggests a positive impact of IT capital on productivity in the service sector, although statistical tests have not been carried out.
- Cross-country analysis also shows a positive impact of ICT intensity on employment. However, occupational changes do not support the capital/skill complementarity hypothesis. Thus, the evidence on ICT's impacts on employment needs careful scrutiny.

This article sheds new light on the issue of the economic impacts of information infrastructure from an international perspective, but also gives rise to further questions. Broadly speaking, the following questions should be investigated.

- Why is there significant variation in the degree of ICT use across countries? And, in particular, how can one explain high ICT intensity rates in the United States? Is the rate of return on ICT investment different? Can institutional differences, such as flexibility of economic organisation, explain this difference?
- It is still unclear whether the productivity paradox arises from a problem of measurement or from real economic effects. Would an analysis of OECD countries using both time-series and cross-sectional approaches help to disentangle this problem?
- The employment effects of ICT need to be further examined, in particular by focusing on the relative shift in demand between skilled and unskilled workers. Total employment effects should be determined by supply and demand conditions for these two categories, as well as labour institutions on wage setting, etc.

None of these questions has a single answer and all are interrelated. For example, the high ICT intensity found in the United States might be explained by the difference in the rate of return on ICT investment arising from the second question. Network externality theory suggests that the marginal productivity of ICT capital depends on the degree of networking of computer systems. In this sense, the absolute size of the ICT capital stock may play a role in the rate of return on ICT investment. Although this over-simplifies the argument, it is necessary to start from a simple hypothesis like this in order to carry out an international comparative study of the economic impacts of the global information infrastructure. The second and third questions are related in the sense that organisational changes are a prerequisite for benefiting from the performance impacts of ICT, and differences in degrees of flexibility may explain inter-country variances in ICT use. For example, some studies have shown that organisational flexibility is imperative in order to achieve the productivity impacts of IT[12] and that the follow-up to this analysis will require an international comparison.

Annex 1

CLASSIFICATION SYSTEM AND AVAILABILITY OF DATA

Industry classification and ICT sectors

The data used for the calculation of ICT intensity are taken from the *OECD Input-Output Database*. This database comprises intermediate flow and capital flow matrices for domestic and imported goods, whose sector definitions are comparable by country (OECD, 1996). The tables comprise 33 business sectors; ICT-related sectors are Sector 16. *Office & computing machinery*, Sector 18. *Radio, TV & communication equipment* and Sector 30. *Communication*, as shown in the sector classification below.

However, some of the tables are not fully compatible with this classification, either by country or by year. The following table shows data availability by country.

For the ICT sectors, Australia, Denmark, Germany and the Netherlands present some problems. For Australia, since data for Sector 16 is included in Sector 18, only ICT capital intensity (16+18) is available, so that the breakdown into IT and CT cannot be carried out. For Germany and the Netherlands, data for Sector 18 is included in Sector 17, a non-ICT sector. In this case, only CT intensity for Sector 16 can be calculated, because the portion of Sector 18 in Sector 17 is unknown. Similarly, for Sector 16 in Denmark, only CT intensity can be calculated.

Incompatibility issue of capital flow matrix

Capital flow matrices in Australia and the United States have been made only for equipment and machinery, and do not include non-machinery investment such as buildings. For other countries the tables include buildings and construction. Therefore, the calculation of ICT intensity in Australia and the United States is overestimated compared to other countries, since a denominator of intensity is small by definition. To correct this bias, the ratio of equipment and machinery to total investment is used to calculate ICT capital intensity in these two countries. These data are extracted from the OECD's *Quarterly National Accounts Database*.

Availability of tables by year

Finally, trends in ICT intensity are analysed from time series tables for up to five points from around 1970 to around 1990. The following table shows data availability by year for each country. For example, data for Italy are available only at one point, and thus cannot be used for evaluating trends of ICT intensity.

Classification system of the OECD *Input-Output Database*

No.	ISIC Rev.2 codes	Description
1	1	Agriculture, forestry and fishery
2	2	Mining and quarrying
3	31	Food, beverages and tobacco
4	32	Textiles, apparel and leather
5	33	Wood products and furniture
6	34	Paper, paper products and printing
7	351 + 352 – 3522	Industrial chemicals
8	3522	Drugs and medicines
9	353 + 354	Petroleum and coal products
10	355 + 356	Rubber and plastic products
11	36	Non-metallic mineral products
12	371	Iron and steel
13	372	Non-ferrous metals
14	381	Metal products
15	382 – 3825	Non-electrical machinery
16	3825	Office and computing machinery
17	383 – 3832	Electric apparatus, nec
18	3832	Radio, TV and communication equipment
19	3841	Shipbuilding and repairing
20	3842 + 3844 + 3849	Other transport
21	3843	Motor vehicles
22	3845	Aircraft
23	385	Professional goods
24	39	Other manufacturing
25	4	Electricity, gas and water
26	5	Construction
27	61 + 62	Wholesale and retail trade
28	63	Restaurants and hotels
29	71	Transport and storage
30	72	Communication
31	81 + 82	Finance and insurance
32	83	Real estate and business services
33	9	Community, social and personal services
34		Producers of government services
35		Other producers
36		Statistical discrepancy

Source: OECD (1995), *The OECD Input-Output Database.*

Availability of tables by sector

Intermediate flow matrix and row sector of capital flow matrix

Coverage of sectors making capital purchases	Australia	Canada	Denmark	France	Germany	Italy	Japan	Nether-lands	United Kingdom	United States
1 Agric., forestry and fishing										
2 Mining										
3 Food, beverage and tobacco										
4 Textiles, apparel and leather										
5 Wood products and furniture										
6 Paper and printing										
7 Industrial chemicals					+8					
8 Drugs and medicines					×					
9 Petrol. and coal products										
10 Rubber and plastics										
11 Non-metallic mineral products										
12 Ferrous metals								+13		
13 Non-ferrous metals								×		
14 Metal products										
15 Other non-elec. mach.			+16							
16 Office and computing mach.	×		×							
17 Elec. machinery					+18			+18		
18 Radio, TV and communication	+16				×			×		
19 Shipbuilding					+20					
20 Other transport			+21, 22		×					
21 Motor vehicles			×							
22 Aircraft			×							
23 Professional goods										
24 Other manufacturing										
25 Elec., gas and water										
26 Construction										
27 Wholesale and retail trade										
28 Hotels and restaurants										
29 Transport and storage										
30 Communication										
31 Finance and insurance				+32						
32 Real estate and business. services				×						
33 Community, social, and personal	+28, 34					+34				

Source: OECD (1995), *The OECD Input-Output Database.*

Availability by year

	Around 1970	Mid-1970s	Around 1980	Mid-1980s	Around 1990
Australia	1968*	1974*	×	1986	1989
Canada	1971	1976	1981	1986	1990
Denmark	1972	1977	1980	1985	1990
France	1972	1977	1980	1985	1990
Germany	×	×	1978	1986, 1988*	1990
Italy	×	×	1985	×	×
Japan	1970	1975	1980	1985	1990
Netherlands	1972	1977	1981	1986	×
United Kingdom	1968	×	1979	1984	1990
United States	1972	1977	1982	1985	1990

Note: * Capital flow matrix is not available.
Source: OECD (1995), *The OECD Input-Output Database.*

Annex 2

INTERPRETATION OF IT CAPITAL MEASUREMENT

The perpetual inventory method allows an estimation of capital stock from time series of capital investment data, the depreciation rate of capital stock and capital stock data at the bench year, as follows:

$$Stock_T = \sum_{t=B}^{T} I_t(1-\delta)^{T-t} + Stock_B \qquad (A1)$$

where $Stock_t$ is the amount of capital stock at time T (t=T) and the bench year (t=B), I_t is capital investment at time t and δ is the depreciation rate of this capital good. In many cases, since benchmark stock data are not available, this figure is estimated under the assumption of a constant growth rate (denoted as r) of capital investment as follows:

$$Stock_B = \sum_{t=-\infty}^{B} I_t(1-\delta)^{B-t} = I_B \sum_{t=-\infty}^{B} \left(\frac{1-\delta}{1+r}\right)^{B-t} = \left(\frac{1+r}{\delta+r}\right) \bullet I_B \qquad (A2)$$

Taking equation (A2) as a base, we can investigate the economic meaning of IT capital intensity. First, it should be noted that this measure is based on current price capital investment data, instead of constant price data which can be used for capital stock formation. In the case of constant rate of nominal capital expenditure growth (denoted by R) and price change (denoted by p), the relationship between capital stock and nominal capital expenditure (denoted by I, again) is expressed as:

$$Stock_T = \left(\frac{1+R-p}{\delta+R-p}\right) \bullet I_T \qquad (A3)$$

Therefore, the relationship between IT capital intensity and IT capital stock share in total capital stock can be described as:

$$\frac{Stock_{IT}}{Stock_{all}} = \left(\frac{1+R_{IT}-p_{IT}}{1+R_{all}-p_{all}}\right) \bullet \left(\frac{R_{all}-p_{all}+\delta_{all}}{R_{IT}-p_{IT}+\delta_{IT}}\right) \bullet \frac{I_{IT}}{I_{all}} \qquad (A4)$$

The coefficient comprises two terms, but it is reasonable to assume that the first term is close to 1. And if it is assumed that $R_{IT} = 0.1$, $R_{all} = 0.05$, $p_{IT} = -0.1$ (price fall), $p_{all} = 0$, $\delta_{IT} = 0.1$ and $\delta_{all} = 0.05$, the coefficient becomes 1/3, which means that IT capital intensity is three times greater than the share of IT capital stock to total stocks. That is, higher growth rates, more rapid price fall and greater depreciation rates mean that IT capital intensity is overestimated as an indicator of the ratio of IT capital stock.

However, in equation (3), changes in IT capital intensity could be a good substitute for changes in IT capital stock intensity, as long as the coefficient (1/3 in the example above) does not change significantly. In making cross-country comparisons, insofar as this coefficient does not differ across countries, results for IT capital intensity will hold for those for IT capital stock intensity. International competition in the computer industry supports this assumption.

NOTES

1. OECD (1997), *Information Technology Outlook 1997*, Paris.
2. For example, Roach (1988) uses US I/O tables, and Miles and Matthews (1992) present data for the United Kingdom. An extensive litterature survey can be found in OECD (1993*a*).
3. For example, Berndt *et al.* (1992) show the skilled labour augmenting effects of IT stocks, based on time series data in the United States, while Morrison and Berndt (1991), and Berndt and Morrison (1995) argue that US manufacturing firms are over-investing in computers. On the other hand, Lichtenberg (1993) and Brynjolfsson and Hitt (1995), based on firm-level micro data, show that the marginal return on IT capital is significantly higher than that on other capital inputs.
4. See Annex 1 for the classification system and availability of data by year and country.
5. In an intermediary flow matrix, Sector 18. *Communication equipment and semiconductors* contains a significant number of non-communication goods, mainly semiconductors and consumer electronics goods such as TVs and radios. This poses fewer problems in a capital flow matrix, in which intermediary transactions (semiconductor) and consumer transactions (TV and radio) are excluded.
6. Due to the missing sector, all four intensities cannot be calculated for all tables. For example, in the Danish tables data for Sector 16 are included in Sector 15 and not separately available. In this case, IT intensities cannot be calculated using Danish data. In addition, there are some differences in the definitions of capital flow matrices across countries, and appropriate adjustments were made for Australia and US data. See Annex 1 for details.
7. It is easy to imagine that the output of ICT products does not fully take into account the recent rapid quality upgrades in computer equipment (Oliner and Sichel, 1994) and semiconductors (Triplett, 1996).
8. In this spillover analysis, direct R&D of non-manufacturing sectors is set to zero due to lack of internationally comparable data on R&D for these sectors. The most serious problem is the difference in the sectoral coverage of R&D surveys in each country (Young, 1996).
9. This model is a cross-country version of that used in Berndt *et al.* (1992).
10. Although IT capital intensity overestimates the IT capital stock ratio, changes in it capital intensity can be a good approximation under some conditions. Details are provided in Annex 2.
11. A very rough estimation of TFP is made, setting β_1 equal to 0.3/0.7 for all sectors and countries.
12. See Nyholm (1995) in the case of Denmark, and NUTEK (1996) in the case of Sweden.

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THE INTERNET: MARKET COMPETITION AND POLICY CONSIDERATIONS

TABLE OF CONTENTS

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I. INTRODUCTION

The Internet has been expanding at an exponential rate and is now a topic of much debate and controversy as its commercial potential and social impact in the Global Information Infrastructure-Global Information Society (GII/GIS) increases. Over the last few years the number of host computers connected to the Internet has doubled each year, while the amount of traffic it carries every year has trebled. Many commentators expect this dramatic trend to continue if not to accelerate.

Much of the economic value of the Internet lies in its provision of a public network for general electronic commerce and communication.[1] Policy makers in OECD countries believe that its continued growth is dependent on market forces; that regulations, if necessary, should be kept to a minimum; and that existing national regulatory constraints should be reduced and perhaps harmonized internationally.[2] The market is still young, and it is believed that it needs to grow before any overall regulatory framework can appropriately be put into place. There are concerns over particular uses of the Internet – such as for the distribution of abusive or pornographic material – but as yet these concerns have not resulted in a general consensus concerning the Internet's regulation.

The commercialisation of the Internet's technological and economic organisation will stimulate its efficient growth as a means of mass communication of information production and delivery, and encourage its development as a medium of electronic commerce. But it is also important to recognise that the applications and services on the Internet are nowadays to a great extent being developed by existing communications, computing and media market players. The very formative stage of new Internet services and markets makes it relatively easy for dominant actors in these traditional sectors to quickly extend (and potentially abuse) their positions in these new service markets. This counterpoising of formative markets with competition may seem odd at first glance, but we will argue that it can be quite clearly seen in the interaction and evolution of recent Internet market structures, digital communications technologies and cost/pricing practices. Greater privatisation will reduce the Internet's traditional public "free-for-all" nature, and the degree to which it remains as a means of mass communication and information will depend upon governments ensuring that competitive market

structures are maintained so that small, medium and large enterprises can all fruitfully conduct electronic commerce.

As the Internet matures and larger firms begin to stake their positions on it governments must ensure that competition remains dynamic through guarding against the development of anti-competitive practices. In particular, trends towards more "balkanised" forms of traffic routing and payments, vertical integration of infrastructure, networking and content companies, as well as the development of Intranet and browser technologies will need to be watched carefully to prevent them drastically narrowing the possibilities for future market development. The issue is not one of governments somehow trying to prevent trends towards individual privatisation of the Internet (a futile exercise anyway), but of making sure that market structures remain open enough to allow competitive entry to all market players.

II. DEVELOPMENT OF THE INTERNET: MARKETS, TECHNOLOGIES AND COST/PRICING TRENDS

The Internet began its existence as an experimental military network, before its expansion to include US and then global academic institutions. The original goal of the network was to devise a system which, through the use of the open and common protocol TCP/IP,[3] would ensure that computer communications would not be susceptible to significant disruption in the event of a single computer or connection being destroyed. It was thus created as an inter-connection of packet switched networks, in which there is little central management of traffic but where terminals or servers co-ordinate information flows between themselves.[4] In this sense, it was "designed to be chaotic", or "organised to be disorganised".

The Internet now interconnects more than 50 000 public and private networks, providing access to between 50-60 million people. By the end of 1996, 80 per cent of America's Fortune 500 companies had sites on the World-Wide Web, compared with only 34 per cent a year earlier.[5] And although estimates vary, millions of people are projected to spend hundreds of dollars each on on-line purchases by the year 2000.

The recent remarkable growth of the Internet has only really occurred since the introduction of commercial market structures in infrastructure and networking provision. Expansion began as controls were relaxed over who could interconnect with the existing networks, and the first commercial Internet Access Providers (or IAPs) (previously operating as non-profit providers of Internet connections) began offering links to commercial enterprises and residential users. Almost all IAPs lease transmission capacity from public telecommunications operators (PTOs) for connections of their facilities to Internet backbone networks. Research and devel-

opment of Internet backbone networks was originally based on funding by the National Science Foundation of co-operation between computing and telecommunication companies under the day-to-day supervision of MERIT, a non-profit organisation. The US Internet was effectively privatised in 1995 when the NFSNET backbone was shut down and private companies took over responsibility for ensuring further interconnection.

While backbone services were traditionally supplied by long distance US telecommunication operators such as MCI and Sprint, these have now been joined by AT&T and other national PTOs around the world. MFS Datanet, a US company, still runs the most important Network Access Points[6] (NAPs) for the global Internet, while the responsibility for assigning and maintaining top-level domain names (addresses) has been contracted by the NSF to Network Solutions Inc., a private US company, until March 1998. But the Internet has been grafted onto the world's telecommunication networks via a myriad of leased lines and is increasingly being developed through capacity internally allocated by the world's major PTOs as they themselves become Internet access providers. An important point to bear in mind concerning market structure, therefore, is that the infrastructures of the Internet are increasingly made up of PTO-structured capacity.[7]

Technological innovations in networking and applications software have also played a major role in the recent growth of the Internet. In addition to creation of TCP/IP itself, a major turning point for the Internet came with the development of user-friendly navigation tools over the World-Wide Web (WWW). This in fact involved two technical innovations. The first innovation was the "hypertext" page which allowed readers to move to related pages by simply "clicking" on highlighted text in the original page, and thus enabled them to move quickly through information in a non-sequential manner. The hypertext language (*i.e.* describing pages which could be "linked") is known as Hypertext Markup Language (or HTML). The Internet protocol which manages their transmission is known as Hypertext Transport Protocol (or HTTP). The "universe" of HTML documents linked together on the Internet constitutes the World-Wide Web.

The second innovation was of application software known as "browsers" which provided an intuitive and graphic interface for accessing and reviewing the HTML pages, thus making the Internet far more accessible to the average user.[8] These innovations have facilitated the dramatic growth in both numbers of users and levels of traffic for commercial applications. But it should nevertheless be noted that while all these technical innovations are based upon the key principle of open standards, they are essentially tools for viewing rather than writing content on the Internet. While they therefore increase the content-viewing capabilities of the individual user, they leave unaddressed the content-development capabilities of users.

The rapid growth of the Internet has also come from the low cost of becoming an Internet Content Provider (ICP) or Internet Access Provider (IAP) and of using the Internet. Small-scale content providers can set up a Web page for little more than the cost of a PC with a modem and a subscription to space on the server of an on-line service provider or IAP.[9] One of the key reasons for the low costs is the open network architecture provided by TCP/IP – data packets take the route which optimises overall network usage rather than that set by commercial agreements between individual network providers – and the system of resource sharing practised by IAPs.[10] Unlike traditional telecommunication services such as voice telephony, most Internet networks transport traffic from neighbouring networks free of charge, thus eliminating monitoring and billing costs. This system is known as "peering".[11] In addition, unmeasured pricing of local calls in the United States has enabled users to connect to their IAP's international leased-line network for the price of one local call irrespective of the amount of time they actually spend on-line, thus encouraging use of the Internet.[12] These charging practices interrelate to produce an overall low-cost network. The low cost of service provision is also tied to the development of flat-rate charging for Internet users. If charges were to become "distance sensitive", the system would become more complex.

The development of commercial market structures, technological innovations and pricing and cost practices has thus been crucial to the successful rapid growth of the Internet. Yet so far this development has been geographically unbalanced. The United States, where developments are most advanced, still accounts for nearly two-thirds of Internet hosts and is where most leading Internet companies are situated. With the exception of the Nordic countries (and in particular Finland), the European Union is estimated to be a number of years behind the United States, with only 20-25 per cent of Internet hosts in Europe.

However, non-US Internet traffic is now growing at more than twice the rate of growth in the United States, and is particularly rapid in Japan where the number of hosts grew by nearly 48 per cent between July 1996 and January 1997.[13] Yet, as outlined below, as the number and type of interconnecting networks comprising the Internet has expanded, developments in market structure, technological innovation and cost and pricing are also throwing up challenges to the continued success of the Internet in promoting electronic commerce. In the rest of this article, we will consider these developments and their implications for competition.

III. CURRENT PROBLEMS AND CONSTRAINTS

The problem increasingly facing continued development of the Internet today is that many of the administrative and business procedures that were designed in

the days of a single, non-profit backbone interconnected with a number of academic and research networks are no longer appropriate for the new and multiple commercial networks and services. Certain issues have become increasingly central to the further general use of the Internet as a public network, and particularly for its development as a mass medium of electronic commerce. Many of these trends result from the growth pains of rapidly developing demand for infrastructure and applications. In most cases the private sector already is or will be able to make the appropriate adjustments, but in certain cases government oversight (or government provision of a forum for the airing and balancing of a range of social and private-sector interests) may be required. The main issues are:

- Low network reliability and quality of service due to the pressure of unprecedented demand for access and inherent design feature, and a high perception of insufficient security and validation for serious commerce. The Internet has worked on a "best-effort" basis, which can mean that when, for instance, a particular buffer becomes overloaded, data can simply be dumped. A related aspect is that, although applications vary significantly in their network demands,[14] there has in the past been no way for a packet of data to request or receive priority or preferential treatment when needed.
- Another problem has been the lack of a cost-based charging framework (at both wholesale and retail level), which can lead to unreliable and inefficient allocation of resources and investment incentives. The traditional practices of unmeasured flat-rate charging and open interconnect between IAPs with no system for cost-based settlements, have created incentives for "free-riders" and lead to congestion. As a result, certain IAPs have been in a position to let others take responsibility for the major investments in leased lines and traffic and routing tables. This problem has been exacerbated by the fact that the routing of Internet communications is often remarkably circuitous. A vast majority of packets go through NAPs in the United States, even if they are in fact destined for, say, neighbouring European countries. But solutions drawing both retail and whole prices towards costs will inevitably favour larger IAPs and infrastructure providers as they have larger economies of scale and greater control over their cost bases.
- Consumer confusion in the face of branding, marketing and content proliferation. As usage moves to the mass market, there is increasing demand from consumers for simplification and the one-stop shop. Thus the market becomes more susceptible to, for example, the "full integration" principle of Microsoft – *i.e.* one "brand" for operating system, applications and Internet software – and programming (the return of pre-packaged, one-to-many broadcasting) by content providers.
- Ambiguity as regards the regulatory framework. This applies particularly strongly at the international level, although also at the federal level in some

countries where states have relevant powers and authority. In addition, the present domain name allocation process is leading to conflict and confusion as regards trade-mark and copyright issues, particularly in relation to private ownership of collective resources.

All these difficulties can lead to the fragmentation of the Internet as a public medium of mass electronic commerce. In order to develop responses which will be appropriate, a structure of competitive relations between players involving regulatory models and measures for the industry is needed by governments.

IV. MODELS OF THE INDUSTRY

At the simplest level, the Internet industry can be horizontally divided into three segments or types of players where value is added:

i) infrastructure provision;
ii) network software and applications; and
iii) service content origination and programming.

Up until a few years ago Internet development was dominated by a fairly clear separation between these three layers. The basic provision of infrastructure (transport) was the predominant area of activity; but software and applications are now developing dramatically. However, the distinction between *i)* and *ii)* is increasingly blurred. Provision of content *iii)* has lagged behind the others in terms of maturity, market power and commercialisation, but is now beginning to grow rapidly.

Many of the smaller players which have grown in these new markets are becoming increasingly worried that dominant players from traditional sectors are, or will be, launching strategies to move up or down the value chain. However, there is currently probably still great potential for early movers in the market for content aggregation and provision. On the other hand, rapid innovations in market segments can themselves raise barriers to entry as they become more sophisticated.

The OSI model[15] gives regulators a useful means of addressing this technological issue by focusing on the essential underlying network architecture which vertically links these three horizontal sets of value-adding actors. Analysts favouring this model tend to work on the premise that Internet market segmentation of value adding must ultimately be based on the practical possibilities offered by the technical structure[16] of Internet networks themselves. That is:

i) The "hard" physical connection (copper, fibre, wireless, including satellite). These are generally telecommunication and cable TV operations.

ii) The Datalink which is concerned with node-to-node transmission. This is also generally a telecommunication operation.

iii) The Network which routes the data and forms data packets. Certain telecommunication operations are now venturing into this layer. More commonly it is provided by specialised companies such as America Online, UUNet and Compuserve.

iv) Transportation ensuring delivery. This is more or less carried out by access and service companies such as UUNet, AOL, Compuserve, Sprintlink.

v) The Session Layer which starts, stops and governs the transmission order – this is where transport starts to merge with software and content. In this category there are both access providers, software and service providers: Sun, Netscape, Microsoft, AOL, Compuserve, etc.

vi) Presentation and syntax for data conversion which makes the "session" layer available to the application layer (ASCII, binary conversion, encryption). Sun, Netscape, Microsoft, AOL, Compuserve are companies active in this area.

vii) Applications layer – the communications applications for e-mail, file transfer, client server applications (*e.g.* Netscape, Microsoft, Yahoo).

This model specifies that each of the seven layers deals only with the layers immediately above and below it, and suggests that companies will be most successful in attempting partnerships and alliances with other companies immediately above and below them (*i.e.* that this is the only way to realise and utilise true and sustainable synergies and competitive benefits). However, it also recognises that there is much flexibility inherent in the integration of these multiple layers.

As the model indicates, however, vertical relations between actors in different infrastructure, computer-software and service-content markets can be vital in determining competitiveness in new Internet services. It is not the task of competition policy (or general government policy for that matter) to avoid or pre-empt such a development *per se,* and there are certainly arguments supporting synergies and consumer benefits of such integration. It is not possible to rigidly categorise the key competition issues arising from these challenges thrown up by the development of the Internet as a sector, or meshing of sectors, as purely of telecommunications, computing/software, or content concern. Clearly there are aspects of all three: important bottlenecks exist in each respect, and it will be important for policy makers to watch the vertical moves of dominant players in telecommunications, computer software/operating systems, and content as they move towards each other and towards that area which is currently characterised by smaller, independent content, service and applications providers.

Market structure, players and vertical integration in the Internet market

While Internet traffic mainly consisted of e-mail and simple file transfers, the focus of competition concerns was mainly at the level of infrastructure markets. For instance, there may be a "logic" and a significant consumer benefit resulting from the movement of the major telecommunications operators towards more integrated provision of Internet services. It is arguable that a dynamic which moves away from the chaotic network of networks provided by a myriad of service providers and carriers, and towards a more organised and co-ordinated end-to-end service[17] for Internet communications, is both inevitable and attractive. This logic may result from the need to better co-ordinate management of networks in order to organise a system for prioritisation of packets. As corporate real time and higher bandwidth services (such as video conferencing) are increasing in demand and being provided over the Net, it is essential to provide a means whereby certain transmissions can be labelled as urgent priorities and guaranteed to be delivered without delay.[18] Corporate users demand the option to pay more and be assured priority. Such payment would also add to the resources available to upgrade and improve the available networks.

With the development of more complex multimedia applications and services, competition concerns should properly widen to include actors in computing-software and service-content markets. For instance, the integration into one browsing/menu/server system of the ability to deal with all files, documents, applications and communications (for WANs, LANs and internal PC applications) may be both an attractive development for consumers and a logical market development. In regard to content, simplicity in finding and ease of use of service content may be a useful consequence of "push", or broadcast services packaging material in well-organised programmed formats, rather than individual consumers having to search chaotic and idiosyncratically organised databases.

Yet what should ultimately be of concern to competition authorities is whether such vertical integration between infrastructure, computing-software and service-content actors creates barriers to horizontal market entry and competition in new Internet markets. In other words, the question is whether vertical integration prevents small, innovative independent companies from developing Internet network access, applications and service content in horizontal markets (say, in the supply of components to large companies) along the supply chain. It is vital that competition policy ensures that moves towards greater vertical integration and concentration in the industry (by dominant players in the software sector, the telecommunication sector and the publishing sector) are indeed the result of market forces and pro-competitive strategies based on real, sustainable competitive advantages and synergies. Competition rules must prevent dominant players from pursing vertical integration based on tying strategy or other ways which are

distortionary, anti-competitive, defensive and/or predatory, and which prevent the development of alternative means of accessing, using and publishing material on the Internet.

The key challenges for the application of competition rules to vertical integration in this new sector will be:

- to balance the risks of market foreclosure with the apparent benefits to consumers; and
- to ascertain the difference between pro-competitive commercial behaviour and anti-competitive strategies on the part of dominant players.

For the foreseeable future, though, it will continue to be difficult to fit the industry into neat and sustainable market definitions. It should be recognised that many companies are today pursuing fairly unrefined "Internet strategies" under conditions of flux and uncertainty. To this extent, consideration of current integration or segmentation trends often requires a due degree of scepticism. The structure of the market for both infrastructure and service provision is still remarkably fluid and the key areas for adding value and profit will continue to change as the Internet develops. This should be borne in mind for the purposes of applying competition rules. Regulators will be unable to rely exclusively on sustained models of the industry, and may need to focus on the activities of groups of companies, or even on individual market players, within the developing market structures of the Internet.

Network infrastructure provision

Public Telecommunications Operators (PTOs)

Public Telecommunications Operators are the major, though not sole, providers of physical Internet infrastructures. The Internet clearly represents both a strategic threat and a potential opportunity for PTOs. To some extent, they are faced with a choice of cannibalising revenue streams now on existing services (as the low-margin pricing structure of Internet transport puts pressure on their high margins for long-distance communications) or failing to establish a position in the new Internet services market (a potentially high-value market). But PTOs also gain an increased source of revenue from the growth of Internet traffic, and many are able to provide "high-quality" Internet transport services to IAPs and ICPs for whom quality is becoming an increasingly important differentiator and for which they are prepared to pay a premium.

In entering these new service markets themselves, PTOs enjoy strong competitive advantages over existing IAPs and ICPs. In general, companies owning their own infrastructure have a significant cost advantage over those who have to

lease them from PTOs in order to gain entry to the IAP market, as this allows them to develop economies of scale. But the PTO competitive advantage lies not just in their ubiquitous networks, but also in relation to IAPs and ICPs in their established customer relations and billing systems. Although infrastructure liberalisation should, in the long run, alleviate the pricing of leased lines above costs, the effects of competition will take time to take hold.[19]

In addition, emerging Internet protocols (TPs) developing in response to demands for more predictability and less congestion on the Internet, allow for prioritisation of certain packets (for example allowing real time voice/video to have priority over e-mail). The deployment of such protocols often requires that the disparate groups of backbone, regional and IAPs agree on how such priorities will be denoted and handled. As a result, it may well be that PTOs will end up dominating the current niche players providing Internet access services (IAPs such as UUNET, PSI, ANS). The latter group may be driven from the market but more likely will be acquired or taken over.

This trend towards increasing co-ordination amongst disparate groups, or even end-to-end provision by single groups, is strengthened by the more efficient pricing and charging mechanisms being developed to provide better incentives for investment and resource allocation and to prevent uneconomic usage of capacity resulting from unmeasured charges. New, more complex pricing arrangements are also expected to accelerate the trend towards larger PTOs, or co-ordinated alliances or partnerships, providing end-to-end reliable Internet service.

In considering these issues, competition authorities will need to consider the extent to which those seeking increased reliability, security and quality of service (and willing/able to pay extra for it) are satisfied with progressive reforms in Internet service compared with offers of more closed or centrally managed IP solutions. Whether or in what form such developments occur is clearly not something which should be pre-empted *per se* by application of competition rules. But competition policy must equally ensure that it is market forces which decide the outcome of technological development and that the behaviour of PTOs is competitive rather than defensive or predatory.

The issues outlined above largely relate to questions of infrastructure provision, and it is unclear how these factors lead naturally to PTO dominance of provision of Internet services *per se*, as offered by ICPs, where the economics are largely different and relate to programming capabilities. Whilst their competitive advantages in the Internet service market (as major infrastructure owners) cannot be ignored and should not necessarily be prevented (in as much as these benefit the consumer), PTOs should be prevented from abusing their dominant position in infrastructure markets in order to gain unfair advantage, and even foreclosure possibilities, in these new and growing service markets. Competition authorities will need to monitor this aspect of vertical integration.

Cable TV and satellite companies

Cable TV and satellite operators are another group of physical Internet infrastructure providers. Like PTOs, cable and satellite operators are also faced with perceiving the Internet as both a threat (*i.e.* to their own plans as providers of broadband interactive services) and a source of new revenues by becoming themselves IAPs or ICPs. Although cable modems[20] have been difficult to develop, a number of cable companies in the United States, the European Union and Australia have or will begin offering high-speed Internet access in 1997. Cable and satellite companies generally plan to offer proprietary packaged content (*e.g.* pay TV channels) along with Internet access, in much the same way as on-line service providers (such as Compuserve and America Online) are doing. While these companies do not have the same infrastructure advantage of PTOs (particularly as regards long-distance backbones) in regard to IAPs, they do have programming expertise which gives them competitive advantages in relation to ICPs.

There are certain limitations associated with this development, however. Both the penetration and the technology of cable and satellite networks varies greatly within and between OECD countries. It is not yet known whether consumers will be prepared to pay for such an increase in access speed (unless they are subsidised by the service provider – which is unlikely given the non-proprietary nature of Internet access), and these modems will also be expensive (they can currently be produced for around US$300). There is also the potential problem of "backbone meltdown": significant increases in demand for high bandwidth may surpass the capacity of current backbones. This may be particularly true of the business market, where use of e-mail may be progressively replaced by video and audio conferencing. However, cable TV operators are developing caching technologies with rapidly increasing storage capacities. Competition authorities, therefore, seem to have less to be concerned with any potential anti-competitive impact of cable and satellite TV companies entering the Internet market than with PTOs – except, of course, where the provider is also a PTO, as is the case in some OECD countries.

Internet Access Providers (IAPs)

IAPs offer connectivity to individual and corporate users and are the commercially least established of the three infrastructure groups. Unlike OSPs they do not provide their own content, but many are now offering WWW space (the ability to set up one's own "home page") to subscribers. Since there are low barriers to entry to this market, many small companies have rushed in, but the developing structure of the market is already putting pressure on many of the smaller start-ups. The most important trend in this context is the merging of IAPs as the

industry consolidates: take-overs and mergers are generally aimed at providing greater economies of scale. As the Internet becomes more commercial there is expected to be a move away from the simple "non-settlement" system for handling each other's traffic. If payments become increasingly measured or rationalised (based on costs of transportation), this will progressively add to the competitive advantage of larger IAPs with greater control over their own or leased backbone networks.

Network and applications: software developers

The important point for competition policy concerning actors in network and applications software markets is that, while the market should be the deciding factor concerning overall development, the Internet market is at such an embryonic stage of development that dominance in one of these key sub-markets can determine the outcome in others. The possibility for abusive and distortionary behaviour is high, and should be watched carefully, precisely because, while Internet architectures free services from physical infrastructures to a degree unavailable with previous media, it ties them to a logical structure which can potentially be monopolised by computer-software companies if these sub-markets remain uncompetitive. In particular, the potential for tying the viability of applications functionality and service content to particular operating-system or browser software threatens the open and dynamic nature of the Internet.

At a general level, the market for Internet networking and applications software is dominated by two companies: Netscape and Microsoft. Both produce server software (web browsers), client software (for such things as Internet telephony), as well as software for Internet security (particularly for securing electronic commerce and for protecting company information – this involves encryption and software "firewalls"), and (recently) software for Internet TV.

Competition between the two exists not only over market shares in these products, but, more broadly, over different visions of the future significance and role of the Internet *vis-à-vis* the PC, servers and operating systems. Microsoft, the undisputed dominant player in the market for PC operating systems (with around an 80-90 per cent share), launched the Microsoft browser, Internet Explorer 3, at the beginning of 1996 and has since managed to gain around 25 per cent of the market. Its aim, however, is to "draw" the Internet service "down into" the PC operating system through increasing vertical integration of Microsoft products and standards. This contrasts with the opposing vision of Netscape (which holds around 75 per cent of the browser market) of increasing reliance on networked software and applications on the Net, which is particularly effective when used with "dumb" network terminals for reception.

Netscape has formed an alliance with Oracle, the largest corporate database software producer, and Sun Microsystems, the largest producer of server equipment and software, to develop software for (relatively) "dumb" network computers (Ncs) which are designed to be a low-cost alternative to PCs. Microsoft has also been developing slimmed-down software for PCs. But, perhaps more significantly, the company has also been developing programmed content services – most notably in its Internet news and entertainment alliance with the broadcaster NBC, called MSNBC. Both Microsoft and Netscape have been developing networking and applications for "push" Web software (which will reshape the Internet into a mould closer to TV). At present, the technologies of the two companies work to different proprietary standards, which means that publishers and users will lose some functionality and content on machines using the rival company's software.[21]

What is clear from this is that Internet browsers provide a more sophisticated way for users (especially corporate users) to deal with files than simple PC operating systems, and have thus become the key driver for software developers of commercial services on the Internet. It would be wrong, however, to see issues of competitive markets solely in terms of product development strategies for browser technologies. Broad structural tends in technological innovation are also established by differences in demand (and particularly in relation to differences between residential and business demand), and policy makers must also be aware of the significance of these in maintaining or undermining competition. Initially much of the marketing and "hype" concerning Internet services were directed at the residential consumer and focused on developing electronic commerce for services, information, entertainment and transactions in the home. Internet software producers have been aware for longer than most of the market that the browser's potential is less as a product in and for itself than as a vehicle or "platform" for the most lucrative and profitable market of business applications software. This is particularly pertinent in relation to the development of Intranet technologies.

Intranets are networks based upon the Internet Protocol (IP) and used by companies for their internal communications – either by deploying a private network using Internet technology (but with their own lines and routers) or by creating a virtual private network or "closed user group" on the public network. Using IP-related products on private networks is increasingly becoming a cheaper, easier and more efficient solution for corporate customers than traditional data networks as, for the most part, the problems associated with the public Internet do not exist.[22] For competition policy the important issue is that, if the take up of the Intranet market continues, it can be expected that IAPs and infrastructure providers will increasingly offer (as they have already begun to) complete Intranet

solutions over their own private networks rather than via the public Internet. The important questions raised in this context are:

- the extent to which the Internet becomes more driven by corporate interests and services as it becomes more commercialised; and
- the extent to which the current problems of reliability, security and unsustainable pricing practices are overcome on the public Internet, without it losing the characteristic advantages it gives to domestic users (non-distance sensitive pricing, network sharing, open protocols).

One of two scenarios may occur. On the one hand, the Internet will develop to allow for prioritised traffic and the organised reservation of capacity; this, in time, will make it feasible for corporate communications to "return" to the public Internet. On the other hand, the current trend whereby increasingly companies seek IP solutions off the "Net" may continue: PTOs and IAPs will increasingly cater for this market – with the former using alliances and partnerships to offer reliable end-to-end solutions – so that ultimately an alternative, more organised "Net" of Intranets will develop. Organised and managed end-to-end telecommunication solutions might then draw in IAPs to lease such capacity for residential users.

However, compared to the general market (which includes the consumer market), the corporate Intranet market is much more competitively structured and dynamic. Microsoft, Netscape and IBM/Lotus are essentially battling it out to become the industry standard for corporate Intranets. So Navigator and the Web-server products are, in this sense, simply a means to an end. Already, over 80 per cent of Netscape sales are actually to corporations which buy not just browsers but server software. However, naturally, the value of Intranets will be severely limited if they cannot "break out" onto the public Internet. So questions of market structure, technological innovation and costs and pricing in a general public Internet will remain pertinent. Competition authorities, by supporting competition in the corporate Intranet market (an easier task than doing so in the general Internet market) can help ensure long-term development of competition in the broader (including the consumer) Internet market.

Service content origination and programming: Internet Content Providers (ICPs) and Online Service Providers (OSPs)

Originally offering news, entertainment and information as a proprietary service to their own subscribers and "closed" to the Internet, nearly all OSPs have now switched to using WWW browsers as their interface to content and to providing full Internet access alongside their own proprietary content. They face increasing threats from big publishing and media companies entering their market as

electronic commerce on the Internet develops. Internet Content Providers (ICPs) provide individual services over the Internet. Increasingly, ICPs are joining with OSPs and media service companies in order to benefit from the competitive advantages of packaged programming.

The question for competition policy is again one of the extent to which the entrance of traditional media conglomerates, and in particular any alliances they might form with computer networking and applications software companies, will result in exclusion of smaller producers. At the moment there seems little direct evidence of this occurring. However, the more extreme demands that some of them have been making in relation to intellectual property protection could have the same effect.[23]

V. REGULATORY FRAMEWORKS AND MEASURES

Regulatory frameworks and measures can aid the development of the Internet as a general means of electronic commerce. To date, much of the debate over legal and regulatory structures has focused on the question of illegal or controversial content. While these issues are important, a narrow concentration on them can obscure the importance of developing laws and regulations which facilitate the competitive development of the Internet.

The Internet is not entirely "unregulated" – existing regulatory frameworks apply already in a number of cases; for example, to telecommunications operators as infrastructure providers and to publishers (and particularly broadcasters) of service content. In the interests of undistorted competition, new regulations directed at the Internet are therefore as a general rule unnecessary and should be avoided. In some cases, however, there may be a case for reform of existing regulations. This is particularly the case where convergence between infrastructures, networking technologies and services content is resulting in international alliances between traditionally dominant providers from these three sectors for the purpose of producing and delivering new services. While international alliances in traditional markets will almost always result in increased market competition, in new Internet service markets they could result in less competitive markets unless existing national regulations (on, for instance, broadcasting) are relaxed. No international competition authority yet exists which could prevent this occurring, and the process of bilateral or multilateral negotiations to resolve anti-competitive behaviour would be ineffectively long in achieving any results. So the critical questions become *which* regulations should be applied to the Internet in order to achieve balanced and sustainable growth, and *how*?

Particular regulatory measures will and should differ across countries, depending upon levels of market development. Because the Bell companies in

the United States have (until very recently) been exclusively local carriers, and have been obliged to offer flat rate or unmeasured local calls, local Internet access prices are lower than in many other OECD countries and allow US users to stay on-line as long as they like without incurring any extra cost. Low local call charges are to a large extent financed through cross-subsidy by interconnection charges which long-distance operators have to pay the Bells to deliver calls. IAPs in the United States thus benefit from subsidised use of the local network; yet they do not have to contribute towards this "subsidy" (which resellers and long-distance operators have to pay) since they are currently exempted as "enhanced service providers" (in contrast to voice providers) from contributing towards that part of a telephone bill which goes towards the cost of interconnection.

This situation has certainly encouraged growth and use of the Internet in the United States, but may be unsustainable in the longer term. Telephone connection to the Internet has led to dramatically increased demand for local circuits which is seen by many to threaten the general practice of flat-rate charging for local telephony. Both long-distance operators and cable TV providers are complaining of unfair and inefficient use of customer access resources. Does this imply that local operators should not be allowed to discriminate between Internet and traditional voice traffic for charging purposes? Under current Federal Communications Commission (FCC) proposals, interconnection charges will be reduced, and this will remove the cost basis of discrimination. This will, in turn, reduce the ability of local operators to provide unmeasured local access charges, and should to some extent slow demand for connections to the Internet.

In other countries, the situation is different. The OECD has highlighted how existing tariff practices and price levels are acting as a barrier to Internet access growth in many countries, and how bottleneck control of infrastructure by PTOs in many of its Member countries is restricting Internet market growth.[24] IAPs and ICPs in the European Community, for instance, often have to charge more to their customers since their own telecommunication infrastructure bills are higher. In particular, European IAPs are paying higher leased line charges than their US counterparts for connection to the local loop. In addition, in many OECD countries, local charges tend to be measured by time (and are generally much higher than in the United States, even for short calls).

Liberalisation of voice communications by the European Union in 1998 – and now in many other countries as a result of the agreement in the WTO for liberalisation of basic telecommunications – should help redress this situation in the long term. But rebalancing of tariffs in the absence of competition at the local level could actually exacerbate the problem in the short term. Thus the pricing debate in Europe and elsewhere has tended to be reversed from that in the United States, focusing on the risks of *excessive* PTO charging and its potential detrimental effect on growth of Internet use. The growth of Internet services in Europe

and elsewhere can therefore be stimulated for the time being and for the foreseeable future by being regulated as "enhanced" or "value added" rather than as voice services. In general, given the uncertainty and flux, it is important for competition policy in the area of Internet pricing to focus on two key issues:

- Charges for use of local-loop telecom infrastructure (on what basis should wholesale and retail users be charged? Can/should they be charged differently for switched and packet switched services?).
- New arrangements involving PTOs and IAPs for handling international backbone Internet traffic. Agreements should be notified at the earliest possible stage and watched carefully in order to ensure that traffic flows and pricing are not being organised in an anti-competitive manner.

The Internet market is, though, an inherently global medium – not only in its reach of customers and service, but more deeply in its essential indifference to physical territory or geographical space. Thus any problems concerning anti-competitive behaviour by major players may need to be dealt with in an internationally co-ordinated and co-operative fashion. The United States and the European Commission have recently been developing expertise in such co-operation in the area of international telecommunications alliances, and it needs to be considered how this can be extended further – both with other countries and in terms of international alliances between major infrastructure providers, network and applications software providers, and service content providers.

One area in which some further international harmonization of approaches may be desirable is in the area of controversial content and conduct. The 1995 US Communications Decency Act, which would have made it illegal to even receive or display "offensive" material on one's PC, was overturned by a US Court on the basis of the US Constitution and the right to freedom of speech. Such constitutional safeguards are not prevalent in most other OECD countries. The crucial point here is that Internet content should not be regulated as a "broadcasting" nor even as a "new audio-visual service". For the most part Internet content is received as a point-to-point service. In this sense content issues should be defined, for regulatory purposes, as closer to the publishing paradigm than the broadcasting one. However, as the Internet is used more and more for broadcasting purposes, international agreement on regulations for securing competitive market entry may be usefully developed.

VI. CONCLUSIONS

As the Internet grows in popularity, the commercialisation of its technological and economic organisation will bring about greater privatisation and reduce its

traditional public "free-for-all" nature. This fragmentation will overwhelmingly be a good effect, and will allow the efficient growth of the networks which comprise the Internet. But the degree to which this process goes, and in particular whether it sustains the Internet as a means of mass communication of information production and delivery, will depend upon whether governments ensure competitive market structures where small, medium and large enterprises can fruitfully conduct electronic commerce.

Governments need to develop appropriate regulatory models for ensuring that vertical integration between major infrastructure providers, network and applications software providers, and service content providers do not result in stifling the growth of small and medium-sized enterprises. Though appropriate regulatory measures will differ from country to country according to the level of market development, some areas of international co-operation and co-ordination may be required.

NOTES

1. For an analysis of the fluid and dynamic nature of the Internet, see Kevin Werbach, "Digital Tornado: The Internet and Telecommunications Policy", OPP Working Paper No. 29, Office of Plans and Policy, Federal Communications Commission, Washington, DC 20554, March 1997.
2. See, for example, Ira Magaziner, "A Framework for Electronic Commerce", White House Information Infrastructure Task Force, various drafts, 1997. This can be found on the Web at http://www.iitf.nist.gov/eleccomm/glo–comm.htm.
3. Transmission Control Protocol/Internet Protocol. These are, in fact, two open protocols, the network protocol and the transport protocol, that are the foundation of the Internet. One of the most powerful characteristics of the networks based on TCP/IP is that computers are "peers" – the open interface is two-way, so each computer is capable of initiating and responding to requests. This type of platform allows "independent interoperability", *i.e.* a document may exist simultaneously on many users' machines, and the PC is at the same time both "client" and "server".
4. Traffic flows are largely decentralised. But there are only eleven root servers that handle central address routing – and nine of these are located in three places in the United States (and one in Finland and, recently, one in the United Kingdom).
5. See *The Economist*, 10 May 1997, "Survey Electronic Commerce", p. 4.
6. These are the points at which multiple backbone providers can interconnect. A huge proportion of traffic runs through MFS' NAPs MEA-EAST (Washington) and MEA-WEST (San Jose). The other three US NAPS are in Chicago (Ameritech), San Francisco (PacBell) and New York (AT&T).
7. See OECD, "Information Infrastructure Convergence and Pricing: The Internet" [OCDE/GD(96)73], Committee for Information, Computer and Communications Policy, Paris, 1996. This paper can be found on the Web at http://www.oecd.org/dsti/sti–ict.html.
8. "Browsers" enable users to view data, determine what it is and configure it for display, thus simplifying Internet navigation. The first browser of any impact was Mosaic, developed in 1993 and distributed free over the Internet. The consequent commercial company, Mosaic Communications, was renamed Netscape Communications in 1994. It now provides the navigational software for around 80 per cent of the market.
9. However, many ICPs will have their own servers and fixed-line connections to a backbone provider.
10. For IAPs, major costs are hardware (servers, routers and modems) and telecom leased lines or virtual networks.

11. However, smaller IAPs are increasingly paying for interconnection with the networks of larger operators.
12. See OECD, "Information Infrastructure Convergence and Pricing: The Internet" [OCDE/GD(96)73], Committee for Information, Computer and Communications Policy, Paris, 1996, and OECD, *Communications Outlook 1997,* Paris, 1997.
13. See *Le Monde,* 21 April 1997.
14. Real-time radio or video, for instance, places much greater demands than e-mail.
15. The Open Systems Interconnection model was developed by the International Standards Organisation over the past 15 years in order to provide an open-standard reference for network development. It describes the building blocks of networks from the foundation up.
16. In other words, successive layers allowing greater functionality.
17. *I.e.* one (or a small number) of end-to-end global Internet network services (including datalinks, network routing, transport, etc.).
18. This is comparable to a service such as Federal Express as compared to the post.
19. Such an advantage is reasonable where essential facilities are not involved – *i.e.* once there is competition in the infrastructure market – as it is largely based on economies of scale. In a sense it is just this advantage which underlies the logic of investment in infrastructure. The question for competition policies is under which circumstances such an advantage should result in restrictions or conditions on vertical integration between infrastructure provision and Internet service provision itself.
20. Cable modems allow data on broadband cable networks to be converted into the appropriate format to be "read" by the PC (or PC/TV). They allow information to be downloaded from the Internet at speeds of up to 10Mbit/s, which is fully sufficient for video and multimedia. This compares to rates of 9.6-28.8 Kbits/s over the PSTN and up to 64kbits/s using ISDN.
21. For a discussion, see *Financial Times*, 2 June 1997.
22. WWW Browsers work on all computer platforms. It is estimated that the future distributing systems using Java have the potential to reduce the cost of running a LAN (Local Area Network) by at least 25 per cent.
23. See also the article by Edward Barrow in this issue of the *STI Review.*
24. See OECD, "Information Infrastructure Convergence and Pricing: The Internet" [OCDE/GD(96)73], Committee for Information, Computer and Communications Policy, Paris, 1996.

COPYRIGHT AND THE GLOBAL INFORMATION INFRASTRUCTURE

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I. INTRODUCTION

There are perhaps increasing numbers of people involved in the digital environment of the Global Information Infrastructure-Global Information Society who view copyright as a tool of oppression, used by big publishers and media houses to stifle freedom of expression. In this article I shall attempt to demonstrate that copyright is, in fact, a means of empowerment; that it encourages freedom of speech; and that it promotes economic development. However, I will also argue that it must be tempered by anti-trust provisions to achieve a balance between anarchy and rigidity. While problems do exist in enforcing a more equitable and economically productive form of copyright, many of these problems are being resolved by digital technologies themselves which lower barriers to market entry, protect individual copyright holders and facilitate their remuneration.

II. THE PURPOSE OF COPYRIGHT

The cornerstone of the information society is the information economy. If it is impossible to develop to earn a living, or a return on substantial investment, from the information society, then there will be no information economy and the information society itself will wither. Copyright is above all a mechanism which allows creators and investors to exact a charge for the enjoyment of their work, and thus earn a fair living.

Copyright is a *technology-driven* legal construct; it was the printing press which forced its development. Throughout its history, new technologies have been absorbed and the law has changed to address new issues arising from the technology. Photographs, gramophone recordings, films and radio and television broadcasts have been accommodated into the copyright framework. As a result of copyright, new media industries have developed around the emerging technologies.

A consequence of the diversity of the technologies driving copyright is that the law itself has evolved to be technology-independent. It does not regulate printing directly, but the making of copies – by whatever process. It does not protect the physical object – books or compact discs – but the underlying creative

literary or musical works. That principle has been further refined, so that copyright protects only the creative manner in which the ideas contained in the work are expressed. The distinction between an idea and the manner of its expression is fundamental to copyright law, and (at least theoretically) resolves the problem that copyright might bestow a monopoly on knowledge.

Copyright is not the only way creators and investors can earn a return: I will, however, argue that it is *in principle* the fairest and best system. The alternatives are second-best.

III. THE ORIGINS AND DEVELOPMENT OF COPYRIGHT

Copyright gives the owner of copyright, the author, the right to control use made of his or her material. It thus extends to intellectual creations the natural justice that applies to physical objects. Ownership of a physical object arises either through purchase or through manufacture. That is, I can get something by buying it or I can make it. Natural justice requires that authors and artists ought to have control of their creations; indeed, until they start to publish them, they naturally do.

Historically, copyright originated as a Faustian pact between printer-publishers (the booksellers) and the state, whereby monopolies and market regulation were granted to the former in return for political and religious censorship by the latter. Governments and churches were at the time feeling threatened by the fact that new printing technologies meant that reading had moved outside their cloistered control, and wanted to find a way to control the printing and circulation of material they considered to be seditious. Printer-publishers, for their part, found themselves competing in the production of popular works, which undermined the investment of the first printer to typeset the work. In the United Kingdom, the mediæval guilds of the City of London had the power to impose controls provided that printing was handled by their members. By the end of the 17th century – a century which saw the end of absolute monarchy and the emergence of parliamentary democracy – this system had outlived its usefulness. The mediæval guilds had, along with the monarchy, lost much of their power, and printing had spread well beyond London. A new form of copyright was required and, in 1709, the Statute of Anne enacted the first modern copyright law. This law revolutionised copyright by making the author, rather than the printer or bookseller, the first owner of copyright.

Nearly two centuries later, the natural justice of the principle of copyright as an author's right was evident enough to become the basis of the Berne Convention. The right itself has proved to be extremely flexible, and has adapted to suit the development of technology. At its core has been the right to control reproduc-

tion; whether it is appropriate that that right should be inflexibly applied to the entire range of products in the information age is today the subject of some debate, but that the author (and his or her heirs or assigns) should have the right to control exploitation is considered basically just. The converse of this fundamentally just principle is that those who enjoy the work – readers, viewers, etc. – are normally the ones who pay for it. Copyright is thus a mechanism which allows the normal processes of trade – the consumer pays, the producer receives – to operate in the realm of works of the intellect. However, alternatives do exist.

IV. THE ALTERNATIVES TO COPYRIGHT

The alternatives to copyright are advertising and patronage. They have a long history. We should not forget that some of the greatest artistic works in the world were created under systems of patronage: but that was in an era when wealthy and powerful people such as the Electors of Hannover, or the Medici of Florence, could indulge their whims without concern for democratic principles of justice.

Until very recently, however, it was practically impossible to exact a direct charge for the enjoyment of broadcasting. In OECD countries, broadcasting developed under two basic models: the advertising-funded independent sector, and licence-fee funding. The BBC in the United Kingdom was until very recently arguably an excellent model of modern-day patronage – largely due to the organisation's robust independence which is unique, and which is accidental rather than intrinsic. In this case, the patronage is a two-tier model; the government gives money to the BBC for programming, some of which the organisation keeps itself and some of which it further advances to outside producers.

Besides, it is becoming clear that broadcasters themselves – if not yet the viewing public – believe that the future lies in pay-per-view: that is to say, payment for enjoyment. In some countries (such as the United States), advertising-funded broadcasting has been the norm; whilst in others, patronage has been more directly controlled by the state, but controlled indirectly through it by political parties, as with television stations in Italy; or in part by various religious groups (as in the case of the Netherlands); or by the state directly (as was the case in the former Soviet Union and its satellites). But even for broadcasters, copyright is important; it allows them to resell their programmes to other broadcasters, and this is becoming more and more important as a source of income whatever the primary source of their funding.

mediæval

State funding is a particular form of patronage; mediæval patrons of the arts used their control of arts funding to enhance their political status. Just as

mediæval artists had to please the whims of their benefactors, so state funding of the arts limits the artist's freedom. Soviet artists were compelled to produce appropriate propaganda; and in the United States there has been controversy over the use of public funds for art which offends public morals.

Arguably no less restrictive, however, is corporate patronage – or sponsorship, as it is more commonly known. The US television networks rely heavily on corporate sponsorship, and the blandness and conformity to mass tastes of much of their output is the result.

Advertising is theoretically a different form of payment than either copyright or patronage, as it is designed to pay for commercially oriented content distinct from, but associated in time and space with, editorial content. In reality, though, little fundamental distinction exists between advertising and sponsorship. Although strict regulation (as, for example, of UK commercial broadcasting) can help preserve some editorial independence, the power of advertisers to influence the overall editorial agenda is considerable. Linking all content to advertising demeans the intrinsic value of editorial (that is, information or entertainment) content in its own right, by relating it to the sales of other, possibly irrelevant goods (such as, say, soap: growth in the market for content is dependent on growth in the sales of soap).

The primary objection, therefore, to any of the alternatives to copyright is that they restrict the *consumer's* freedom of choice. The question of what the ultimate reader or viewer may see is determined not by him or her, but by the sponsor, patron or advertiser. This conclusion may at first sight seem surprising, but it is supported by the fact that those developing countries with no or weak copyright laws often have strict controls on press freedom.

Copyright is not incompatible with the alternatives; indeed, it is complementary. Today's advertising-funded media industries rely on copyright to regulate their terms of business. But if copyright were abolished, the advertising-funded media business would be able to adapt, perhaps painfully, to a new *régime*; whereas authors would be forced, even more than at present, to skew their art to the commercial demands and objectives of their new paymasters.

There is, though, no real prospect of copyright being abolished. It is, however, at present often practically unenforceable in the networked world of the Internet. Content distributed via the Internet is often wholly dependent on the whims of those who pay. Yet in the interests of the principle of the ultimate consumer's freedom to choose, it is right that it should be the ultimate consumer who pays. This, then, is the basic democratic and economic argument in favour of copyright *vis-à-vis* its alternatives.

V. THE OBJECTIONS TO STRONG COPYRIGHT

Until fairly recently, there has been limited objection to copyright in the developed world; and most of the objections which have occurred have been economic, in that those who found themselves obliged to pay for the use of material objected to having to pay. But, in fact, there are very few people who object to the principle of copyright (that the author is the first owner of the rights in the creative work) *per se*; the argument now is over the extent of copyright in a digital environment.

Copyright law specifies what kind of materials are protected by copyright, and the contemporary debate is really over what electronic acts should be classed as acts restricted by copyright – for example, copying which is transient or incidental, the act of electronic transmission, or the viewing rather than the downloading of material. There are also some derogations from copyright, and there is substantial debate over these derogations. In the United States, the main derogation is called "fair use";[1] it is very wide-ranging and its application is judicially determined. There is a large amount of judicial precedent on the subject. Other jurisdictions tend to have more specific derogations determined by statute.

Copyright holders (authors and publishers) broadly support strong copyright, with the fewest possible derogations. Those who use copyright material extensively, on the other hand, support relatively weak copyright protection with extensive derogations. In the discussion which follows I have used the term "strong copyright" to mean an extensive, widely enforced and enforceable copyright law with the minimum of derogations.

It should not be surprising that (despite philosophical protestations to the contrary) any group's position on matters of copyright can broadly be determined by predicting the economic impact: producers favour strong copyright, consumers favour weak copyright.

Three groups, in particular, have specific objections to strong copyright laws:

- academics and librarians;
- developing countries;
- telecommunication companies ("telcos") and hardware manufacturers.

There are also general objections on monopoly grounds.

Academics and librarians

Librarians, particularly academic librarians, have been vocal in their objections to strong copyright. The use of copyright law by scholarly publishers to restrict photocopying of scholarly journal articles is often strongly resented. It is

normal practice for contributors to scholarly journals to assign the ownership of copyright to the publisher. These contributors are in the main academics – the same people who are the principle readers of scholarly periodicals. As restricted library budgets and escalating subscription costs have led to fewer and fewer original copies of scholarly journals being retained, so pressure has grown on libraries to make articles available in the form of photocopies. The widespread adoption of this practice has had a clear impact on subscription sales, leading to further upward pressure on subscription rates. Publishers' efforts to enforce copyright by restricting photocopying have often been seen as depriving the original authors and their peers of access to works which they originally created.

Unlike their professional counterparts, academic authors are not generally paid for what they write and have less interest in direct remuneration than in the widest possible propagation of their work. Whereas in theory they are at liberty not to assign their rights, in practice there appears to be little choice if the work is to be published at all. For this reason, some authors' societies argue that copyright, or some aspects of it, should be inalienable and incapable of assignment. It is a curiously contradictory position. Copyright is at present a property right which can be bought and sold, and it belongs at first entirely to the author. Making the right inalienable – that is, unsaleable – imposes restrictions on it and thereby reduces its value – which would be to the detriment of authors. If there is a problem with the assignment to publishers, it stems from the publishers' greater bargaining power – which should be dealt with under unfair contract legislation rather than under copyright legislation.

Academics and librarians have also marshalled significant philosophical arguments against strong copyright. Their objective, particularly in the public sector, is to spread knowledge as widely as possible; and they claim that strong copyright prevents knowledge reaching those who cannot afford to pay for it. Copyright is sometimes described as "a tax on knowledge". Again, were academic authors not to assign their rights to publishers, they would be able to use their ownership of copyright to pursue wider dissemination.

Developing countries

The governments of developing countries are concerned that their people should have access, in particular, to educational materials but also any information or knowledge which might help in their development. This is a long-standing claim and led to the introduction, in the Paris revision of the Berne Convention, of a derogation to the exclusive right of the copyright holder, allowing developing countries to produce local editions and translations at a lower cost. Some developing countries – for example, Indonesia – have for this reason never acceded to the international copyright conventions. The underlying assumption is that devel-

oping countries need access to material from the developed world and will be net importers of intellectual property.

At the Geneva Diplomatic Conference in December 1996, the developing countries presented a formidable negotiating block against the European and American proposals for strong copyright in the Global Information Infrastructure. This may, however, have been somewhat short-sighted, since not all developing countries are necessarily always net importers of intellectual property. Many have, for example, thriving popular music cultures which would be boosted by stronger local and international copyright laws. Music could have had a significantly greater impact on Jamaica's balance of payments in the 1980s as popular music world-wide was influenced by Jamaican reggae; but as a result of lax copyright laws, much reggae production relocated offshore. (Copyright laws, though, were not the only reason for this relocation.) Recent estimates also suggest that the copyright-related industries in India (which include the "Bollywood" film industry and the thriving computer software industry based around Bangalore) amount for as much as 6 per cent of GNP (by comparison, the estimated UK figure is only 3 per cent); yet the government of India took the "weak copyright" position at Geneva. Government indifference to the interests of its creative industries is not, however, confined to the developing world.

"Telcos" and hardware manufacturers

Telecommunication companies ("telcos"), Internet Service Providers (ISPs) and Internet Access Providers (IAPs) have a broad interest in weak copyright and a major concern over a particular feature of some of the proposed strong copyright legislation: that of their responsibility for the acts of their customers. They could potentially be held liable for infringements of copyright taking place over their networks, particularly if transient copies are held to be infringements. On this question, as on that of censorship, the telcos are adamant that they cannot be held responsible. But as substantial financial organisations, they make much more attractive targets for litigation than an individual posting an infringing copy on a bulletin board operated by a telco; and copyright owners believe that giving the telcos responsibility would force them to take a much more proactive role in enforcing copyright.

The telcos' concern is, to a lesser extent, shared by the hardware manufacturers – but since, unlike the telcos, they do not actually make copies, but merely provide the facility to do so, they are at less risk. In the United Kingdom, music copyright holders have (unsuccessfully) sued the producers of a consumer tape recording machine which had provision specifically for copying, at high speed, from one tape to another. However, there is a growing belief amongst copyright

holders that forms of technical copy-protection built into hardware (whether the machines themselves or the network) are essential.

The second aspect of the telcos' and hardware manufacturers' objections to copyright is that rigorous application might limit the deployment of technology and their share of total expenditure on it. At present, the Internet is not free: in most countries, as well as payment to an Internet access provider, users pay the cost of telecommunication connections. If the amount users are prepared to pay is limited, an increase in the amount going to content providers will be followed by a reduction in the amount going to the telcos. Any increase in the cost of accessing the Internet, by way of charges for content, will have an impact on the rate of growth, and is potentially damaging to the telcos; it may not be a coincidence that the Internet has been most successful in the United States, where communication costs are lowest. In the industries where copyright owners have the most power – film and music – copyright concerns have seriously delayed, and in some cases prevented, the deployment of new technology. Compulsory copy-protection systems built into hardware also make the hardware itself less useful to purchasers and may have the effect of limiting sales.

These concerns are also shared to some extent by some software companies, though the industry is divided. Software companies rely on copyright to protect their products; but additional money spent on content results in less money spent on software. Microsoft is firmly in the "strong copyright" camp, and pursues unlicensed users of its software with vigour. Content is a major part of its product range: with the Microsoft Network and its award-winning multimedia CD-ROMs. Corbis, a company owned by Microsoft chairman Bill Gates, has acquired rights to many of the world's art collections. Netscape, on the other hand, is less disposed towards strong copyright and appears to harbour few ambitions to become a major content provider. It relies on a shareware distribution model under which corporate and private users are encouraged to buy licences to use its main product, World-Wide Web browsers, and uses its dominance in that market to develop more lucrative markets for server software and corporate intranets.

Copyright and competition

From a free-market standpoint, copyright is potentially objectionable because it creates a monopoly; and monopolies are open to abuse. However, the monopoly extends only to one particular form or expression of an idea; and that idea is seldom exclusive to the protected manner of its expression. In the realm of computer software – particularly operating systems – there are however justifiable concerns about abuses of monopoly power. Microsoft's dominance of the market for computer operating systems puts it in an advantageous position to develop

application programs to run in that operating system and the company has been required by the US competition authorities to maintain "Chinese walls" between operating system and application program developments. The European Union's Software Directive contains specific exceptions to copyright to permit the development of interoperable interfaces.

Nevertheless, the present dominance of Microsoft Word in the market for word-processing software is a result of several factors:

- The merit of the product itself.
- The heavy promotion of bundled software deals, particularly to corporate customers.
- Microsoft's access to undocumented features of the Windows operating system.
- The need for file compatibility, which is particularly important when more and more files are exchanged as e-mail attachments. Rival products must be able to save material in Microsoft's Word 6 file format if they are to be usable in a connected environment; Microsoft's control of the file specification gives it a huge advantage over its competitors.

Of these factors, the use of copyright in file formats and other interfaces to promote the use of proprietary solutions is arguably fundamentally anti-competitive. However, copyright is not the only intellectual property right tool used to support anti-competitive activity. Know-how (protected by confidentiality) and patent law are also used. Microsoft's access to undocumented features of Windows is know-how, and it is perhaps the strongest weapon in the company's defence against competitors. Patent protection in some cases is even stronger than software copyright (the protection is absolute, not merely against copying). Arguably the problem is not the strength of copyright and these other tools *per se*, but the use of copyright and other intellectual property rights (including know-how) to defend and extend a dominant position in a market-place.

Article 86 of the Treaty of Rome, and equivalent competition law in other jurisdictions, outlaws abuse of a dominant position. The physical layer of the global information infrastructure is subject to regulation where monopolies occur. The monopolies of the telcos are being broken up and competition is established in most OECD countries and in a number of non-OECD countries. Competition in telephony requires compatible interfaces and standard switching technology. Operating systems, network protocols and even application programs are no less part of the infrastructure of the information society than the physical wires, and competition in these areas is equally desirable and dependent on standard interfaces. Ownership of copyright in software is equivalent to ownership of wires; ownership encourages private investment in both cases; and in both cases,

monopolies can ensue which may be abused. Competition law exists to control abuse of monopoly positions.

However, without content – information and entertainment – the information infrastructure cannot help global society develop. The information society is the information infrastructure plus content. Control either the infrastructure or the content and you control the information society. Thus it is essential that monopolies in content are not allowed to develop. Organisations such as Time-Warner, Bertelsmann and Pearson, and individuals such as Rupert Murdoch and Ted Turner, are jockeying for strong positions in the information economy. They are substantial owners of copyright. They are subject to the temptation to use copyright and other intellectual property laws to maintain and extend their grip on the information society. Again, however, what must be controlled is the *abuse* of the monopoly granted by copyright.

Strong copyright laws require news corporations to acquire copyright fairly (from freelance journalists, for example) and to make the appropriate investments. Weakening copyright law may damage newsbarons but it also damages their suppliers. If the acquisition of content is fairly done, it is unfair to expropriate property rights in content. Derogations to copyright law are a form of expropriation, and apply across the board. Media moguls' potential abuse of copyright should, therefore, be tackled not by copyright legislation but by competition and anti-trust legislation, for their abuses are anti-competitive.

There is, however, one area in which some changes to copyright law may be required: derived works. With physical property and commerce in physical property, the rights of the owner are well understood. The vendor's ability to control the use made of a product by the purchaser is strictly limited; once the purchaser has acquired a thing, he or she can do what he likes with it – including making it into another thing. There is no difficulty in treating things derived from other things; but copyright law has considerable difficulty in dealing with works derived from other works. This is an issue to which I shall return towards the end of this article.

VI. EMPOWERING INDIVIDUALS

The Information Society boosts the real economy in many different ways – efficient communication makes existing businesses perform better; necessary investment in infrastructure boosts growth in the network hardware industry and transport costs are saved as telecommunications substitute for travel and physical delivery of documents. However, these effects are likely to pale into insignificance compared to the benefits that could be gained from the unleashing of the creativity of individual citizens. The connectivity provided by the information infrastruc-

ture brings each individual's creative endeavour into the reach of every person connected to the network.

The World-Wide Web and the hypertext transport protocol were originally developed to enable co-operative working amongst high-energy physicists. During its subsequent commercial expansion it has lost much of its original spirit. Whereas it was intended that the whole should, with the co-operative working designed into Web protocols, be substantially greater than the sum of the contributing parts, today's commercial World-Wide Web is full of unnecessary and useless material.

Perhaps part of the problem is that the original Web protocols were designed for the use of physicists having a common purpose, and without regard to the need for commercial interaction. Contributors to the common purpose received their rewards elsewhere – in the form of greater respect from their colleagues, or simply the satisfaction gained from co-operative scientific progress. But such motivation is not universal. The Web needs a universal motivator to harness the collective inspiration of its contributors, and which can replace the shared academic motivations of its earliest users. In the commercial market-place, money is the universal motivator – yet the content creator is the only player not to be fairly rewarded in the current explosive growth of the Web.

The major media companies of the world see the Internet as a market, and they see Internet users primarily as consumers. This one-way view of the network misses its essential characteristic. Internet users are both consumers and producers; as consumers they pay (the money going to ISPs and telcos); but as producers they are unpaid. Media companies, accustomed to passive consumers in front of the television screen are uncomfortable with the two-way nature of the Net, because it puts them in the difficult position of having customers who are also competitors. But it is one of the Net's most attractive features for society, because this interactivity can liberate the creative talent of citizens towards the greater economic good.

The two-way nature of the Internet is at the root of the copyright problems it presents. In computer terms, it is a read/write medium. Most mass-market media are read-only; but when it becomes possible for end users to write to a medium, it is also possible for them to copy to it. In the United Kingdom in the early 1980s, computer companies such as Sinclair, Amstrad and Commodore produced cheap machines which resulted, for a time, in the United Kingdom having the highest penetration of computers into the home of any country in the world. These computers were primarily games machines, and fairly quickly a generation of schoolboy programmers grew up with the skills to write computer games.

However, an anarchic playground culture of piracy – which the school authorities were unwilling or unable to control – led to a UK computer games industry

being stillborn. The computer games industry moved away from read/write machines to read-only machines, with the games consoles being made, mainly, by Japanese manufacturers. Software was supplied on read-only media – mainly cartridges – which were very effective in preventing piracy. The Japanese console manufacturers were able to sell their consoles very cheaply – even as loss leaders – since they could recoup their investment on the sales of software. Whereas the first generation of computer games players could go on to write their own games on their own machines, the Sega and Nintendo generation were consumers only; a great deal of potential creativity was thus stifled. The creativity of the first generation of gamers flowered but withered. If the read write medium was the soil, copyright was the fertiliser, and it was not applied. The creativity of the Sega and Nintendo generation never flowered.

The Global Information Infrastructure has the potential to release far more creativity than the schoolboy shoot-em-up fantasies of computer games. And the media industry is not blind to the potential threat that this could present to them, so they are pursuing a number of alternative routes. One is to re-invent the Global Information Infrastructure and the Internet as a read-only, one-way mechanism. Television set-top boxes, developments such as the Network Computer proposed by Sun and Oracle and "push technology", lead to this conclusion. Communication from the user will be limited to the transmission of payment instructions and navigation commands, perhaps with one-to-one e-mail thrown in. Another is to pursue strong copyright, backed by technical means, and where possible to own the technical means of protection. Rupert Murdoch, for instance, owns a number of key patents for data encryption, used in the management of subscription-based satellite television channels. There is clearly potential for anti-competitive abuse of these patents – in the pursuit of an information society as a society of couch-potato consumers rather than creative contributors.

VII. LOWERING BARRIERS TO MARKET ENTRY

Competition is hindered by the existence of barriers to entry; technology, though, is succeeding in lowering many of the barriers to entry into the information economy. Large media organisations are faced with increased potential competition from new entrants to their business, unhindered by barriers. For this reason they have an incentive to steer the development of the information infrastructure away from the two-way Internet towards a one-way network based on television set-top boxes. This non-Internet technology creates and maintains new technological barriers to entry. Whether it will succeed remains to be seen.

Most Internet subscribers in the developed world can now put up their own Web sites, as Web space is included in the subscription – a cost of, at most, a few

hundred US dollars per annum. Barely two years ago, this would have required either a substantial rental or the provision of a dedicated server complete with permanent leased-line connection, at a cost of several thousand dollars per annum. The majority of these personal sites carry little more than "pet portraits", but some are genuinely innovative. Lowering the barriers to entry unleashes new creativity and creative potential. When the barriers to entry in computer games were lowered, there was a brief flowering of talent, extinguished as the barriers were raised by new console and cartridge technology developed as a result of the lack of effective copyright control and remuneration existing within the technology at the time.

A phenomenon of recent years, Western popular electronic dance music, illustrates another problem concerning lowering of barriers to market entry. This movement started entirely independently of the major players in the music industry, from thousands of home computers in individuals' bedrooms. The barriers to entry into music making were lowered by technology. However, the dance music phenomenon also raised some important copyright problems. Much dance music relies on sampling, in which sounds are recorded, digitally manipulated and replayed. Sometimes, samples are taken from existing records – and in so doing copyright can be infringed. Sampling leads to derived works, which are a particular problem for copyright management.

VIII. DERIVED WORKS

Dance music made from samples, university coursepacks, news digests and multimedia CD-ROMs are all examples of derived works. Very few creative works are entirely original – writers and artists are influenced, or inspired, by their forbears and by the culture in which they live. Virgil's debt to Homer was considerable; and great composers freely borrowed folk-tunes. Copyright law has had to come to terms with the distinction between inspiration and theft, and it has not always done so satisfactorily.

New technology makes it much easier to borrow material than ever before, and in so doing, value is added to the work. All the works mentioned above are more than merely an assembly of their component parts. The musician with his sampler copies samples from another work but creates an almost entirely new work. The university, equally, makes a new work – the coursepack itself – from the collection of extracts and articles in the coursepack. The multimedia CD-ROM, with sound-clips, pictures and text would be worthless if the components were not linked in a suitable manner. How different is their use of the components from "inspiration"? In the case of "inspiration", conventional copyright analysis has it that the idea (not protected by copyright) is taken and

expressed differently. But in the case of these derived works, some of the original expression is taken and added to a new expression of new ideas.

The connectivity of the information infrastructure will encourage derived works; it takes much of the hard work out of inspiration. But the inspiration of the network is more than just the exchange of ideas; ideas are exchanged more easily and more quickly in their packaging of expression. Copyright, which protects the expression but not the idea, can be used to stifle the development of derived works, and imaginative solutions are required. In the case of sampling, the music industry in the United Kingdom moved quickly to establish a licensing scheme. This allowed the rapid development of commercial sampled dance music. There was little fear that the new product would in any way harm the commercial success of the original. On the other hand, university coursepacks are still a problem. There is a widespread perception in the world of textbook publishing that coursepacks substitute for textbooks. Various licensing proposals have been developed, but none is yet fully acceptable both to the copyright holders and to the universities. The producers of multimedia CD-ROMs face a major problem of rights clearance, and there is growing evidence that the problem of rights clearance is stifling the development of the multimedia industry.

Solutions to the problem of derived works...

The Free Software Foundation's General Public Use Licence

The Free Software Foundation is an organisation opposed to the concept of proprietary software. The Foundation developed the General Public Use Licence to encourage a model of software development in which each new user was able to add to the software and improve it. A great deal of Unix software has been developed with the General Public Use Licence by programmers working in industry and in academia. The General Public Use Licence uses copyright to force development along the lines supported by the Free Software Foundation, by imposing conditions on the use of the software. It is a condition of use of the software that if it is modified, no proprietary rights may be claimed in the modification and the modified software may only be distributed with the same conditions. The Foundation calls this concept "copyleft"; but it depends upon copyright law to work.

A major weakness of the concept is that it depends upon continuing hidden subsidies from the employers of the programmers who contribute to it. Either the programmers contribute to it in their own time, or they do so in their employer's time: either way they depend upon the salaries paid by their employers to survive.

Collective licensing

Many of the problems of derived works can be resolved by collective licensing. Copyright holders agree to certain specific uses of their material, which are not directly competing with the primary purpose of the copyright work, on blanket terms. A collecting society aggregates payments from a large number of different users.

The collective model has a long and successful history in the music business (in the licensing of the public performance of musical works, for example), and has been used to deal with the issue of reprography. Nevertheless it has several drawbacks. One is the requirement that a significant proportion of affected rightsholders must agree the need for a licensing solution to a particular problem. Rightsholders have not, for example, generally agreed that the collective solution is appropriate for dealing with university coursepacks, although they have accepted the need for a collective solution to the problem of ad-hoc photocopying.

Another problem is that few collective models are yet able to address the fact that works have differing values. Most collective licensing models presuppose a single price, regardless of merit, and sometimes a common usage volume. They tend to favour the average rather than the exceptionally-successful. The collecting societies are for the most part not-for-profit organisations operating on behalf of their rightsholders in secondary market areas which do not compete directly with the primary exploitation of the work. Some of them have developed licensing models (based on transaction-processing computer systems) which are more market-responsive than the basic blanket models. For coursepacks and for multimedia rights clearance, the collecting societies' transactional systems have great potential.

The ECMS+ approach

A range of projects have attempted to develop "Electronic Copyright Management Systems", or ECMS. Whereas only three or four years ago, such ideas were a pipe dream, the projects have demonstrated that it is possible to control individual access to material and to monitor that the use of the material in derived works. One of the consequences of ECMS is that they resolve the read/write conundrum: with ECMS, the medium remains read/write, but copying is prevented. ECMS are at or very close to commercial exploitation. Some of the ECMS models can identify material down to individual bits of data, and can carry licensing terms and conditions, as well as managing rights in a long chain from first producer to final consumer. This bit-level granularity combined with licence-chain management, which I refer to as ECMS+ is not yet at commercial implementation – and potentially generates huge storage and processing demands –

but could, at least in theory, resolve absolutely the technical problems associated with derived works.

Pride and moral rights

Nevertheless, ECMS will not solve the problem of derived works unless the copyright holders of the original work are prepared to licence the material in the first place. This can sometimes be difficult. Few artists are happy with the notion that their work may be more popular (or even "better") if it is, to their eyes, mutilated by inclusion in a derived work. To include it in the derived work may be a "derogatory treatment" of the work, compromising the original author's moral rights.

Part of the merit of the Free Software Foundation's approach is the acceptance that all computer programs are capable of improvement; when a programmer places his or her work in the General Public Licence scheme, he or she accepts that it will be tinkered with by a long succession of later users. Yet a sampled dance music record could sell many more copies than the original; and as coursepacks come to dominate the provision of educational material, publishers may find it more profitable to licence for inclusion in many coursepacks than to develop specific course textbooks. In other words, the derived work may be more profitable than the original *for the original author* as well as for the final distributor.

Copyright law incorporates moral rights – the right to object to a derogatory treatment of the work, or the right to be credited with authorship. Moral rights are explicitly granted to authors in the legislation in most European countries, and are understood to be implicit in the legislation of many other countries. It is appropriate that the works of creative people should be treated with due respect; however, moral rights do not imply the sanctity of their works.

Part of the problem is that the structure of copyright law, and of the law of moral rights, incorporates a presumption that the answer is "no". Moral rights are infringed by a treatment which is prejudicial to the honour or reputation of the author, which are subjective notions. Yet surely it should not be an infringement of moral rights, or of copyright, to be an inspiration to succeeding creative people; indeed, expressed in those terms, derivative use enhances the honour and reputation of the author. However, the fact that the rightsholder has the legal power to object tends to encourage a somewhat craven attitude towards the moral rights question by the legal advisers of those who produce derivative works.

Authors' societies have also tended to exacerbate the problem by taking a belligerent stance on moral rights in the case of derivative works. Should there be a general presumption that inclusion in a derivative work is a tribute to the author's honour and reputation, provided that when inspiration includes direct

copying a measure of financial return is included? Such return should be in proportion to the value contributed to the derived work by the original – yet this can seldom be easily determined. An arbitrary approach, as used in many current licensing schemes, will never be completely satisfactory. The solution is to devise and to implement appropriate market-based approaches. This has been discussed in a number of the ECMS projects; and its implementation requires a suitably cost-effective micro-settlement system.

Compulsory licensing

The Berne Convention places strict controls on the use of compulsory licensing, and compulsory licensing is effectively a derogation to copyright and thus a form of expropriation. Nevertheless there are arguments in favour of some forms of compulsory licensing associated with publication.

Network dissemination changes the nature of publication. In conventional publishing, the publication right (the right to issue copies to the public) is exhausted; that is to say, it can be exercised only once. Once a work is published, it stays published, but the copyright holder has the right to decide whether or not to issue copies of the work to the public in the first place. Since, with network dissemination, each act of access to the work involves an act of copying, and since the right to control copying is not exhausted, the rightsholder can decide to whom the work is to be made available even when it has been published.

There is a good case, both in terms of freedom of information and in terms of fair competition, for saying that the rightsholder should not be able to select readers of a published work. If the work is unpublished, the rightsholder can impose conditions of confidentiality on readers, but once published, it should be available to anyone who is prepared to pay the established price. The rightsholder should be free to change the price, but only to do so uniformly – that is to say, the rightsholder should not be able to discriminate between readers on the basis of price. This objective can be achieved by a statutory licence which would restrict the ability of copyright holders to act anti-competitively without being an unfair expropriation of their economic rights.

IX. CONCLUSION

Copyright's potential to empower lies in its fundamental natural justice. The combination of copyright law and the technology of the Global Information Infrastructure is exciting indeed. However, if the full potential is to be realised, several further changes are required. Perhaps most important is a resolution of the problem of derived works – ensuring that copyright clearance is easily available

and that each person who contributes to the work is appropriately rewarded. There is a balance to be struck between the interests of the various contributing parties; but the resolution is likely to be more technological than legal. Copyright law allows for them each to have appropriate rights; copyright technology (in the form of electronic copyright management systems) will allow those rights to be monitored and remunerated.

All intellectual property rights are monopoly rights and capable of abuse. Competition law and unfair contracts law must apply to transactions involving intellectual property; monopolistic abuse of an intellectual property right should be subject to the same sanctions as any other monopolistic abuse.

The application of copyright to new technology – already established in most developed countries – was confirmed at the international level at last year's WIPO diplomatic conference at Geneva. Copyright holders were on the whole disappointed by the outcome; however, the failure to incorporate the reproduction right into the new treaty on copyright may not turn out to be as disastrous as many of them predict. The very concept of a reproduction is extremely difficult in the electronic domain: if reproduction is the central right of copyright it could make reading an act restricted by copyright, on the one hand; on the other hand, it can fail to protect entirely valuable economic interests – as, for example where the provision of a pointer to a representation of a work gives the appearance of being a copy. Copyright law, driven by technology, is evolving beyond the reproduction right to a more general exploitation right encompassing both tangible reproductions and public performance. An international *sui generis* database right, along the lines of the right now established in Europe, has been postponed – but not indefinitely.

Potentially much more serious is the threat of further restrictions on encryption software. Encryption is fundamental to ECMS and in particular to the payment aspects of ECMS. The software is readily available illegitimately or semi-legitimately; yet the security services of many countries are trying to restrict its dissemination. This simply makes life harder for the law-abiding, and does nothing to impede the activities of the terrorists who already have the technology. Restrictions on current cryptographic algorithms such as RSA are already severe, and are seriously impeding the development of Internet commerce. In addition, the right to privacy is complementary to the right to free speech; no individual can be confident of his or her liberty if his or her communications are liable to interception.

NOTE

1. Fair use is a common-law defence against an action for copyright infringement, which developed in the United Kingdom and the United States in the 19th century. In the United Kingdom, the common-law defence was replaced by the statutory defence of fair dealing in the Copyright Act of 1911, but fair use remained in the United States. The US Copyright Act of 1976 made fair use a statutory defence, and specifies four factors which the courts have to take into consideration in determining whether or not a particular use is fair. In summary, these are: the purpose and character of the use; the nature of the copyrighted work; the amount and substantiality of the portion used and the economic effect of the use. Substantial caselaw, some decided at the Supreme Court, now exists; and it has, for example, been determined that off-air video recording for the purposes of time-shifting is a fair use. The cases have also concluded that the fourth factor, the economic effect, should be the predominant (but not necessarily the over riding) factor in deciding whether a particular use is fair.

   Note that fair use now applies only in the United States of America. It is a derogation from the exclusive right of the copyright owner and is permitted under the Berne Convention by virtue of Article 9.2; other signatories to the Berne Convention have other derogations.

TECHNOLOGY AND EMPLOYMENT: THE ROLE OF ORGANISATIONAL CHANGE AND LEARNING

TABLE OF CONTENTS

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I. INTRODUCTION

Causes of and remedies for the problem of technological unemployment have long been sought. Accordingly, the amount of literature, both positive and normative, produced on the subject, is massive. Unfortunately, the increase in the intensity and geographical extent of the unemployment problem that has occurred in the last two decades or so, has shown that, first, the *positive* analysis of unemployment has been largely unable to anticipate such trends, and second, its *normative* analysis has been mostly unable to provide governments with effective tools to counteract the trends.

The aim of this article is three-fold. First, to give a flavour of the major theoretical perspectives and research findings on technological unemployment. Second, to provide a coherent picture of the present unemployment situation by drawing upon a variety of theoretical and empirical studies. Third, to propose an overall policy approach along with more specific policy actions for unemployment.

II. THEORETICAL PERSPECTIVES ON TECHNOLOGY AND LABOUR DEMAND

Although the issue of whether technological change affects labour demand and, through it, unemployment levels has been debated throughout the 19th and 20th centuries, no agreement has yet been reached. A broad range of studies have approached the issue from three main perspectives:

- the "compensation" perspective;
- the "deterministic" perspective;
- the "contextualist" or "contingency" perspective.

Many classical and most neo-classical economists have adopted the "compensation" perspective. According to this perspective, disruptions in the labour market due to technological change are assumed to be short-lived, the market system being endowed with a set of compensatory mechanisms which assure the prompt re-employment of laid-off workers. The mechanisms of compensation may involve one or more of the following channels: increased demand in the

equipment producing sector; increased demand for cheaper products; increased economic activity following profit re-investment; increased labour demand due to wage reductions. The mainstay of the "compensation" perspective is that these mechanisms operate automatically, unless institutional constraints – above all, wage rigidity – exist: it follows that the only effective unemployment policy is the elimination of any kind of rigidity from the market. In reality, the "compensation" perspective rests on a whole set of either very strict or unrealistic assumptions:[1] the automatic working of the compensatory mechanisms is therefore anything but assured.[2]

Under the "deterministic" perspective, which emerged in the 1960s, technological change is seen as having an intrinsic impact on the quality of labour demand. This perspective has been adopted by economists and sociologists mainly concerned in showing how "good" or "bad" technological change is in terms of its effect on the skills of the workforce. Moving from quite opposite assumptions about the context in which technological change occurs, two major schools of thought have adopted the "deterministic" perspective. On one hand, the "de-skilling" school views management and labour as being opposed in an endless conflict and argues that managers support mechanisation and automation because they steadily degrade the workforce, making it easier to control. On the other, the "upgrading" school maintains that as new technologies are introduced, workers are freed from the most routine activities and can therefore expand their control over a larger part of the production process.[3] Unfortunately, the never-ending debate between these two schools of thought is mainly ideological, and neither has received much support from the empirical evidence.[4]

Finally, research undertaken since the late 1980s has adopted a "contextualist" or "contingency" perspective – or, as it has also been called, a "softer" form of technological determinism[5] – according to which the impact of technological change on labour demand is assumed to be crucially dependent on the organisational context in which it occurs. The evidence, especially at the micro level, shows a high degree of variability in the impact of new technologies on labour demand. This fact is interpreted in the sense that it is the interaction between the technological domain and the organisational one, and their evolution over time, which determines the impact on labour demand. The aprioristic belief in the existence of general laws or trends is replaced by a search for more circumscribed patterns in a world which remains highly variegated.

To sum up, under the "compensation" perspective the possibility of technological unemployment is acknowledged, but at the same time is supposed to be a temporary problem which will be solved by the working of automatic mechanisms. Under the "deterministic" perspective the qualitative dimension of labour demand is seen as an intrinsic requirement of technology, but the unemployment implications are not elaborated. Under the "contextualist", "contingency" or "soft deter-

minism" perspective, technological and organisational changes are seen to interact with each other along their evolution, and together produce a whole set of different impacts on labour demand – it is the analysis of this variability which bears the highest potential for a novel policy approach to technological unemployment.

III. EMPIRICAL STUDIES ON TECHNOLOGY AND LABOUR DEMAND

The empirical literature on the effects of technological change on labour demand is immense and varied. Not only do empirical studies differ in terms of their theoretical perspectives, they also vary in focus and level of analysis. A simplifying classification can be made by identifying two basic dimensions. The literature deals either with the relationship between: *i)* technological change and (un)employment; or *ii)* technological change and skills. The research strategies used are either: *i*) case-studies (of firms, industries, regions, occupations, etc.); or *ii)* aggregate analyses.

The main results from such research, which has been mostly carried out in the United States and the United Kingdom, can be stylised as follows:

- *Case studies on technological change and unemployment.* These studies generally find that technological change destroys more jobs than it creates. By their very nature, however, such studies fail to consider the indirect effects occuring outside the firm, industry, etc., under investigation (*cf.* Section VIII).[6]
- *Aggregate studies on technological change and unemployment.* Input-output analyses account for inter-industry linkages, and in theory could provide a better account of indirect effects. However, such analyses are extremely sensitive to the underlying assumptions, especially those concerning the effects of technological change on the input-output coefficients. For this reason, when employed for forecasting purposes, they often result in a set of alternative scenarios and, therefore, do not provide any clear tendency in unemployment rates.[7]
- *Case studies on technological change and skills.* These studies find a high variability in the upgrading or downgrading of skill requirements, depending on the technology and the context in which it is adopted.[8]
- *Aggregate studies on technological change and skills.* Technological change appears to have little aggregate effect on skill requirements, although a slight tendency towards upgrading is sometimes found.[9]

In conclusion, despite the large amount of empirical research, the relationship between technological change and labour demand is fraught with uncer-

tainty. This uncertainty may result from a variety of causes: data limitations, conceptual inconsistencies, and so on. It is here held that, although these and other explanations might be partly relevant, the major source of uncertainty lies in the *neglect of organisational and institutional change*. In other words, technological change appears to stand in no clear relationship to labour demand because it is the way in which technologies interact and evolve along with organisations that determines the impact on labour demand.

This is hardly an innovative perspective: Schumpeter long ago pointed out that innovations result from "new combinations", be they of a technical or organisational nature, or both. Unfortunately, his insights have been partially lost for, by and large, research has kept its focus on the technology dimension of innovation activities, to occasionally introduce the organisational dimension for *ad hoc* justifications.[10] In this chapter, organisational change is brought back to the core of the analysis, therefore adopting the above-mentioned "contingency" perspective.

IV. WHAT IS TECHNOLOGICAL UNEMPLOYMENT?

Unemployment has been split into various categories – *e.g.* technological, structural, cyclical, natural, frictional – depending on what are supposed to be its likely causes and/or its most effective remedies. Unfortunately, none of these categories is unambiguously defined. In mainstream theory, it is held that for any country at any given time a "natural rate" of unemployment can be identified; changes in the actual rate of unemployment can be defined as "cyclical" movements – that is fluctuations around the natural rate – or "structural" movements – that is, changes in the natural rate itself.[11] How can the two be discerned? As cyclical movements are caused by changes in aggregate demand, they can be indirectly inferred by looking at the inflation rate. Structural movements, on the contrary, are supposed to stand in no relation to the rate of inflation. Therefore, if an upward trend in the unemployment rate is accompanied by: *i)* a decrease in the inflation rate, we are witnessing a negative cyclical movement – that can be counteracted by an expansionary policy; *ii)* a stable rate of inflation, we are in the presence of a negative structural movement; *iii)* an increase in the inflation rate, the negative structural movement is partly offset by a positive cyclical movement – and no room is therefore left for expansionary policies.

The mainstream approach, which requires a set of very strict assumptions, comes to the conclusion that structural unemployment is essentially due to wage rigidity. Were wages perfectly flexible, any tendency towards structural unemployment would be immediately offset by a reduction in the wage rate: only unemployment due to lack of aggregate demand (cyclical) would be possible.[12] One of the

underlying assumptions is that there is *a single market for a homogeneous labour force*: labour demand and supply are expressed only in terms of total quantity. The existence of different occupational categories and jobs requiring different skills – that is, the existence of a highly segmented labour market – is simply assumed away.

Alternatively, structural unemployment has been defined as the qualitative mismatch of the demand for labour and the supply of workers.[13] Since technological change crucially affects the long-term qualitative profile of labour demand – *i.e.* occupational composition and work content – it therefore appears a prime source of structural unemployment. At the same time, technological change also affects labour demand in the short and medium term: workers are displaced by labour-saving innovations, new skills are required for managing new technologies, and innovation-induced increases in competitiveness shift workers from firm to firm. In order to deal with the multifaceted nature of technological change the following taxonomy – adopted as a working hypothesis for this article – can be proposed:

- *frictional unemployment* is mostly associated with the continuous processes of firm-level incremental innovation, and is essentially short-term in nature;
- *cyclical unemployment* arises from the diffusion of radical technological innovations within certain industries, and is essentially medium-term in nature;
- *structural unemployment* affects whole economies when a new "techno-economic paradigm" diffuses throughout the entire economic system, and is essentially long-term in nature.[14]

However, some qualifications are called for. First, although the three terms evoke well-known categories, they are here used for a practical purpose: structural, economy-wide and long-term unemployment can be used interchangeably, as can cyclical, medium-term and industry-level unemployment, and frictional, short-term and firm-level unemployment. Second, it is by no means held in this article that macroeconomic variables, and, accordingly, macroeconomic policies have no effect on unemployment. The idea is that insufficient labour demand and policies aimed at restoring it, affect not only cyclical unemployment, but all three forms of unemployment.

Third, the effects of technological change are here assumed to be essentially on the demand side of the mismatch of labour demand and supply. The labour supply is quantitatively and qualitatively determined by the interrelations among institutional factors (*e.g.* welfare policies, quality of education and training, degree of unionisation), demographic factors (*e.g.* overall growth and cohort structure of the labour force), social factors (*e.g.* female participation rates, family dimension)

and historical-geographical factors (*e.g.* availability of local labour supply). However, some hints will be made as to the impact of technological change on these factors, which are largely country-specific.

Finally, the impact of technological change on unemployment is also influenced by the intensity of international competition and the activities of multinational companies. In fact, while unemployment is surveyed on a national basis, the dynamics of the labour market also – and increasingly – depend on firms' international operations. This is particularly important once the indirect effects – *e.g.* those deriving from gains and losses in firms' competitiveness (*cf.* Section VIII) – are considered. In other words, processes of domestic adjustment have to be investigated in the context of open economies.

V. AGGREGATE CHANGES IN WORK CONTENT AND OCCUPATIONAL COMPOSITION

In the preceding section technological unemployment has been defined as the qualitative mismatch between demand for and supply of labour. In other words, a portion of the workforce is unemployed because the capacities of some workers do not match the skills demanded by firms. Techno-organisational change affects skill requirements in two ways: in the short run by altering the work content of individual jobs; in the long run by shifting the composition of jobs in the economy. Some authors convene that over the long term techno-organisational change has somewhat downgraded the work content of individual jobs, at the same time upgrading the skill level via occupational redistribution in the economy. Individual jobs have been incessantly downgraded and those at the lower-skill end have been phased out, while old and new high-skilled occupations have increased in weight. The net aggregate result of these offsetting trends is approximate stability or a small upgrading of skill requirements.[15]

Looking at the evidence on long-term occupational trends, the most striking change that occurred in all industrialised economies is *the remarkable increase in white-collar workers*: in the United States, for example, their share increased from about 20 per cent at the beginning of the century to 60 per cent today. It is worth noting that such an increase is only partially associated with the process of de-industrialisation of the economy. In the United States, the share of manufacturing employment declined slightly from one-quarter to one-fifth over the same period, and the proportion of non-production labour in manufacturing has climbed from around 18 per cent in 1920 to 32 per cent today.[16] In the more recent period, however, the process of tertiarisation of the economy has accelerated its pace: since 1970 employment has been generated almost exclusively in the service sector – typically its private segment in the United States and in the public

segment in Western Europe – thus contributing to the expansion of white-collar workers.[17] Within manufacturing, a steep absolute increase in managers, and a substantial relative increase of craft workers over total production workers has been surveyed over the same period in the United States.[18]

The evidence for changes in work content is more ambiguous. As shown in Section III, case studies on the skill impact of technological change have found mixtures of both upgrading and downgrading, while aggregate studies have overall found slightly upgrading trends. The case study evidence supports the view that the skill effects of technological change crucially depend on the organisational change that goes along with it, and may also indicate that technological change has a polarised effect on the workforce, downgrading low-skill jobs and upgrading high-skill ones.[19] Aggregate studies do not find evidence of downgrading trends because they do not keep under control the occupational composition, which, as just mentioned, is a strong upgrading factor.

Overall, the hypothesis of a simultaneous downgrading through shifts in work content and upgrading through occupational composition, resulting in an approximate stability of skill requirements at the aggregate level seems plausible. However, if skill requirements are more or less invariant over time, how can they be a source of unemployment? This question leads directly to the debate around the concept of skill and its measurement, which will be discussed in the next section.

VI. THE SKILL MEASUREMENT ISSUE AND THE "SKILL LIFE CYCLE"

Three main strategies can be adopted in measuring the skills of the workforce: non-measurement, indirect measurement and direct measurement strategies. The *non-measurement strategy* simply assumes that skill levels are accurately captured by occupational groupings – blue-collar, white-collar, managers, etc. The *indirect measurement strategy* uses variables such as wage rates or years of schooling as indicators of skill levels. Finally, the *direct measurement strategy* relies on empirical operations and/or explicit protocols for the designation of skill levels; direct measures can be obtained by means of *expert ratings* and *self-report ratings*.[20]

Economic research on the levels and changes of skills has been carried out mainly adopting the non-measurement and indirect measurement strategies. For example, the conclusion that occupational redistribution has been historically associated with an upgrading of skills (*cf.* Section V) derives from the assumption that white-collar workers are more skilled than blue-collar workers, *i.e.* it implies a non-measurement strategy. It is indirect measurement strategies, however, which take the lion's share of mainstream economic research on skills. It is worth noting that unemployment policy implications are a direct derivation of the chosen mea-

surement strategy. As unemployment consists of the low-skill end of the workforce, and skill, wage and educational attainment levels are broadly equivalent, it cannot but follow that wage flexibility should be increased – in order to employ low-skill workers in the short run – and education and training should be promoted across-the-board – in order to increase the skill profile of the workforce in the long run.[21]

However, this set of assumptions does not stand confrontation with the evidence. First, low-wage jobs are not the only jobs threatened by unemployment, upper-level clerical and lower-level managerial personnel have also been made redundant.[22] Second, the labels "white-collar" and "blue-collar", or differences in levels of educational attainment, reveal little about the actual skill requirements of jobs.[23] Moreover, the strongest critique to the first two research strategies and their underlying assumptions comes from research undertaken using the direct measurement strategy. Its major premise is that skill is a multidimensional variable and that, as such, cannot be measured in terms of "high" and "low".[24]

The direct measurement strategy is very suitable for micro case studies. However, sources such as the *Dictionary of Occupational Titles (DOT)* – an expert rating of the US workforce whose fourth edition (1977) contains measures of over 40 variables for over 12 000 jobs – have enabled researchers to undertake aggregate analyses. Unfortunately, there is not much agreement upon how many and which dimensions to consider. Several taxonomies have been proposed, *e.g.* cognitive, interactive and motor skills;[25] or basic academic, social and higher order skills.[26] One of the most commonly used taxonomies identifies two broad skill categories: *substantive complexity* and *autonomy-control*.[27] Substantive complexity pertains to the degree of interaction between "data, people and things" characterising a job. Autonomy-control pertains to the degree of choice available within a job.[28]

The evidence shows that at the aggregate level substantive complexity has on average increased because of occupational shifts, while autonomy-control has on average decreased because of changes in work content.[29] In other words, growing occupations are those which require more ability in combining the various components of a task, while workers are losing room for action in carrying out such tasks. Although this picture may sound similar to that drawn in Section V, there is one crucial difference: once the existence of at least two skill dimensions is acknowledged, diverging trends for each dimension can no longer offset each other, and technological unemployment becomes a theoretical possibility. Part of the workforce may be unemployed because it fails to meet the technology-induced requirements for substantive complexity.

Apart from long-term trends, it appears that skill requirements follow a cyclical path which is closely associated with phases in technology development.[30] According to this "skill life cycle" interpretation, in the early development stages

technologies require a new set of skills – broader or narrower depending on the novelty of the technology – on the part of the engineers and technicians directly involved with the process. As technologies mature, tasks become increasingly standardized and are gradually transferred to operatives with more routine skills. In the earlier phases a demand for new skills emerges, but rigidity on the supply side may give rise to situations characterised by both "skill shortages" and unemployment. In the later phases, the decrease in demand for new skills, and the adjustment on the supply side, bring the labour market closer to equilibrium.

This interpretation provides an interesting insight which calls for further elaboration. The "skill life cycle" is essentially correct in assuming that the introductory phase of a technology is characterised by skill shortages and unemployment: the reason is that organisations are rigid, and a mismatch between the new technology and an incompatible organisation is likely to occur. On the contrary, what happens to labour demand after the introductory phases depends on the following set of factors:

- the degree of usability of a technology;
- the nature of the technology impact;
- the organisational adjustment accompanying technological development.

These factors will be respectively discussed in the following three sections.

VII. TECHNOLOGY DESIGN, USABILITY AND COMMUNICATION

Technologies are usually seen as applications of scientific knowledge to the production process characterised by little or no flexibility, which force both organisational structures and workers' skills to adapt accordingly. Recent studies have shown, on the contrary, that technologies are not intrinsically rigid, and that the way technologies are implemented in the workplace is partly determined by social pressures and preconceptions – labour management conflictuality, the "idiot proofing" myth, etc. – and occasionally by the availability of key skills, thus giving rise to inverse causation.[31] Hence, many aspects commonly attributed to technology are not so much inherent to it, but are the outcome of technology design.[32] And skill requirements can be somewhat controlled if technologies are *designed for usability*.[33]

The issue of technology "user-friendliness" is increasingly raised, particularly in relation to information technology.[34] Still, "user-friendliness" is a more limited concept than usability, as it usually refers to the time needed for users to learn how to routinely use a certain technology. Efforts to improve the "user-friendliness" of a technology can be undertaken at any moment during its development. The concept of usability goes much further: it means providing users not

only with a swift acquaintance with the new technology, but also with the capability to apply it in unexpected situations.[35] For efforts in ensuring the usability of a technology to be effective, they have to be undertaken at the very beginning of the design process.

The importance of design for usability is confirmed by the rapid increase in maintenance and repair tasks often associated with the introduction and early development of a new technology in the workplace.[36] If the new technology has been designed with a high degree of usability, operators will quickly develop the diagnostic skills needed to deal with the breakdowns that inevitably occur. Otherwise, such breakdowns will hinder the implementation process, and most of the blame will be put on the unwillingness or inability of workers. Furthermore, a poorly designed technology will require excessive resources to be devoted to its *exploitation*, leaving little room for the *exploration* of new possibilities, thus jeopardising the long-term survival of the system.[37]

Usability also means designing a technology in such a way as to facilitate communication flows within and beyond the system in which it is introduced.[38] Contrary to what is commonly believed, social skills – co-operation, working in groups, peer training and, above all, oral communication skills – are becoming increasingly important, while academic and learning skills are required only at a very basic level of mastery.[39] Workers do not operate in isolation, but rather participate in interpersonal networks that generate, retain and transmit knowledge.[40] Technology design is therefore crucial. Poor design inhibits informal interaction among workers, at the same time requiring more advanced specialist skills. Design for usability, on the contrary, facilitates interpersonal communication among less "knowledgeable", but more "socialised", workers. Poor design produces traditional "high division of labour" systems where knowledge resides in each worker, and learning pertains to each of them individually. Design for usability produces "low division of labour" systems where knowledge resides in interpersonal networks and learning pertains to the whole system – the so-called "learning organisation".

VIII. SPECIFIC ASPECTS OF TECHNOLOGICAL CHANGE

So far "technological change" has been used in a very generic way. For present purposes, it is useful to briefly discuss the following related topics: the difference between various categories of technological change; the different implications of technological innovation and diffusion; the indirect effects of technological change.

First, the following taxonomy of technological change has been proposed. *Incremental innovations* take place in a continuous, almost imperceptible fashion

within practically every firm: pieces of equipment are replaced, software is updated, products are slightly modified. *Radical innovations* are more discontinuous events in the history of a firm, associated with the launching of new products and/or the adoption of novel production processes. Finally, *changes in the "techno-economic paradigm"* occur roughly twice in a century when the appearance of a new pervasive technology – general purpose engines like the electric dynamo or the computer – provides the basis for entire new sets of products and services and for completely new patterns of production.[41]

Second, too often the discussion around technological change is focused on the innovation phase, to the detriment of the *diffusion* phase. In fact, what matters in terms of the impact of technological change on economic variables – and, for present purposes, on skill requirements – is not so much the first time new technologies are introduced, as the extent and the speed of diffusion of new technologies among potential adopters. Independently of the level of analysis, several studies have found that the median experience masks a very wide variation in the degree of technology adoptions, skill requirements and employment effects.[42] Information on technological innovation and its average impact needs to be complemented by information about the *extent* of technology diffusion and the degree of variability in its impact.

The *speed* of diffusion largely depends on the responsiveness of the industrial structure to disparities in firms' competitiveness; that is to say, on how rapidly firms' competitive advantages (disadvantages) translate into gains (losses) in market shares.[43] In highly responsive markets, the technological leader quickly gains market shares and/or forces other firms to quickly adopt the new technology, with the converging result that the new technology rapidly diffuses throughout the industry and creates a sudden and substantial demand for new skills.[44] In less responsive markets, on the contrary, market structure is more rigid and the diffusion process is much slower, thus reducing the demand for new skills.

Finally, Section II's criticism of the compensation mechanisms was limited to their being presumedly automatic: compensation mechanisms do exist, but empirical research often fails to fully consider their indirect effects. As the focus of compensation mechanisms is usually on macro-variables, it is worth emphasizing the role of a major category of indirect effects of technological change that operate at the micro level: indirect effects following *shifts in firms' competitiveness*. For example, lay-offs associated with the introduction of a labour-saving technology could be offset by subsequent hiring due to increased technology-induced competitiveness. Actually, educated guesses have suggested that this sort of indirect effect may eventually go much of the way to offsetting the negative direct effects.[45] This may not always be the case; the point here is that conclusions based on analysis overlooking the indirect effects of technological change can be strongly misleading.

The importance of indirect effects can hardly be overestimated. As regards technological diffusion, for example, while a slow process of diffusion is likely to put less strain on the labour market of a country, it also undermines the degree of firms' competitiveness within that country, and hence *indirectly* creates unemployment. Slowing down the process of technological diffusion, therefore, does not appear to be a viable policy because of its substantial indirect effects.

IX. ORGANISATIONAL CHANGE AND LEARNING

It has so far been argued that the labour demand impact of technologies depends on how they have been designed, their stage of development, their nature, degree of diffusion and indirect effects. However, technologies do not exist and evolve in a vacuum, but in the context of quite complex organisational structures: the co-evolution of technologies and the organisations in which they are embedded has a crucial influence on the demand for labour. To use an analogy, one may think of the technology base of any system as its "potential", and its organisational structure as the "degree of exploitation" of such potential: together they determine the demand for labour.[46] Once a new technology is introduced, the potential increases, but its exploitation is conditional to the development of an "appropriate" organisational structure.

Assuming that technologies and organisations can take on only two states, "unchanging" and "changing", four hypothetical situations are obtained:

- *Unchanging technology, unchanging organisation.* The system being in a steady situation, no techno-organisational mismatch can arise. Still, the competitiveness of such a system *vis-à-vis* its competitors is doomed to decrease, and negative indirect effects on labour demand will appear.
- *Changing technology, unchanging organisation.* This is the typical case of techno-organisational mismatch, as the adoption of a new technology increases the "potential" of the system, but the lack of organisational evolution hinders the "exploitation" of such potential. This situation is quite common at the phase of introduction of a new technology, and, as the "skill life cycle" approach predicts, this phase is normally characterised by skill shortages/under-utilisation – and unemployment through negative indirect effects.
- *Changing technology, changing organisation.* If the organisational adjustment is compatible with the new technology adopted in the system, the increased potential is fully exploited, and, as in the later phases of the "skill life cycle", demand for new skills is low and positive indirect effects increase the level of employment. It is however possible that the organisational adjustment is not compatible with the new technology adopted: in

this case skill shortages/under-utilisation and unemployment will also be likely to persist.

- *Unchanging technology, changing organisation.* Organisational change may also occur independently of changes in technology. This is the case when attempts are made to increase the degree of exploitation of a given technological potential, and again the effects on labour demand depend on the effectiveness of the organisational adjustments implemented.

Needless to say, this is an extreme characterisation with severe limitations, especially with respect to the unrealistic "two-state" hypothesis. Still, it emphasizes the fact that the co-evolution of technologies and the organisations in which they are embedded are a necessary but not sufficient condition for avoiding mismatches between labour demand and supply.

Organisational change is commonly understood and investigated as an "intra-firm" event. Among the most recent trends surveyed in firms' organisational change are: *downsizing* (reducing numbers on the payroll to reduce overhead expenses); *reengineering* (focusing on the redesign of business processes using information technology to make possible "breakthrough" improvements in performance and costs); increased integration among different functional areas; increased central office functions and elimination of decentralised sub-offices; greater reliance on *numerical flexibility* (temporary and part-time work, overtime, flexible working hours, etc.); greater reliance on *functional flexibility* (job rotation, multi-skilling, total quality management, etc.).[47] Overall, these trends point to leaner, more flexible and less hierarchical organisational structures.

But organisational change may go well beyond firms' boundaries. At the core of the lean production system, for example, lies a completely new approach to subcontractor relationships: subcontractors are organised into various layers and are much more involved in product innovation.[48] Inter-firm collaboration in R&D, production and marketing is increasingly common.[49] The trend towards inter-industry externalisation and intra-industry subcontracting is creating new opportunities for small firms and the self-employed.[50]

Finally, organisational change also includes what is commonly known as *institutional change,* that is a reshaping of the socio-institutional fabric of which a modern economy is made. Management styles, labour-management relationships, infrastructural networks, market structures, the educational system: all these and other aspects can be involved in a process of institutional change, and be completely transformed by it. A good example of the substantial modifications associated with institutional change is provided by the long-term changes in work content and occupational composition reviewed above (Section V). The recent increase in co-operation between firms and institutions such as universities and public research centres also reflects institutional change.

Together, these recent trends in organisational change delineate the following picture: most firms, the largest ones in particular, are concentrating their resources on their core activities and knowledge base, at the same time extending their reach by developing wide and well-structured networks of external relationships. It is here maintained that organisational change is the way systems *learn*, and that the three forms of organisational change identified – intra-firm, inter-firm and institutional change – correspond to three major forms of *learning*.

First, organisational change limited within the boundaries of a firm corresponds to *incremental learning*, based on learning-by-doing and revising existing routines.[51] Incremental learning is therefore obtained by allowing workers to continuously improve their on-the-job skills. For example, the diffusion of job rotation and multi-skilling practices and the increased integration among different functional areas clearly facilitate incremental learning.

Second, organisational change which goes beyond the firm's boundaries corresponds to *second-order learning*, based on the creation of completely new routines.[52] Second-order learning cannot be obtained by simple learning-by-doing, since it requires knowledge which is not within the reach of the firm's knowledge base. Networks of external relationships provide in this case the opportunity to get in touch with other sources of knowledge and possibly to learn how to shape new routines. If a parallel is drawn between the increased integration *within* firms typical of incremental learning, and the increased co-operation *between* firms characterising second-order learning, the latter case may also be viewed as a form of *industry-wide learning*.

Third, organisational change which involves whole societies corresponds to *institutional learning*, based on the emergence of entirely new sets of skills and occupations. Institutional learning can best be obtained by the co-operation of all actors in a society: firms operating in different industries, education and training institutions, trade unions, etc. Continuing the parallel mentioned above, this case may also be called *economy-wide learning*. To sum up, incremental, second-order and institutional learning roughly correspond to learning processes occurring at the firm-, industry- and economy-wide levels, respectively.

X. THE OVERALL PICTURE

It is now time to try and see if the working hypotheses laid out in Section IV and the evidence and arguments presented in Sections V to IX bring about a coherent picture of technological unemployment from which policy implications can be drawn.

In carrying out their everyday activities, firms are constantly and almost imperceptibly introducing technological innovations of an incremental nature. If

firms accompany such innovations with some organisational adjustments, such as increasing the level of internal flexibility and horizontal communication, the direct effects of such changes are roughly negligible: workers can adjust their on-the-job skills through learning-by-doing and revising their routines (incremental learning). However, some firms may fail to undertake such adjustments, with the result that they will lose in relative competitiveness. This gives rise to indirect effects on labour demand: "losers" may be forced to lay off part of the workforce, whereas "winners" may need extra workers. *Frictional unemployment* may arise because some time is needed before the expelled workers are re-employed. The frictional unemployment problem is sometimes hampered by geographical mismatches between labour demand and supply (*i.e.* "winners" and "losers" are located in different regions).

In addition to incremental innovations, firms can be involved in processes of radical, discontinuous innovation, as when new production processes are adopted or completely new families of products are launched. The direct effects associated with the introduction of radical innovations can be quite dramatic: the technological leap will be reflected in the requirement for new skills to manage its adoption and solve the breakdowns that inevitably occur (early phases of the skill life cycle), and a consistent part of the workforce can be made redundant in the case of labour-saving innovations. As the technology matures (later phases of the skill life cycle), the intensity of the direct effects will come to depend on a host of factors. *Ceteris paribus*, the mismatch between labour demand and supply is more severe if the new technology has been poorly designed and diffuses at a very high pace throughout the industry concerned.

The crucial aspect, however, is organisational change. If the radical innovation is accompanied by a compatible organisational change, its potential can be fully exploited, and the strain on labour demand relaxed. And for the organisational change to be compatible, the cross-fertilization of different knowledge bases and organisational routines occurring within networks of external relationships (second-order or industry-level learning) is usually required. If, on the contrary, organisations fail to undergo such adjustments, the demand for new and complex skills will substantially rise, and the compensation mechanisms will fail to produce sufficiently large indirect effects. In conclusion, whenever the negative effects on labour demand associated with the introduction of radical innovations will not be offset in the subsequent phases of technology development, *cyclical unemployment* will appear.

Finally, the historical evidence shows that every 50 to 60 years a new pervasive technology appears, which provides the opportunity and threat of upsetting well-established production patterns throughout the entire economic system, and of creating whole new families of products and services. The impact of these so-called changes in the "techno-economic paradigm" on labour demand at the firm

level is quite similar to that discussed above for radical innovations. However, as the new techno-economic paradigm diffuses economy-wide with large differences across industries and locations, severe mismatches between labour demand and supply may arise.

Again, the degree of mismatch will be the lower the better the design of the new technology, the lower the pace of diffusion, and the more compatible the accompanying organisational change. In this case, the compatibility of the organisational adjustment to the new technology is obtained if the different institutions in society are willing to question their internal organisational structures and rules and to interact with each other in the search for new solutions (institutional learning). Failing this process of adjustment, the system will undergo a period of crisis; the increased demand for new skills and the lack of positive indirect effects will determine *structural unemployment*.

In sum, the picture presented here suggests that processes of learning via organisational change can relax the strain that technological change puts on labour demand. In other words, technological innovations need to be "learned" by the system in which they are implemented: and in some cases learning can occur at different levels. Only incremental innovations seem to be associated with a learning process which mostly impinges upon workers' skills, with little alternative to it. On the contrary, radical innovations and changes in techno-economic paradigms provide an alternative: either very demanding learning requirements can be placed on workers; or learning can take place at the organisational level, as a reshaping of roles and routines made possible by an intensification of both internal and external relationships. In the former case, skill shortages and medium- to long-term unemployment are the likely outcome; in the latter case, most of the strain of the new technology is absorbed at the organisational level, and requirements for workers may be limited to higher communication and interaction skills.

Unfortunately, organisational change is characterised by inertia, and the process of adjustment cannot be pushed beyond certain limits.[53] In addition, the continuous increase in international competition does not leave any room for policies aimed at slowing down the process of diffusion of new technologies, as the indirect effects of such policies would be detrimental. That is to say, on the one hand there is the need to develop and diffuse new technologies as quickly as possible, and on the other there is an intrinsic limit to the rate of organisational adjustment: the result is an unavoidable minimum degree of mismatch, and therefore part of the unemployment problem appears to be inherent to the working of modern economies. However, beyond such minimum degree of mismatch there is still much room for policy action.

Before turning to the policy implications, however, some features of the information and communication technology will be presented in the next section.

The diffusion of these technologies, in effect, seems to play a major role in the current high unemployment situation.

XI. INFORMATION AND COMMUNICATION TECHNOLOGY AND STRUCTURAL UNEMPLOYMENT

The commercial introduction of the computer in the mid-1950s can be considered as the outset of the present "techno-economic paradigm". Actually, the computer is a general purpose engine that can be applied in a wide variety of specific processes, and as such has been the basis for reshaping the production process in many industries and for the creation of a range of new products, services and entire industries.[54] However, the development of the computer has been accompanied by a host of radical innovations in the field of microelectronics, fibre optics, software engineering and communications technologies which have converged into what is now called *Information and Communication Technology (ICT)*.[55]

In the last four decades ICT has spread throughout entire economies, but, contrary to expectations, its impact on variables such as productivity and employment has been quite disappointing – a situation expressed by popular terms like "the productivity paradox". While many partial explanations have already been proposed, it is here held that a major explanation can be derived from the picture outlined in the preceding section. That is, the lack of substantial positive effects of ICT, and the emergence and persistence of structural unemployment in particular, depend on the incomplete process of institutional adjustment that has accompanied the diffusion of ICT.

The early phases of ICT had very significant implications for the skills of those who were directly involved with it – electronic engineers, technicians and programmers – since they had to deal with entirely new concepts, languages and operational principles.[56] During the later and still ongoing phase of diffusion, ICT has found applications in a variety of fields, and its severe impact on skills has come to affect an increasing number of users. This is confirmed by numerous case studies on ICT applications: lack of people with the necessary skills – microelectronics expertise in particular – is a major constraint on companies.[57] At the same time, the adoption of ICT has offered the potential for savings in any production input, and therefore is often associated with workforce reduction, especially in financial services and network services.[58] In sum, the degree of mismatch between labour demand and supply has anything but decreased during the diffusion of ICT.

It has been argued that the labour mismatch is a common feature of the early phases of introduction of a new technology. And that organisational inertia, espe-

cially at the economy-wide level, makes institutional learning quite a lengthy process. Similar patterns have been found in the diffusion of other pervasive technologies like the electric dynamo and the internal combustion engine.[59] However, with some speculation it is here suggested that three interacting factors may have played a significant role in producing and maintaining a high rate of unemployment in many industrialised countries during the last two decades.

The first factor is the poor design of ICT in terms of usability. An emblematic case is given by the operative system needed to run a computer: *DOS*, a poorly designed system, has gained the lion's share of the market since the early 1980s, while *Macintosh*, a much better designed system, has been kept at the periphery of the market. By the late 1980s *DOS* was so diffused that being at least acquainted with it became a more or less explicit requirement for many clerical positions. In the meantime, *Microsoft* (the *DOS* producer) undertook an effort to obviate the problems arising from the poor design of *DOS* by imitating the characteristics of *Macintosh*, and this effort culminated with the launching of *Windows*. However, *Windows* does not replace *DOS*, rather it is an interface between *DOS* and the computer user: it imitates the *Macintosh* "environment", but is still rooted on the poorly designed *DOS*. As a result, a well-designed technology which was available in the early 1980s has reached widespread diffusion in a mediated form with a ten-year delay. And the imitation is still negatively affected by its poorly designed basic structure: the 1994 best-seller business software contained a program specifically devised to ease the removal of old or unnecessary software from *Windows*.[60] The point here is that, had the *Macintosh* operative system reached a wider diffusion, skill requirements for clerical occupations would have been much lower; accordingly, time and energies could have been shifted away from understanding how to exploit a poorly designed system towards exploring the new possibilities of a better designed one.

The second factor is the very fast pace at which ICT is diffusing. Actually, a self-reinforcing process between ICT adoption and competition on international markets has been at work. Having to face an increasing degree of domestic and foreign competition, many firms have invested heavily in ICT. The investment has been accompanied by a reorganisation of their physical layout, as ICT allowed the central co-ordination of geographically decentralised units. And this in turn has increased the degree of competition even further, and so on. For example, ICT has substantially augmented the international tradeability of many service activities in which competition was traditionally of a domestic nature.[61] In short, an unprecedented intensification of world-wide competition has been coupled with an elevated pace of ICT diffusion. However, because of the low degree of ICT usability discussed above, a rapid upsurge in new and ever-changing skill requirements has followed in most industralised economies, which has not been adequately matched by a parallel change in the quality of labour supply.

The third factor is a lack of compatibility between organisational adjustment and the introduction of ICT. It has been observed that ICT has a two-fold potential in the workplace, it can "automate" or "informate" tasks. The way in which organisations are reshaped during the adoption of ICT largely depends on the relative emphasis placed by management on these capacities.[62] The "automate" option is reminiscent of the "de-skilling" view, according to which management introduces new technologies to increase its control over labour. Analogously, emphasis on the capacity to "informate" is the theme dear to the "upgrading" school, for which the adoption of new technologies enables workers to expand their knowledge of the production process and to operate for its improvement (*cf.* Section II).[63] Impressionistically, it has been said that ICT would act as an "overseer" of the workforce in the former case, as its "surrogate" in the latter.[64]

Although the conclusion cannot be supported by the evidence, it seems likely that the relative emphasis has so far been given more to the "automate" option. This conclusion does not necessarily require a "conflictualistic" image of the management-labour relationship; given the urgency of ICT adoption because of intense competitive pressures, and the lack of usability in its design, ICT has often been introduced into organisations that were shaped independently of it. At first, ICT was mostly perceived by management as a technology that, like many others, was creating the opportunity for improving productivity. Only much later, after having realised that the expected effects were missing, has management become increasingly concerned by organisational adjustment, as is shown by recent trends towards "reengineering" (*cf.* Section IX). This also explains why recent case studies have found that communication skills are becoming increasingly important (*cf.* Section VII).

Reengineering operations have the potential to shift the balance away from the "automate" option towards the "informate" one. When this happens, organisations become true learning institutions: knowledge resides in the network of internal and external relationships, instead of in each individual, and learning stems from the continuous reshaping of such a network, rather than from the constant renewal of workers' skills.[65] Anticipating an argument that will be discussed in the following section, the implications for education and training are crucial. The impression that educational institutions have so far largely failed to provide workers with the required skills is a symptom of insufficient institutional adjustment. But the reform of such institutions has also been complicated by the constant modifications of skill requirements. If learning organisations became a widespread reality, a clear mandate for education and training institutions would be a general improvement of social skills.[66]

XII. A "PROMOTION OF LEARNING" APPROACH FOR UNEMPLOYMENT POLICY

In this chapter it has been argued that the mismatch between labour demand and supply arises from the incompatibility of organisational change to technological change; that organisational change is essentially a process of learning; and that some specific aspects of technologies (degree of usability, pace of diffusion, etc.) can hamper such a learning process. This process is required at different levels: incremental innovations require incremental learning, which mostly occurs within individual firms; radical innovations require second-order learning, which transcends firms' boundaries and affects entire industries; changes in the techno-economic paradigm require institutional learning, which impinges upon the whole social and institutional structure of an economy. It has also been suggested that the lack of these forms of learning can roughly be associated with frictional, cyclical and structural unemployment, respectively.

Organisational change can thus assume the role of "shock absorber": if it does assume such a role, the full technological potential will be exploited; otherwise, the shock will be passed on to labour demand and mismatch problems will arise. The stronger the shock, the wider the extent of the organisational network that has to adjust and, hence, learn. In the preceding section it has been claimed that ICT is a pervasive technology whose diffusion is producing the shift to a new techno-economic paradigm, and is thus calling for adjustment at the widest level possible, the whole socio-institutional system. Policy implications will therefore be mostly focused on the ICT "shock".

At a very general level, there is the need for governments to assume a more *proactive* stance on the unemployment issue. This requires that governments first acknowledge the emergence of the ICT paradigm and its dramatic socio-institutional impact, and then promote institutional adjustment. Unfortunately, being themselves institutions, governmental departments suffer from organisational inertia and tend to act in a reactive fashion: too many policies are still based on obsolete views of the world rather than on the emerging one.[67] But once they realise the advent of the ICT paradigm, governments will have to redirect their policies, adopting a new overall approach which may be called *Promotion of Learning (PoL)*. Some policy directions informed by the PoL approach are given below.

Education and training policies. The ubiquity of the "skill shortage" problem seems to unequivocally indicate the need for improving higher education, especially in technical fields, and continuous training. It is worth stressing, however, that while skill shortages usually characterise the introductory phase of a new technology, their persistence during the phases of technology development – such as those ICT is currently going through – is quite atypical. Other sources of

skill shortages have been identified in this article, namely the low degree of ICT usability, the high pace of ICT diffusion, and the incompatibility between organisational change and ICT. It has also been noted that many firms have recently undertaken "reengineering" operations: if these operations succeed, the workplace will be "informated" rather than "automated" by ICT, and the firms undertaking them will become learning institutions. And learning institutions require an abundance of basic social skills such as communications skills.

In the light of this argument, policy implications for education and training are no longer straightforward. In the short term there is no doubt that improved technical skills would benefit the productive system. In the medium to long term, however, skill requirements will crucially depend on the outcome of these "reengineering" processes. If they succeed, they will decrease the need for technical skills while increasing the demand for social skills. In this case, a reform of the educational system aimed at raising the provision of technical skills would be useless in the short term – because the educational system is characterised by a high degree of inertia – and counterproductive in the long term – because surpluses of highly educated workers may arise.[68]

It is therefore preferable that governments try to satisfy the most immediate needs by adjusting the more flexible training system – for example by promoting continuous on-the-job training – and deal with the long-term trends by assuming the proactive stance mentioned above. That is to say, rather than simply trying to predict future patterns of skill requirements, governments should try to steer such patterns in the light of an overall PoL approach, and immediately start a reform of the educational system aimed at raising the provision of basic social and communication skills.

Labour market policy. Increased *wage flexibility* may lower unemployment levels. The direct effect of lower wages is an immediate reduction in incentives to expel and disincentives to hire workers; still, their long-term indirect effect (via competitiveness) could be an increase in unemployment. That is to say, the decrease in frictional unemployment obtained by higher wage flexibility could be more than offset by an increase in structural unemployment.

On the contrary, the PoL approach appears to support both *numerical flexibility* – part-time work, flexible working hours, etc. – and *functional flexibility* – job rotation, multi-skilling, total quality management, etc. These procedures have a higher potential to increase competitiveness and activate those compensatory mechanisms leading to a reduction in structural unemployment.

Technology policy. Two themes related to technology have recurred in this chapter and have to be discussed for their policy implications: *design for usability* and *technology diffusion*. The poor design of ICT in terms of usability has been indicated as an important factor in maintaining high skill requirements. Unfortu-

nately, this issue has not yet entered the policy debate; a policy area where design for usability should emerge is *standards setting.* It is increasingly recognised that technological standards are a precondition for learning:[69] the degree of usability of a new technology may be adopted as a criterion for choosing which technology is worth promoting out of a group of alternatives. In the case of ICT, the system could have already "locked in" to poorly designed standards; nevertheless, the sudden and spontaneous "explosion" of information networks such as the *Internet* may provide a window of opportunity to reopen the competition among operative systems.

The high pace of ICT diffusion has also been mentioned among the causes of mismatch between labour demand and supply. It is worth recalling, however, the dual effect of technology diffusion. In the immediate, it puts a lot of strain on the labour market since it raises the demand for new skills and lowers the demand for older ones. In the medium to long term, technology diffusion is a prime determinant of the competitiveness of firms, industries and whole economies; insufficient technology diffusion therefore gives rise to negative indirect effects leading to structural unemployment. In conclusion, ICT diffusion has to be endorsed without reservation, while its short-term negative effects can be minimised by other facets of the PoL approach, such as the promotion of on-the-job training, "reengineering", etc.

Industry policy. The PoL approach identifies at least three fields for intervention. First, the process of *structural adjustment* should be facilitated. Industries and services such as information technology, education and training, personal services, entertainment and health care are increasing their weight in most industrialised economies, and governments should avoid the temptation to go to the rescue of those industries that are correspondingly shrinking.[70] The faster a country shifts its structure towards high-demand industries, the higher its competitiveness in perspective, the less it will suffer from structural unemployment.

Second, *co-operation*, both inter-firm and between firms and other institutions, should be promoted. It has been argued above, in fact, that networks of external relationships are an essential source of learning, both for individual firms (second-order learning) and for the economy as a whole (institutional learning). To give a practical example, anti-trust authorities should take this learning perspective into account when assessing the effects of inter-firm alliances.

Third, the creation of an adequate *information infrastructure* should be fostered. The information infrastructure is the *sine qua non* of the ICT paradigm, and the success of the PoL approach largely depends on it. At present many options are still open as regards its funding and technical characteristics: the information infrastructure may be funded by governments or by private companies; it may be based on standard cable, fibre optics, or satellite technologies. Or it may result from a combination of all of these. What really matters is that a *wide*, *cheap* and

usable information infrastructure is laid out.[71] If this happens, the information infrastructure will become the physical support of a learning society.

Macroeconomic policy. Fiscal policies and monetary policies can also be informed by the PoL approach. *Fiscal policy* can be reshaped, on the expenditure side, by giving more weight to the public investment component, especially investment related to ICT; the above-mentioned need for an information infrastructure is a good case in point. On the revenue side, tax reductions or exemptions could be granted to new start-ups and self-employed individuals which are finding novel opportunities in the processes of externalisation and subcontracting of large companies.

As regards *monetary policy*, more attention should be devoted to the investment disincentive impact of high interest rates. Again, this is particularly important for small firms and the self-employed, as their access to credit is normally more restricted and/or more expensive. Overall, macroeconomic policy can contribute to the reduction of unemployment by facilitating entrepreneurship and supporting the growth of small firms.

Some concluding remarks can be made. First, since labour demand, labour supply and technology adoption show high regional and local variability, policies should always leave room for *local and regional adaptation*. Second, government should support *good industrial relationships* and *labour-management co-operation*, as the tendency to use ICT to "informate" rather than "automate" the workplace would be thus strengthened. Finally, the PoL approach – and the proactive stance on the unemployment issue – would be effective only if a high degree of *inter-policy co-ordination* could be reached and maintained.

NOTES

1. The hypotheses on which the "compensation" perspective rests are: *i)* technological change is associated exclusively with the introduction of new equipment; *ii)* production creates its own demand, in both product markets and the single labour market; *iii)* markets are in perfect competition; *iv)* the temporal and spatial dimensions are neglected.

2. "... we may draw the important conclusion that the structural dynamics of the economic system inevitably tend to generate what has rightly been called *technological* unemployment. At the same time, the very same structural dynamics produce counterbalancing movements which are capable of bringing macroeconomic conditions towards fulfilment, *but not automatically*. There is nothing in the structural evolution of technical coefficients on the one side and of per-capita demand on the other, as such, that will ensure fulfilment of macroeconomic conditions, *i.e.* the maintenance of full employment. Therefore, if full employment is to be kept through time, it will have to be actively pursued as an explicit aim of economic policy."(Pasinetti, 1981, p. 90).

3. While some authors share the view that both "de-skilling" and "upgrading" schools are technologically deterministic (*cf.* Attewell, 1992), others assert that only the "upgrading" school is such (*cf.* Vallas, 1990).

4. "Compared with the putative wisdom of upgrading and downgrading traditions, the collective evidence from aggregate studies shows no dominant trend in the twentieth century and suggests evolutionary not revolutionary rates of change. In summary, the dominant feature of aggregate study evidence is uncertainty..." (Spenner, 1988, p. 147).

5. Adler (1992).

6. Cyert and Mowery (1987).

7. *Ibid.*

8. Spenner (1988).

9. *Ibid.*

10. An indication of such research bias is given by the flourishing empirical research on patents. Although under a set of assumptions and restrictions patents can be considered as an indicator of firm-level technological change, they do not stand in any relation to organisational change. Organisational change has been by and large dropped from the research agenda on innovation.

11. Krugman (1994).

12. In its more radical forms, mainstream theory contends that, since the commodity market is also always cleared, not even cyclical unemployment would be possible. This way, keynesian-type expansionary policies are ruled out as well.
13. Katsoulacos (1986*b*).
14. "... The rather fundamental nature of the paradigm change means that... for a considerable period there is a 'mismatch' problem with respect both to skills and management styles and with respect to capital stock. These mismatch problems give rise to major problems of structural unemployment and adjustment..." (Freeman and Soete, 1987, pp. 68-9).
15. Rumberger (1987), Spenner (1988), Howell and Wolff (1992).
16. Attewell (1992).
17. OTA (1986), OECD (1994).
18. Attewell (1992).
19. Milkman and Pullman (1991).
20. Spenner (1990).
21. Berman *et al.* (1994) go even so far as to assume that distinctions like production *vs.* non-production, more-educated *vs.* less-educated, and high-skill *vs.* low-skill occupations are essentially one and the same thing.
22. Ginzberg *et al.* (1986), Howell and Wolff (1992), Peitchinis (1983).
23. Howell and Wolff (1992), Rumberger (1987). Zuboff (1988) argues that the very distinction between white- and blue-collar workers is being blurred by the diffusion of information technology in the workplace, and that the organisational skill base is becoming more homogeneous.
24. Spenner (1990).
25. Howell and Wolff (1992).
26. Rumberger *et al.* (1994).
27. Spenner (1990).
28. "... Substantive complexity refers to the level, scope, and integration of mental, manipulative, and interpersonal tasks in a job (...) Autonomy-control refers to the discretion or leeway available in a job to control the content, manner, and speed with which tasks are done. We must carefully distinguish autonomy-control from formal authority. Authority refers to between-role differences in legitimated power; autonomy-control refers to the discretion and leeway within a role." (Spenner, 1990, p. 402.)
29. Spenner (1988).
30. Flynn (1988), OECD (1991), Peitchinis (1983), Rumberger (1987).
31. Campbell *et al.* (1990), Campbell and Warner (1992), Cornfield (1987), Cyert and Mowery (1987), Darrah (1994).
32. Zuboff (1988).
33. Adler and Winograd (1992).
34. Binkin (1988), Cyert and Mowery (1987), Freeman and Soete (1994), Rumberger (1987), *The New York Times* (1995).
35. "... The key criterion of a system's usability is the extent to which it supports the potential for people who work with it to understand it, to learn, and to make changes.

Design for usability must include design for coping with novelty, design for improvisation, and design for adaptation." (Adler and Winograd, 1992, p. 7).

36. Flynn (1988), Freeman and Soete (1994), OECD (1991).
37. March (1991).
38. "... The technology itself, even when it is not intended as a communications product, serves as a communication medium between user and user and between designer and user (...) When our perspective shifts from viewing users as mechanistic "human components" to viewing them as dialogue partners, the key design criteria shift to those of communicativeness..." (Adler and Winograd, 1992, pp. 7-8).
39. Rumberger *et al.* (1994).
40. Darrah (1994).
41. Freeman and Perez (1988). Actually, one of the categories identified by these authors – changes of "technology system" – has been omitted here.
42. Grayson (1993), Littek and Heisig (1991), Howell and Wolff (1992), Northcott (1993), OECD (1989, 1991), Podgursky (1998), Spenner (1988).
43. Market responsiveness in turn depends on factors of various nature, like the existence of anti-trust laws (institutional factor), capacity constraints (supply-side factor), and the time necessary for consumers to learn about new products (demand-side factor).
44. For the sake of brevity it is here assumed that the technology leader is also the most competitive firm. Actually, as argued below, technologies have to be matched by compatible organisational structures to be effective.
45. Christie *et al.* (1990).
46. "... Technology defines a range of possibilities; other social and economic processes take over from there... managerial discretion adds uncertainty to the relationship between technological changes and skill transformations..." (Spenner, 1988, pp. 162-163).
47. Conti and Warner (1994), Cressey and Scott (1992), Cyert and Mowery (1987), Freeman and Soete (1994), Ginzberg *et al.* (1986), Lynch and Osterman (1989), OECD (1991), Rajan and Hayday (1988), Zuboff (1988).
48. Womack *et al.* (1990).
49. Cyert and Mowery (1987), Freeman and Soete (1994).
50. Cyert and Mowery (1987), Fierman (1994), Rajan and Hayday (1988).
51. "... 'Incremental learning', whereby organisational knowledge is increased by performing or refining existing routines within a stable context that attaches the same set of meanings both to old and new routines..." (Ciborra and Schneider, 1992, p. 272).
52. "... 'Second-order learning', whereby the context of meaning is changed. Old routines lose their original significance and acquire a completely new meaning, and routines previously ignored, suppressed, or unimagined are put into place and executed..." (Ciborra and Schneider, 1992, p. 272).
53. As regards adjustment in consumption patterns, for example, Pasinetti observes: "... when it happens – as is periodically bound to happen – that a sudden jump is required in the rate of consumers' learning, in order to keep up with technological discoveries, there is no reason to expect an immediate response (...) Difficulties do arise because periodic *accelerations* of this process of learning are required. More specifically, the maintenance of full employment requires a speeding up periodically in

the rate at which technical improvements are, so to speak, to be digested... "(Pasinetti, 1981, p. 242-243).

54. David (1990).
55. Freeman and Soete (1987).
56. Peitchinis (1983).
57. Campbell and Warner (1992), Christie *et al.* (1990), Flynn (1988), OECD (1989).
58. Christie *et al.* (1990), Cressey and Scott (1992), OTA (1986).
59. David (1990), Freeman and Perez (1988).
60. "... why is one of the biggest hits in the business... a humble, no-frills program that gets rid of software? Because computers are still so hard to use that dumping a program you no longer want or need can take hours, if you can figure out how to do it (...) The fact that such a program is even necessary, much less a runaway success, speaks volumes... about one of the personal computer industry's greatest weaknesses (...) the industry has succeeded in getting PCs into 31 per cent of American homes, but it is still far from a consumer-friendly business." (*The New York Times*, 1995, C1-8).
61. Freeman and Soete (1994).
62. Zuboff (1988).
63. However, the following discussion shows that upgrading will be limited to communication skills.
64. Peitchinis (1983).
65. "The informated organisation is a learning institution, and one of its principal purposes is the expansion of knowledge – not knowledge for its own sake (as in academic pursuit), but knowledge that comes to reside at the core of what it means to be productive (...) Learning is not something that requires time out from being engaged in productive activity; learning is the heart of productive activity. To put it simply, learning is the new form of labor."(Zuboff, 1988, p. 395).
66. "... the need for communication [is heightened]. Interpretive processes depend upon creating and sharing meaning through inquiry and dialogue. New sources of personal influence are associated with the ability to learn and to engender learning in others, in contrast to an earlier emphasis upon contractual relationships or the authority derived from function and position."(*Ibid.*, p. 400).
67. For example, some governments are still extremely concerned by the health of the motor vehicles industry, assumed to be a reliable indicator of the economic health of their countries.
68. Flynn (1988).
69. Adler and Winograd (1992).
70. Freeman and Soete (1994).
71. For example, *Internet* is an information infrastructure which largely satisfies the requirements mentioned in the text. In addition, it has the advantage of having spread spontaneously, and therefore its shows an inherent propensity to "informate" rather than "automate".

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UNIVERSAL SERVICE AND PUBLIC ACCESS IN THE INFORMATION SOCIETY

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I. INTRODUCTION

Background

The concept of "universal service" is based on the premise that telecommunication services now play such a fundamental role in commercial and social life that everyone, whoever or wherever they are, should have access to a basic level of telecommunication facilities and service if they are to participate fully in modern society.[1] The objectives stemming from this concept of universal service have been a fundamental commitment in many countries. In general terms, the so-called "Universal Service Obligations" (USOs) emerging from these objectives have constituted a requirement that public telecommunication operators provide basic voice telephone service to all who request it at a uniform and affordable price even though there may be significant differences in the costs of supply. The provision of uneconomic telephony services subject to universal service obligations has generally been through cross-subsidisation, usually through relatively high long-distance charges and low charges for local access and use.

Perhaps the clearest way to further explain the concept of universal service in telecommunications is to describe its practical requirements. In a number of countries universal service obligations require a telecommunication operator to:

- meet all reasonable demands for basic telephone service, including rural and remote areas;
- provide public payphone boxes in specified numbers, geographical distribution and serviceability;
- prohibit the use of prices (or other terms and conditions) which discriminate against certain groups, including people in rural areas;
- provide special (*e.g.* residential low-user) schemes which recognise the problems of low-income customers;
- provide free directory information services for blind and disabled people;
- provide free public emergency call services;
- provide priority fault repair services for long-term sick and disabled people;
- provide text relay services for deaf people;
- provide special telephones for the hearing-impaired;
- provide facilities for hearing-impaired people in public call boxes.

The above universal service requirements pertain to a basic voice grade service (although the telecommunication line supplied has also enabled low-grade access to facsimile, e-mail and Internet services). In recent years, however, there have been questions raised about whether such a "plain old telephone service" (POTS)-based definition of universal service is still adequate.[2] Telecommunication suppliers are now increasingly privately owned and operate in markets which are increasingly competitive, technologically dynamic and "converging". What is the appropriate nature and scope of USOs in such markets?

Objectives of the article

The aim of this article is to help in clarifying issues involved in considering the question of what, if any, extension to the coverage of universal service is warranted. In particular, the article seeks to identify criteria which can assist systematic assessment of appropriate "universal service" and "public access" requirements in an age of increasing competition, technological change, convergence and a rapidly developing information society. While universal service refers to the provision of service to individual households, "public access" points are designed to provide access kiosks to those without individual access, rather like public access to a public payphone instead of an individual subscribership.

This study occurs at a time of considerable optimism about the capacity of new communication services to deliver social and economic benefits. The broad challenge to policy makers is the task of developing policies to ensure not only that these potential benefits materialise and are maximised, but that they are spread equitably.

A few countries have recently examined, or are examining, whether the level of universal service should be extended beyond voice telephony to cover new and advanced services. What guidance can be gleaned from these efforts for other countries yet to do so? A related question is the guidance that can be developed to assist consideration of appropriate USOs and public access mechanisms in the context of converging communication markets. This question has been underlined by expectations of an increasing need to access new services and networks as a result of the development of the so-called "Information Society". As penetration of these new advanced services increases and on-line services become increasingly commonplace in everyday life, lack of access will be a serious disadvantage, reinforcing the divide between the information "haves" and "have-nots". This disadvantage is expected to become critically important when the normal way of accessing everyday services is by electronic means. Such concerns have spawned arguments that the universal service mechanism should be expanded to ensure a safety net of "public access" facilities to the new services and networks of the Information Society.

The structure of the article

Following this introduction, Section II discusses factors that are driving the reconsideration of USOs. These factors include: *i)* increasing competition; *ii)* increasing privatisation of telecommunication supply; *iii)* the impact of new technology; *iv)* the impact of technological convergence; *v)* regulatory convergence; and *vi)* the developing networked Information Society. Section III identifies and applies a decision-making process for systematically assessing candidates for USO status. The general conclusion reached is that few, if any, of the new services would meet the test for USO status on the basis of these traditional criteria. But, as Section IV recognises, the objectives behind concerns over access to the Information Society are economic as well as social and are clearly far broader than those underlying the concern for universal service in telecommunication supply. Accordingly wider criteria need to be identified and a different process applied when it is these broader concerns that are to be addressed. Finally, Section V presents the article's conclusions and recommendations.

II. FACTORS DRIVING A RECONSIDERATION OF UNIVERSAL SERVICE COVERAGE

The impact of competition

Preservation of universal service was a major reason for resistance to competition in many countries. It was feared that competition may erode the ability of the incumbent monopoly to cross-subsidise loss-making areas/services, could threaten the sustainability of universal service policies. But there is now mounting evidence that universal service objectives can – particularly when complemented with appropriate regulatory safeguards – be sustained in a competitive environment. An OECD study[3] concluded that the effects of competition on universal service can be systematically examined in terms of impacts on several factors, as set out below in Box 1.

Although Box 1 indicates that in general, the effects of competition on universal service have been favourable, affordability continues to be a significant concern in some countries and evidently a major reason why some who want access to a household telephone do not have it. In Australia, for example, as Table 1 indicates, new service connection cost and repeated connection charges incurred by highly mobile people are still a major affordability issue.

While for many people telephone charges have fallen, there remains a concern for those who make few long-distance and international calls and have thus benefited least from the falling prices of these services. While the significant price

Box 1. **Impacts of competition and regulation on universal service**

1. *Penetration rates* have increased significantly; competition resulting from market liberalisation has allowed entry of operators delivering new cost-effective technology (mobiles, wireless in the local loop) with competitive pressures stimulating the incumbent to accelerate roll-out of new technologies and innovations; a range of different service packages – a number of which are attractive to households with limited incomes – have been made commercially available to customers; this increase in choice and diversity of supply is one of the key ways in which universal service is being achieved.
2. *Connection charges* have fallen in some cases through lower cost connection enabled by competition-driven new technology (*e.g.* wireless) thus facilitating universal service (*e.g.* in rural and remote areas).
3. *Telecommunication call prices*: telephone charges for many have fallen through lower international and long-distance call prices although there have been increases in rental and local call prices as a result of price "rebalancing"; telephone bills for lower income and low-user subscribers have been contained through "price cap" regulation and innovative USO mandated schemes allowing subscribers more control over bills through call barring facilities, etc.
4. *Rental charges*: price increases here can be restricted (as demonstrated by the UK's "RPI + 2%" price cap).
5. *Deposit requirements*: flexible payment systems to accommodate the needs of lower income subscribers have emerged in several countries.
6. *Access by the disabled to telephone use*: a multitude of schemes have emerged, often volunteered by telecommunication operators (since a good "public citizenship" image can provide a useful competitive margin).
7. *Availability and serviceability of public payphones* has improved; in some countries new market entrants with new technology are demonstrating that the supply of public payphones in some areas can be profitable.
8. *Quality of service* has improved since quality of service is an important aspect of competitive strategy; quality improvement for low-profit customers can be mandated by regulation.

rebalancing which is occurring in some countries is expected to be only a short-term occurrence necessitated by the need to move to more competitive cost-based tariffs,[4] this has sharpened the focus on the criterion of "affordability" in sustaining connection to the telephone service because of the level of usage charges[5] rather than by the cost of connection. In some cases the cost of

Table 1. **Reasons for not having a telephone at home**

Responses	Number of households without a telephone	%
Expensive to connect	76 000	32.1
Expensive to operate	16 000	6.8
Expensive to connect and operate	23 000	9.5
Don't need one	53 000	22.2
Waiting for connection	18 000	7.7
Living in short-term accommodation	12 000	4.9
Other	40 000	16.8
Australia	**238 000**	**100.0**

Source: AUSTEL, *Telecommunications Universal Service – Measures of its Delivery in Australia*, November 1996, p. 12.

uncontrolled access to long-distance and new services (*e.g.* by children) was partly the cause. Some countries have responded to this concern by requiring, as a USO, the provision of the facility to bar unauthorised calls. The concern over affordability has led an increasing number of countries to impose price cap regulation with sub-caps for some individual services. Countries have used a range of different price cap formulae indicating that the scheme can be tailored to influence the nature, extent and speed of price "rebalancing" according to conditions in each country.[6]

Competitive neutrality

The recognition that competition is delivering substantial benefits has strengthened the resolve of an increasing number of countries to continue lowering barriers to market liberalisation so as to ensure effective competition.[7] It is recognised that appropriate reforms to universal service requirements and delivery can remove an important barrier to competition. Indeed, the European Union's recent universal service guidelines require Member States to ensure that a universal service scheme does not distort the pattern of market entry and that one operator is not unduly favoured over others.[8]

But in an era of increasing competition, technological change and convergence, the need for competitive neutrality extends much further. It concerns not only neutrality among telecommunication operators but between telecommunication and other communication suppliers and, indeed, between communication operators and those in other industries. The principle of competitive neutrality would also insist on the need to apply the principle of regulatory symmetry – at

least as a strategic long-run objective. Again symmetry should apply not only to competing telecommunication operators but also between competing communication suppliers. In this longer-term perspective, communication operators should be treated like other businesses with the same privileges and responsibilities (including those connected with serving the disadvantaged and selected institutions such as schools and public libraries). While this is a strategic longer-term perspective, it is important that policies applied in the shorter term should have this principle in mind, so that as far as possible, policy reform (including that for universal service) moves not against, but in the direction of such regulatory symmetry.

Quality of service

Although improved technology and competition has resulted in enhanced quality of service in many areas,[9] there is concern that it has not improved as much in less profitable areas. There have been arguments that an obligation should be placed upon carriers to provide service at particular standards of quality in these less profitable areas. Care should be exercised, however, to ensure that any such quality of service regulation does not rule out trade-offs between price, quality of service and market positioning.

The aged and disabled

Another important traditional function of the USO for telecommunication service has been to ensure that the aged and people with disabilities are not disadvantaged in their access to basic telecommunication services. While the emergence of new and converging information technologies will present many opportunities for people with a disability, there could also be significant difficulties. For instance, interactive video communication (*e.g.* through video-conferencing) offers the chance for real-time communication for deaf people who use a sign language. However, for some, problems with accessing basic telephony services could be amplified with the increasing necessity to use computers to communicate, access information and transact business (*e.g.* make payments) in the networked society. While responsibility for addressing such problems is now recognised under Equal Opportunity and Disability Discrimination Acts in an increasing number of countries,[10] there should be continuing vigilance that this vulnerable group is not forgotten. Where such Acts exist, an important task is to ensure that their objectives are effectively pursued by all telecommunication carriers and major equipment manufacturers. The broad range of special schemes already in place to assist the disabled to access telecommunications, either introduced voluntarily by operators or mandated by USO requirements, provides some reassurance in this regard.

The increasing privatisation of telecommunication supply

In short, with the increasing privatisation of telecommunication suppliers questions have been raised about whether traditional USOs, supplied by government-owned monopolies, are still relevant and appropriate? Are there compelling reasons why privately-owned operators should continue to provide and bear the costs of USOs, let alone be required to extend the range of USOs provided?

New technology

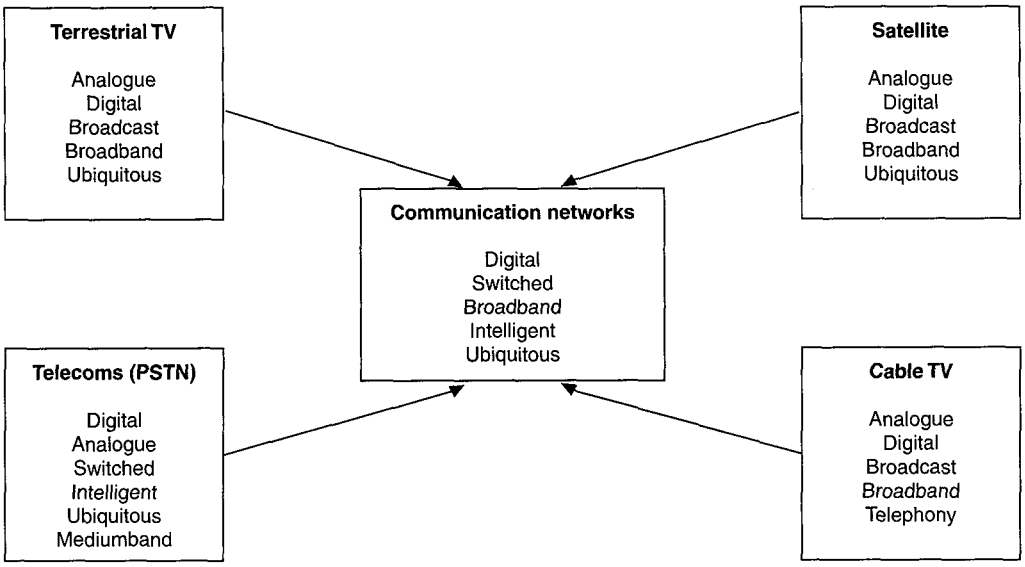
As noted earlier, the technologically dynamic telecommunication industry is providing cost-effective solutions to the delivery of universal service, for instance, in remote and rural areas. Moreover, the prospect of an increasing combination of traditional and new services (including audio-visual and information services) is rewriting the economics of service provision and network deployment, both to residential and business users wherever they are located. With the prospect of such unparalleled technological change continuing, the means of delivering USOs must remain flexible and open to change. In short, governments and regulators are in no position to pick technological "winners". The need for technological neutrality that this demands cautions against the definition of universal service on the basis of access to particular network resources or in terms of specific technical specifications since this could bias investment decisions and may negatively impact on fledgling technologies which have future promise.[11] This is particularly important in an era of converging technologies.

Technological convergence

The process of profound change with convergence between different technological platforms is resulting in services that were once distinct being offered over various infrastructures such that service boundaries are becoming increasingly blurred. Figure 1 illustrates aspects of the convergence process. This convergence is blurring the lines between media[12] with a single means – be it wires, cables or airwaves – able to carry service that in the past were provided by separate ways. Conversely, a service that was provided in the past by any one medium – be it broadcasting, the press or telephony – can now be provided in several ways. As a result, artificial barriers between communication markets are falling as firms discover new economies of scale, scope and interoperability.

A good example of a technology which manifests the "convergence of modes" is the Internet. In the past, broadcasting has been characterised as point-to-multipoint transmission of information by electronic means. Traditional exam-

Figure 1. **Convergence of communication networks**



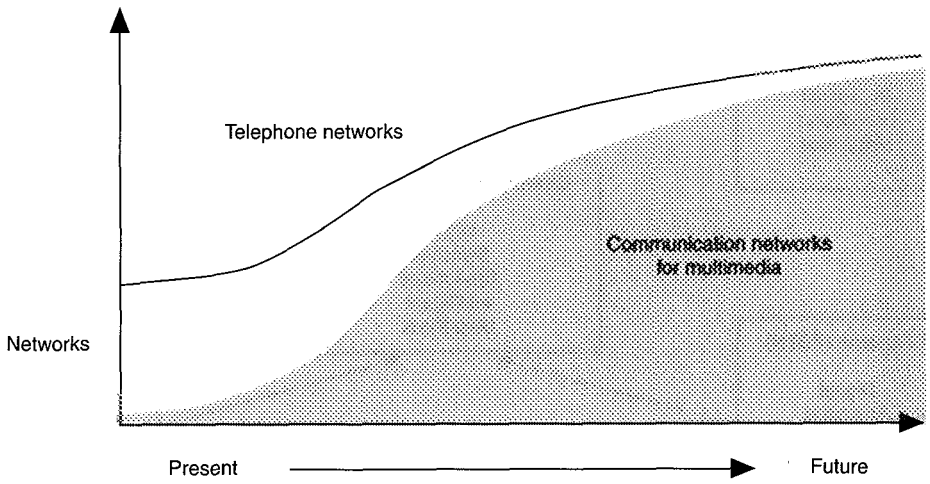
Source: Author.

ples include the broadcast of television and radio services from terrestrial towers, as well as via satellites and cable television networks. More recently new services have emerged that use the Internet to broadcast news and information. These Internet-based services challenge the traditional concept of broadcasting as point-to-point transmission since they may derive information from multiple sources and can be customised to meet the demands of individual users.

In addition to, or instead of, the telephone and cable television networks, various access technologies are likely to be used to provide access to households. For example, there is likely to be a significant expansion of wireless access services in the near future. Indeed, an increasing number of people already have mobile phones; they will be joined by others using satellite broadcast and two-way satellite services, low-power portable communicators for voice, data and paging, and other wireless technologies which can provide both mobile and fixed-location connections. The rapid diffusion of digital inter-active television receivers to give practical access to converged services is also being accelerated as prices tumble.

The sort of access or terminal does not matter since it is the possibility of access to services that is important. It is increasingly recognised that as many possibilities as feasible should be left open so as to allow consumer demand, innovation and creativity in the market to decide the future.[13] Figure 2 illustrates

Figure 2. **Telephone networks and multimedia networks**



Source: Japanese Ministry of Posts and Telecommunications, *Final Report of Study Group for Research into Universal Services and Rates in the Multimedia Age,* May 1996, p. 16.

how these technological developments will impact on access possibilities. These considerations advocate that the concept of universal service be adapted to reflect the shift from service-specific networks to that of multiple alternative networks, each capable of delivering an ever broader range of services. In other words, a universal service seems more appropriately specified in terms of access to a given bandwidth rather than a specific service or technology.

Regulatory convergence

In the new environment of rapid convergence, policy that focuses on content, sometimes called "information policy", and policy that focuses on delivery, sometimes called "telecommunication policy", will become intertwined. The, already unfolding, seamless web of telecommunication technologies will make insistence on distinguishing between channel and content artificial and unrealistic. As such technological and regulatory convergence proceeds, the criteria which have influenced broadcasting policy are likely to become increasingly relevant to those of telecommunications.

Some public broadcasting service providers have a universal service mandate similar to that in telecommunications in terms of a responsibility for ensuring

that their signal can be accessed throughout a country. But broadcasting policy often goes beyond this since it tends to be more politically sensitive than telecommunications because of the relationship with media and cultural policies and possible impact on social goals.[14] Thus the responsibility of broadcasting regulators frequently includes audio-visual policy, network (carriage) regulation, frequency allocation and content regulation with its concerns over national culture.

In other words, it is likely that the universal service concept will be increasingly influenced by concerns about *content* as well as by infrastructure. Universal service obligations for infrastructure suppliers (*e.g.* digital capacity, ISDN technology telecommunication) may be extended to include the provision of capacity to access non-telephony content. Indeed, as discussed later, this is already occurring in regard to the call for subsidised high-grade Internet access for schools and public libraries.

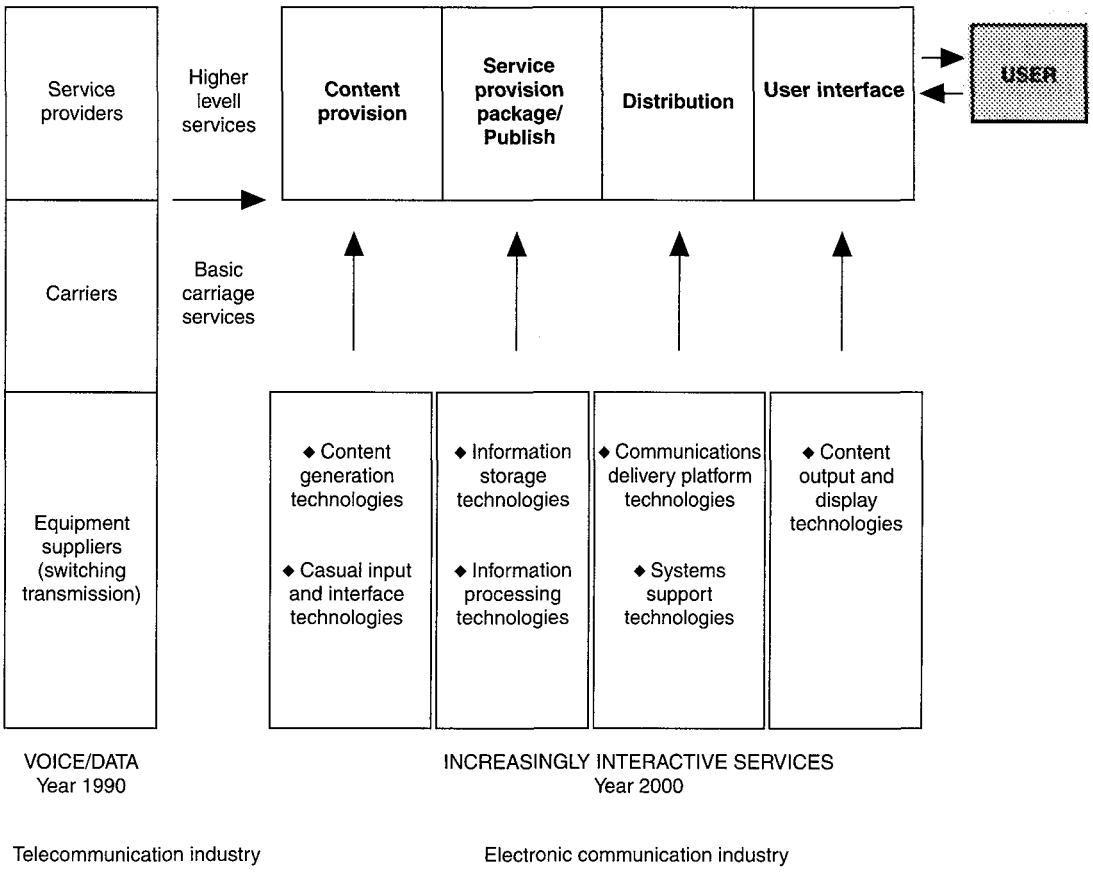
These factors will increase pressure for expanding the concept of universal service beyond the "plain old telephone service" to encompass new communication capabilities. There is thus the likelihood that communication operators will not – as the principle of regulatory symmetry requires they should – be treated like other businesses, with the same privileges and responsibilities (including those connected with serving schools and the disadvantaged). While this concern about regulatory symmetry stems from a strategic longer-term perspective, it is important that policies applied in the shorter term should bear this principle firmly in mind so that as far as possible, policy reform moves not against but in this direction.

The developing information society

As the information society develops and more and more elements of the economy, such as education, health care, entertainment, information and services in general, become linked to networks, there are concerns that disadvantaged sections of the community are not excluded or left behind by being unable to gain "access" to these networks. But "access" is a complex issue. Figure 3 illustrates how the question of access becomes more complicated as the electronic communication industry develops. To facilitate "any-to-any" access, the concept of a USO would need to be relevant for access across the various sectors of the communication industry, *i.e.* print media, broadcasting and telecommunications. Should a consideration of access to "standard communication services" therefore need to look more broadly across the range of media and delivery channels in a "communications" context (as opposed to a focus on broadcasting or telecommunications individually)?

The concerns over such access to the electronic communication industry have a distinctly economic as well as social dimension, often expressed along the

Figure 3. **The changing structure of the communications industry**



Source : Centre for International Research on Communication and Information Technologies (CIRCIT), *Promoting Competition in the Converging Information and Communications Industries : Will the Australian Model Deliver?* August 1996.

lines that the new communication products and systems are vital to the ability of a country to remain internationally competitive in a global market-place and to create challenging, well-paid jobs. These concerns have led to arguments that the USO mechanism should be extended to recognise the needs of a networked information society. Indeed, some governments have already begun to take action. For instance, the US 1996 Telecommunications Act, in mandating universal service as a explicit aim, goes beyond basic telecommunication services to identify the provision of access to advanced telecommunication services for schools, health care and libraries as one of the principles for the "advancement of universal service". We return to this issue in Section IV.

III. A SYSTEMATIC APPROACH TO REDEFINING THE SCOPE OF UNIVERSAL SERVICE

Proposed approaches for assessing whether a service warrants USO status

Section II discussed various factors driving governments to consider whether the USO concept should be extended to cover access to a range of new telecommunication services. This section addresses the task of identifying a systematic procedure for assessing claims for USO status. To commence this task, a survey to identify various approaches thus far proposed, was conducted. It is pertinent to note that in this section, the criteria applied in the proposed approaches are largely ones underlying the traditional USO concept. Section IV extends the focus by recognising that these traditional USO criteria could be expanded to acknowledge the broader social, economic and political objectives motivating government involvement in facilitating access and participation in the networked Information Society.

A survey of various proposed approaches for assessing USO status

The Australian Bureau of Transport and Communications Economics[15] (BTCE) provided an early attempt to specify a systematic approach to assessing a service's eligibility for USO status. It suggested a five-step framework for considering possible contenders for inclusion in an upgraded USO which includes being able to:

i) adequately identify and define the product;
ii) determine that the product is sufficiently "essential" to justify the major policy interventions associated with a USO designation;
iii) determine that costs are reasonable relative to benefits;
iv) find a practical and effective implementation mechanism; and
v) work through any likely significant effects on other policy goals.

The BTCE suggests that if it is difficult to carry out any of these steps for a particular product, the case for endowing the product with USO status is diminished.

In the United States, the 1996 US Telecommunications Act[16] requires that in considering whether a telecommunication service should be included in the definition of universal service, consideration has to be given to the extent to which the service:

i) is essential to education, public health or public safety;
ii) has, through the operation of market choices by customers, been subscribed to by a substantial majority of residential customers;

iii) is being deployed in telecommunication networks by telecommunication carriers; and
iv) is consistent with the public interest, convenience and necessity.

In the European Union, it was concluded that any extension of the concept of universal service must be determined principally by user demand and technological evolution. Any extension should be based on a market-based analysis of the demand for, and widespread availability of, a particular service, and a political assessment of its social and economic desirability. The EC considers that only when these two criteria are satisfied, would it be justifiable to impose a legal obligation to guarantee that the service is universally available at an affordable price.

In Canada, a government report[17] which addressed ways of accelerating the rate at which Canadians move on to the Information Highway placed the primary role on market forces. The report recommended, however, that where market forces fail to provide a minimum level of access, the government step in to ensure affordable access to essential services for all Canadians, "regardless of their income or geographic location".

In the United Kingdom, OFTEL[18] proposed an approach similar to that of the BTCE for reviewing USOs, suggesting that the review mechanism include consideration of the extent to which:

i) the service is necessary to allow individuals a full and fair opportunity for economic and social participation in the United Kingdom;
ii) most customers in that customer class already use the service;
iii) the overall benefits of adding the service to the universal service definition justify the costs involved; and
iv) any changes are necessary to reflect the development of regulation under new legislation.

OFTEL proposed that the basic definition of universal service be reviewed periodically to ensure that a service be mandated a USO if the level of service reaches a point at which "unacceptable social and economic disadvantage is placed on customers lacking access to those services".

It is notable that BT agreed that the criteria for incorporation in the universal service obligation should be:

- widespread use in society; and
- clear signs that significant groups are excluded or at serious risk of being excluded from access to these services because of market imperfections.

The Australian Review Group into the Standard Telephone Service[19] drew on the framework proposed by the Australian Bureau of Transport and Communica-

tions Economics to adopt a decision-making process which includes the following key elements:

- assessment of whether the services under consideration are of "social importance";
- determination of the extent to which they will be made available by the market;
- assessment of the costs of intervention through a USO mechanism to ensure the wide availability of the socially important services which would not otherwise be reasonably accessible; and
- whether the benefits of intervention compare favourably against the costs, having regard to the distribution of benefits and costs, and the effects on other policy goals.

The Australian Review Group advocated that intervention should only occur where the benefits outweigh the costs. Moreover, it should not occur where an expansion of USO coverage would substantially increase the overall level of USO expenditure.

A systematic decision-making procedure

Drawing on the common elements of the above proposed approaches, a systematic decision-making procedure should contain, as a starting point, at least the key dimensions set out in Box 2.

Emphasis on market demand

The emphasis on market demand reflects, in part, a need for the USO reform agenda to be based on a clear market-expressed indication of preference and value. This is critical because of the pace and unpredictable direction of technological change and demand, and the costs of inaccurately anticipating them. As noted earlier, neither policy makers nor industry are in a position to reliably predict the implications of technological progress and commercial innovations over the coming years.[20] Therefore, in considering whether to widen the definition of universal service, thereby mandating the widespread provision of a particular service, decisions should not be taken prematurely and care should be taken not to bias investment decisions. For instance, requiring a universal upgrade of customer access lines (*e.g.* to digital capability) could have the effect of limiting competition in rural and remote areas. New market entrants could be discouraged if they had to compete against a USO provider with mandated high capability offering services significantly below costs. While such an outcome may have short-run advantages, it could produce adverse long-run outcomes such as a

Box 2. **A systematic decision-making procedure for considering USO status**

A systematic decision-making process for considering a claim for USO status should include:

- Assessment of whether the service under consideration for USO status is an essential service of significant "social importance".
- Assessment of the degree of expected market penetration of the service.
- Determination of the nature and extent to which the service will not be made available by the market and why.
- Assessment of the social and economic disadvantages incurred by those without access if there is no government intervention in this expected market situation.
- Assessment of the costs of intervention through the use of the USO mechanism.
- Assessment of the costs of intervention through the USO mechanism compared against the use of other approaches to establish that it is superior.
- Establishment that the benefits of intervention through the USO mechanism exceed the costs of doing so, taking into account the incidence of such benefits and costs (especially those on unsubsidised telecommunication customers); and of effects on other communication and broader policy objectives. Intervention should only occur where overall benefits persuasively outweigh overall costs and where a substantial increase in the level of USO expenditure would not result.

reduction in innovation and investment in new technology. Any extension of universal service if unnecessary or premature:

i) may provide or subsidise services which many users may be able to pay for on a normal commercial basis;
ii) will cause other customers to pay for services they neither need nor use; and
iii) may deter market entry due to the costs involved for market participants.

Wherever possible, therefore, the market mechanism should be allowed to play the primary role. The role of policy and regulatory frameworks would be to strengthen market competition since this will result in lower prices and an accelerated market diffusion of services.

Telecommunication operators have supported this market-focused principle. For instance, BT has argued that wherever possible the market mechanism should be allowed to play the primary role.[21] BT argues that applying USO status to a new service before it meets the market test would mean: *i)* assuming that the market would fail; *ii)* guessing what the market and services will be; *iii)* denying

some players the opportunity to offer commercial services by placing obligations on others; and *iv)* imposing a considerable cost on consumers.

Arguments for an upgrade of the USO on behalf of uneconomic subscribers should be constrained by the need not to impose an unreasonable cost penalty on other (economic) subscribers. Moreover, any expansion of the definition of the standard service within a USO concept should avoid giving rise to unnecessary and damaging operator (and investor) uncertainty about the future scope of universal service and the potential costs this will imply.

Concepts of "need" and "market demand"

Public debate on USOs sometimes appears to confuse concepts of "need", "expectations" and "demand". In this context, the Australian Bureau of Transport and Communications Economics proposed an analytical process to help explain consideration of demand-side issues.[22] The aim of the BTCE framework, depicted in Figure 4, was to establish whether there is unmet demand which is infrastructure-related. The Bureau argued that only in cases where the market is expected to result in socially unacceptable unmet demand does the issue of policy intervention through a USO mechanism arise. That is, only when a particular service is widespread and commonly used will its mandated availability to the residual unconnected as a USO become an issue on equity grounds.

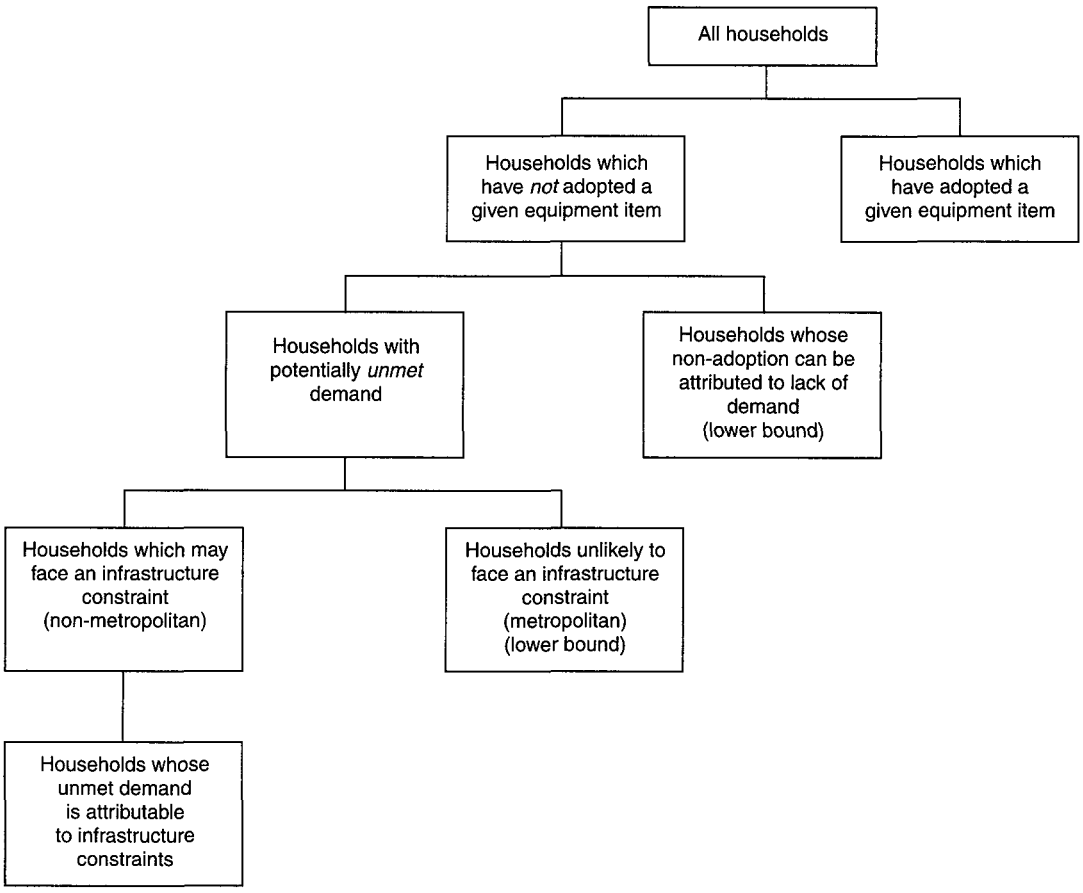
Can a "threshold" level of market penetration be prescribed?

The extent to which services are taken up by unsubsidised subscribers is seen by some to offer a useful indicator, or "trigger", for when such services should become candidates for USO status.

In considering the appropriate threshold penetration rate, the BTCE suggested that a 50 per cent take-up seemed reasonable. The UK Institute for Public Policy Research suggests, however, that the service should be accessible to 70 per cent of subscribers with at least 50 per cent of eligible users having taken up the service.[23] What this difference of views illustrates is that the threshold level is a debatable, probably arbitrary, factor. While such efforts to inject *objective indicators* for assessing USO status are to be encouraged, recommendations about the current and likely penetration figures should not necessarily determine the question of "social importance".

A *subjective assessment* of the importance of a particular service in meeting social needs is also important.[24] This requires a judgement about a number of issues, including whether a wide availability of the service provides benefits not only to the individuals who are most likely to make use of them, but also for the community at large. And whether there are significant social costs if the service is

Figure 4. **Analytical framework for assessing infrastructure-related unmet demand for data services**



Source: Australian Department of Communications and the Arts, *Report of the Standard Telephone Service Review Group,* December 1996.

not made widely available, in particular whether access to this type of service is necessary for effective participation in society?

Important services to be made available nation-wide at cost-based prices

For services that might not be regarded as essential on the grounds of social importance, but where nation-wide accessibility is nevertheless considered important (*e.g.* as economic infrastructure), there may be a need to consider a regulatory requirement to foster nation-wide distribution to customers at cost-based prices. Such a requirement on operators to provide service at cost, it should be made clear, would be quite distinct from mandating a USO-type provision of a subsidised service on the grounds of "affordability".

New services fail to meet assessment criteria

The use of a systematic procedure for assessing claimants for USO status, outlined above in Box 2, in studies conducted by the BTCE and the Australian Review Group[25] led these studies to the conclusion that the case for new services – including facsimile, ISDN and access to the Internet – to be accorded USO status did not prove convincing. For one thing, they failed to meet the "level of market penetration test" at present (although the qualification is made that if market penetration continues to grow, this assessment might need to be reviewed).

To illustrate the use of the criteria applied, ingredients of the assessment are indicated in Box 3. The summary in this box was compiled to illustrate the process used. It does not comprehensively cover the considerations included in the actual assessments that were conducted. The conclusion that none of the services considered qualify for USO status does not deny that there may be significant

Box 3. **Summary assessment of standard "POTS" USO and some new claimants for USO status**

	Current USO	Facsimile	ISDN	Internet	Digital capacity
Has the degree of "essentiality" and social importance of access to the service been adequately established by the extent of market penetration?	Standard voice telephony is pervasive and used for many purposes. Lack of service constrains participation in society and business.	Important to business but residential use still low even for those households with a home business.	Market penetration is still very low and, while it is seen to have a number of substantial potential areas of application, these remain largely unproven in a mass market.	Despite explosive growth, market penetration is still low but this could change in time especially for e-mail usage. With greater coverage the "externality" factor will become relevant as will concerns about social "isolation" if denied access.	Despite growing (although still uncertain) demand due to growing interest in the Internet, electronic commerce, etc., the proportion of households with computers and modems is still relatively low and still concentrated on those with higher incomes and home businesses.

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(continued)

Do estimates of benefits persuasively exceed costs?	Benefits probably significantly exceed costs. Basic USOs are provided at relatively low marginal cost.	Most can already access with existing customer access telecom lines. Significant benefits for some now denied access. Costs involved will depend on supply assumptions (*e.g.* wireless services could reduce connection costs for rural and remote subscribers)	Value of benefits depens on applications which are still uncertain. Costs could be very high depending on what is mandated.	Benefits considerable for some and could further increase as coverage expands. Access to the Internet is relatively cheap, but costly PC and modem, or interactive television required.	Appears to be consistent with the direction of the commercial market which may mean that the extent of USO support required could be small. A targeted approach would be more cost-effective than upgrading all services.
Effects on other policy goals?	Could limit incentives for investment and affect competitive neutrality.	Uncertain, although effects seem positive particularly for business.	Uncertain. Could transgress technological and competitive neutrality.	Uncertain, although promises considerable positive effects on business, productivity, education, etc.	Uncertain. New market entrants could be discouraged by competition against a USO provider with mandated high capability offering services below costs. Could reduce new technology and innovation.

Note: The summary in this box was compiled to illustrate the process used. It does not purport to cover comprehensively the considerations included in the actual assessments that were conducted.

benefits (including "externality"-type benefits)[26] which could result from the widespread diffusion of the service in question. The assessment found only that it would be inappropriate to *mandate* universal coverage of the services through a USO mechanism. The majority report of the Australian Review Group did recommend that the supply of digital capability telecommunication lines to all Australians by the year 2000 be mandated as a USO. However, this recommendation was contested by a minority report[27] and the Australian Government has reserved its decision pending further inquiries.

IV. UNIVERSAL SERVICE AND PUBLIC ACCESS IN THE CONVERGING NETWORKED INFORMATION SOCIETY

USOs and public access to the converging services and facilities of the networked Information Society

The concern about "access" to the Information Society is distinctly separable from the concern for universal service in the sense of "universal access to a defined minimum service of specified quality to all users at an affordable price". Public access concerns are not focused on delivering service at minimum standards nor on obligatory provision upon demand to each subscriber at "postalised" prices. While, in a sense, arguments for public access points may seem to share the rationale of a USO-mandated provision of public payphones, the requirements for such access are based on much broader objectives and necessitate the provision of terminals, computers and network connections. Moreover, public access to the Information Society requires more than just physical connections. Other requirements may include:

- information, publicity and training to initiate the unconnected;
- education programmes for schooling and learning on-line;
- establishment of networks and data-pools for health-care professionals;
- public library reference information;
- Internet sites for museums, galleries and other cultural resources; and
- electronic delivery of government services including up-to-date information on policy and regulatory developments, improving the transparency of government institutions and mechanisms.

A policy to enhance universal service coverage to include access to the networks and services of the Information Society will thus require a complex co-ordination of a much broader body of different policy objectives and perhaps of related funding mechanisms than has been necessary for telecommunication USOs.

What Information Society initiatives, if any, are necessary?

The challenge to policy makers issued by the developing Information Society is to design effective policies which serve not only to materialise and maximise the potential benefits of the Information Society, but to distribute them equitably. But, to what extent will market demand serve to determine the appropriate nature, extent and speed of diffusion? What policies, if any, are required to achieve this objective? There are no quick, generally applicable answers to this complex issue. The broader objectives (which include economic as well as social outcomes) underlying concerns about adequate access to the Information Society

mean that traditional USO concepts and criteria are inadequate and should be complemented by a policy framework encompassing and co-ordinating a broader body of criteria.[28]

A systematic approach to this issue requires essentially that the source of any problems be first identified and then specifically addressed with tailored cost-effective measures rather than through the use of blunt policy instruments. While mechanisms suggested by such an approach may be less immediately satisfying than an imposition of new blanket requirements through a USO-type mechanism, they may well be both far less costly and more effective in the longer run.

A logical and sequential process for determining necessary Information Society initiatives

The steps set out in Box 4 provide a framework for proceeding logically and sequentially to identify what policies, if any, are necessary to ensure access to the Information Society.

All this may seem a protracted and pedestrian process. But the complexity of the task is unsuited to simple solutions. The need for detailed consideration need not stall an enthusiasm for immediate action in the case of objectives/programmes that can be quickly and confidently identified and implemented.

Public access points to facilitate access

A question which has already received considerable attention in some countries is whether public access points should be set up in areas such as educational institutions, public libraries, health-care and community centres, etc., providing new open gateways to the Information Society? These "kiosks" could provide public access to computer terminals, software, applications and broadband links to the Internet and other on-line services.

In considering such initiatives to deliver higher-level services to particular community access points, it is important to be clear about what outcomes are being sought. For instance, community access points might be seen to be desirable as:

- a practicable way of delivering certain kinds of services not suitable for effective delivery from residential households, for example, video-conferencing; and/or
- a transitional step to facilitate or accelerate the universal availability of service; and/or
- places in which to initiate and educate people about new communication services and technologies.

Box 4. **A logical and sequential policy process for determining necessary Information Society initiatives**

A logical and sequential policy process for developing access to the Information Society might include the following steps:

- identify and specify objectives and desired outcomes clearly and specifically;
- assess the extent to which market demand and delivery will meet the specified objectives;
- identify barriers to achievement of Information Society objectives through market forces;
- identify alternative policies for cost-effectively addressing these barriers;
- specify criteria for selecting the best (mix) of these policies;
- identify appropriate implementation programmes and the schedule of such programmes;
- estimate the cost of such programmes;
- consider the extent to which these costs are reasonable when considered against the benefits involved;
- consider the extent to which these costs are sustainable;
- consider the extent to which programmes may need to be modified in view of estimated costs and benefits;
- establish the relative merits of alternative mechanisms for funding programme costs;
- decide on appropriate implementation procedure and the timing of such implementation;
- determine a procedure for regular monitoring and periodic review of progress in achieving objectives;
- establish a process for reviewing, in the light of such progress, the appropriateness of policies and programmes for achieving the specified objectives.

In the sense of providing access to groups and regions for which such access is expected to be denied or delayed if left to market forces alone, the argument for public access "kiosks" seems to share the rationale underlying the provision of public payphones. However, mandating provision through a universal service mechanism may not be the most effective mechanism for pursuing the objectives of community access points.

In Australia, the Review Group[29] concluded that, at this stage, commercial initiatives and targeted programmes involving government, users and the telecommunication industry provide a better way of encouraging the development

and use of new services than through prescribing particular "higher-level" carriage services which must be made available to particular institutions through the universal service mechanism. The Review Group expects that commercial incentives to deliver service will strengthen in this area, and believes that carriers, industry and government can develop productive joint initiatives. These initiatives could be developed in consultation with relevant institutions and community organisations, and involve private and public resources. The initiatives may cover a mix of infrastructure, customer equipment, special tariffing and support for applications development.

In fact, there is already considerable evidence[30] that even in low-profit areas such non-mandated delivery may not turn out to be so difficult to achieve since, for some operators, there may well be commercial and competitive advantages involved in this delivery, not the least of which is the customer perception of "good corporate citizenship" behaviour. There are a number of other ways in which a public access provider might receive significant commercial benefits from providing the service, not unlike the benefits to a universal service provider OFTEL considers could include:[31]

- enhancement of corporate reputation;
- marketing and brand recognition;
- information on how customers use the service;
- benefits associated with customer life cycles (customers who are currently unprofitable may become profitable in the longer term);
- benefits associated with ubiquity (customers moving to a new area are more likely to take service from the universal service provider, even if there is a competitor who could provide service, simply because they know that the universal service provider can provide service);
- the avoidance of loss of business through poor image and loss of trust due to disconnecting or discouraging subscribers;
- avoidance of the costs of disconnection; and
- minimisation of planning costs.

OFTEL concluded that the size of the benefits to the universal service provider "is likely to be sufficiently large to offset the universal service costs of uneconomic areas, uneconomic customers and uneconomic public call boxes". When these benefits are taken into account, the current net cost involved in the provision of universal service in the United Kingdom "is not proven" and does not justify setting up a universal service funding mechanism[32] "in the short term". To what extent does a similar conclusion pertain for funding public access? At any rate, these considerations insist that communication suppliers should not be denied the opportunity to deliver service to public access points without regulatory intervention. Indeed such delivery should be encouraged by the policy framework.

The need for safeguards

While government-private initiatives have proven productive and their potential could probably be more fully exploited in communications, governments should also be on their guard against anti-competitive incentives in this context, especially on the part of the dominant incumbent telecommunication infrastructure provider. In communication markets where competition is soon to be, or barely, established, the latter may have a strong incentive to capture large public customers, including educational institutions, with attractive special deals in order to prevent their potential rivals from gaining a foothold in this market. For budgetary reasons, the public institutions, thus connected, will often not be in a position to change to more attractive operators or networks once competition has become more established. Certain safeguards might be borne in mind in this context, such as ensuring that the duration and terms of the contract between the institution and the telecommunication operator should be clear and transparent. Wherever possible, it would be preferable to ensure open competitive tendering for such contracts, *i.e.* where network competition exists or is soon to exist it should have the opportunity to match or better the incumbent's offer.

Subsidised access for schools and public libraries

Subsidised access for schools and public libraries has received particular attention. Indeed the US 1996 Telecommunications Act identifies the provision of access to advanced telecommunication services for schools, health care and public libraries as one of the principles for the "advancement of universal service" in the future. Asked to consider the specific needs of schools and libraries in defining the services eligible for universal service support, the US Joint Board on Universal Service recommended that all eligible schools and libraries receive discounts of between 20 and 90 per cent on all telecommunication services, Internet access and internal connections, subject to a US$2.25 billion annual cap. The Joint Board recommends that economically disadvantaged schools and public libraries, as well as schools and libraries located in high-cost areas, receive greater discounts to ensure that they have affordable access to telecommunication and advanced information services.

In the United Kingdom, while OFTEL considers that educational institutions are an appropriate starting point in view of their vital role in skilling and equipping young people for the Information Society, it concluded that it is inappropriate to define subsidies to schools under the universal service category, for the following reasons:

- All telecommunication operators responding to OFTEL's consultation document were opposed to using formal universal service as a mechanism for

subsidising a different level of service for educational institutions and public access points. The operators argued that, instead, the industry should be given the opportunity to meet the requirements commercially.
- The present definition of universal service is very restricted in terms of meeting the wide-ranging needs of educational institutions and public access points. Whereas educational institutions and public access points have a variety of non-telecommunication needs including training, internal networks, computer hardware, software, and technical support applications, universal service could only be used to mandate a narrow range of services.
- More work is required to develop a better understanding of the needs of educational institutions and public access points and also so as to avoid any administrative duplication.
- European Union directives on universal service currently restrict the possibility of defining a higher level of universal service.

However, a recent report by a task force convened by OFTEL has recommended that a baseline of digital connectivity or equivalent (*i.e.* offering bandwidth of at least 128 kbit/s) is available to all schools throughout the United Kingdom and that "appropriate action" be taken "to address the needs of those schools which are unable to access ISDN or its equivalent". The report recommended that telecommunication operators introduce "more affordable charges" for telecommunication links for schools including, where possible, flat-rate charges which allow for unlimited usage so as not to restrict access to advanced services.[33]

This recommendation should be considered against the warnings about transgressing the principle of competitive and technological neutrality sounded emphatically elsewhere in this article. Here the concern is rather with the appropriate *funding* of such a recommendation if implemented.

Funding Information Society initiatives

Funding subsidised access to schools

The US Joint Board on Universal Service recommended that support for schools and public libraries be drawn from the same source of revenue used to support other universal service purposes. Although it may be an expedient approach, this funding policy appears to mix a policy on universal service for telecommunications with objectives linked to education and information policies.

Even where the reasoning in favour of special support for these institutions is supported,[34] *the requirement that telecommunication operators bear the cost of*

subsidised provision is contentious and open to challenge. It is important to be clear that to require a telecommunication operator – in effect, telecommunication subscribers – to bear the cost of what is essentially an educational policy programme would be a significant change in USO principles and practice.

With telecommunication operators increasingly operating in competitive markets and circumstances similar to those in other industries, they should be increasingly treated in a similar way with similar obligations and rights. As the telecommunication industry converges with the broadcasting and information technology industries, this need for symmetric treatment becomes even more important. It is important to bear in mind that many governments pay for, or subsidise, the purchase of food, shelter, clothing and education for specific social groups without imposing the cost on the suppliers or retailers. Are the reasons why things should be different in communications compelling enough?

The US policy is in contrast with the approach taken in the European Union. Here the guidelines prohibit funding of schemes outside the scope of the formal USO from a Universal Service Fund. This does not prohibit national governments from designing assistance schemes for access to Information Society programmes, so long as they are funded separately (*e.g.* from general revenue).

Funding more generally

Where activities are required which go beyond those which may be expected from commercial companies operating in a competitive environment, the contributions towards ensuring access should be fair and proportional. Any desire to ensure that services are delivered to less profitable sections of the community will need to be balanced by the need to maintain profit incentives for private-sector provision of new innovative services.

Programmes focused on the broader objectives of access to the Information Society should be funded from broader revenue sources than a communication universal service fund financed by telecommunication operators. To the extent that the objectives of the incentive/assistance programmes are identifiable, funding for Information Society initiatives could be appropriately drawn from various bodies concerned with, for example, education, health, the arts, information technology and computing. Governments could encourage, sponsor and co-ordinate Information Society funding programmes drawing in initiatives, support and funding from various bodies.

Subsidies for public access provision, where necessary, should be transparent and it would be important to ensure that this funding is contestable and accountable. Consideration should be given to mechanisms for competitive bidding so as to guarantee that it is the best and most innovative operators and

service providers that are awarded associated subsidies and funding where appropriate. Such an approach would provide a robust basis for meeting requirements in a sustainable way.

Monitoring and periodic review

The dynamic circumstances of today's unparalleled technological developments demand a preparedness to periodically revisit policies and programmes. Of course, reviews should be conducted free of presumptions and prejudices and be based on rigorous, objective and carefully documented analysis. This highlights the need for good data. Indeed, improved information is crucial for assessing the nature and scope of any problems and for developing well-targeted and cost-effective strategies for overcoming them.

V. CONCLUSIONS AND RECOMMENDATIONS

Concerns about access to the new services and facilities emerging from the technologically dynamic telecommunication industry and its "convergence" with broadcasting and information technology has resulted in calls for a reconsideration of the nature and scope of USOs so that they are more adequate and relevant in an era of technological acceleration towards a networked Information Society.

At a time of increasing competition and privatisation, rapid technological change and convergence, it is important that universal service objectives be determined and achieved without distortions to competitive neutrality not only among telecommunication operators but also between telecommunication and other communication suppliers. The principle of *competitive neutrality* also insists on the need to apply the principle of technological and regulatory neutrality – at least as a strategic longer-run objective.

A USO reform agenda should be cautious and based on careful analysis because of the rapid pace and unpredictable direction of technological change and demand, and because of the costs of inaccurately anticipating them. Arguments for an upgrade of the USO on behalf of uneconomic subscribers must be constrained by the need not to impose unreasonable costs on other telecommunication subscribers and raise damaging uncertainty for operators and investors about the future scope of universal service.

Wherever possible the market mechanism should be allowed to play the primary role. A primary role of policy and regulatory frameworks should be to strengthen market competition since this will accelerate market diffusion of services. The extent to which services are taken up by unsubsidised subscribers

offers a useful indicator for when such services could become candidates for USO status.

A systematic decision-making process should be used to assess the case for upgrading USOs. It is notable that studies using such a systematic procedure have concluded that the case for several new services and facilities to be designated USO status, including facsimile, ISDN, the Internet, did not prove convincing.

In defining universal service, the identification of particular services with a particular network technology or infrastructure should be avoided. The concept of universal service needs to reflect the shift from service-specific networks to multiple alternative networks. Defining a new universal service requirement on the basis of access to particular network resources or by technical specifications (such as ISDN) could bias consumption and investment decisions and may negatively impact on fledgling technologies which have future promise.

As the Information Society develops and more elements of the economy – education, information and entertainment – are linked to electronic networks, there are increasingly concerns that certain groups will be excluded or left behind by being "unconnected" resulting in a divisive society of "information 'haves' and 'have-nots'".

The challenge to policy makers is to design effective policies which serve not only to materialise and maximise the potential benefits of the Information Society, but to distribute them equitably. The broader objectives underlying concerns over access to the Information Society (which include economic as well as social and political ones) mean that traditional USO concepts and criteria are inadequate and should be complemented by a policy process encompassing and co-ordinating a broader body of criteria.

A systematic approach would require, in essence, that the source of any problems be identified and then specifically addressed with tailored cost-effective measures, rather than through the use of a blunt USO-type mechanism.

Arguments for public access points to the networks and services of the Information Society should be recognised as being distinctly separate from the concern for universal service in the sense of "access to a defined minimum service to all users at an affordable price". Public access points are not concerned with delivering service at minimum standards nor of obligatory provision on demand to each subscriber at "postalised" prices. While in a sense arguments for public access points may seem to share the rationale of a USO-mandated provision of public payphones, the requirements are based on much broader objectives and encompass the provision of terminal equipment (computers/ modems, etc.).

Although it may seem an expedient approach, imposing the cost of providing special support to schools, public libraries, etc., by way of subsidised provision of infrastructure and services, upon telecommunication operators is contentious and open to challenge. To require that telecommunication operators bear the cost of what, in the case of schools, is essentially an educational policy programme must be recognised as a significant change in USO principles and practice. Where considered appropriate, the provision of subsidised services to schools should be paid for from the educational budget (or from general revenue). Telecommunication operators are increasingly privately owned, and as they increasingly operate in competitive market circumstances similar to firms in other industries, they should be treated in like manner, with similar obligations and rights.

This argument applies more generally to the funding of any other initiatives concerning access to the Information Society. To the extent that the objectives of the programmes are identifiable, funding for Information Society initiatives could be appropriately drawn from the various bodies concerned with, for example, education, health, the arts, information technology, etc.

The dynamic circumstances of today's unparalleled technological developments demand a preparedness to periodically review policies and programmes. Of course, reviews should be carried out free of presumptions and prejudices and be based on rigorous, objective and carefully documented analysis. This highlights the need for good data. Indeed, improved information is crucial for assessing the nature and scope of any problems associated with equitable access to the Information Society and for developing well-targeted and cost-effective strategies for overcoming them.

NOTES

1. The provision of universal service in telecommunications is also considered to have important "externality" benefits (that are not recognised by suppliers and would accordingly result in undersupply). As new customers join the network, the value to all customers of being on the network increases because they can – either actually or potentially – access a larger number of other users. It is also argued that other externalities exist since telecommunications, as a means of communication, can provide an alternative to services such as transport, thereby avoiding the costs of pollution and congestion. Also there may be benefits from access to a telephone in case of emergency and in helping to reduce crime. (See *e.g.* OFTEL, *Universal Telecommunications Services: Proposed Arrangements for Universal Service in the UK from 1997,* February 1997, p. 8.)
2. The question about what upgrading, if any, is required to the scope of USOs in response to rapid technological advances is being addressed in a number of countries. Those whose concerns are driving this reconsideration of USO coverage can be usefully categorised into:
   i) people without access to the standard telephone service;
   ii) people with access to the standard telephone service but who regard their level of voice telephony service as inadequate;
   iii) people with access to the standard telephone service but who regard their level of service as inadequate because it delivers inadequate performance for services other than voice telephony, such as facsimile, data and access to the Internet; and
   iv) people with access to the standard telephone service delivering acceptable performance for services other than voice telephony, such as facsimile, e-mail, data and access to the Internet, electronic commerce and educational applications, but who want further enhancements or new services.(See Australian Department of Communications and the Arts, *Report of the Standard Telephone Service Review Group*, December 1997. Accessed from the Internet site http://www.dca.gov.au).
3. OECD, *Universal Service Obligations in a Competitive Telecommunications Environment*, ICCP Series No. 38, Paris, 1995.
4. Japanese Ministry of Posts and Telecommunications, *Final Report of the Study Group for Research into Universal Services and Rates in the Multimedia Age*, Part 1: Rates in the Multimedia Age, Part 2: Universal Service in the Multimedia Age, May 1996.
5. The fears about affordability were not entirely unfounded in some cases. For instance, in Sweden, call prices rose by about 100 per cent between 1993 and 1996 as a result of price rebalancing according to Swedish Ministry of Transport and Communications, *Modern Telecommunications for Everybody – Green Paper on a Revised Swedish Telecommunications Regulation*, August 1996.

6. However price caps can be distortive especially when applied for long periods, and thus should be used only as a temporary device (see OECD, *Price Caps for Telecommunications: A Review of Policies and Performance*, ICCP Series No. 37, Paris, 1995). The recent move by the United Kingdom to reduce price cap coverage from some 75 per cent to about 26 per cent of BT's revenue source (see OFTEL, *Telecoms Price Control: The Final Phase*, June 1996) is to be applauded and should be followed by other countries as soon as circumstances permit.
7. OECD, *Communications Outlook 1997*, Paris, April 1997.
8. European Commission, *Universal Service for Telecommunications in the Perspective of a Fully Competitive Environment – An Essential Element of the Information Society*, Communication to the European Parliament and the Council, Brussels, February 1996.
9. OECD, *Communications Outlook 1997*, Paris, April 1997.
10. For example, the UK Disability Discrimination Act 1995 makes it unlawful for providers of services to discriminate against a disabled person by:
    - refusing to serve;
    - failing to address problems which make it unreasonably difficult for the disabled person to make use of a service;
    - providing a lower standard of service or service in a worse manner; or
    - providing a service on worse terms for a reason which relates to the disabled person's disability.

    The UK Act places a duty on providers of services (including telecommunication operators) to:
    - amend practices, policies or procedures which make it impossible or unreasonably difficult for disabled people to use their services;
    - remove or overcome physical barriers which make it impossible or unreasonably difficult for a disabled person to use the service; and
    - provide "auxiliary aids or services" where this would enable or facilitate a disabled person using the service.
11. The move in some countries to mandate provision of ISDN at "affordable" prices might be viewed in this context. In Denmark, for instance, ISDN has been specified as a universal service. In Australia, the government has required Telstra to accelerate the deployment of ISDN and has spoken of placing ISDN prices within a price cap constraint. In the United Kingdom, too, OFTEL has considered bringing ISDN into price cap control. Nonetheless, ISDN penetration is currently very low, and while it has a number of substantial potential areas of application, these remain largely unproven in a mass market.
12. See *e.g.* OFTEL, *Beyond the Telephone, the Television and the PC"*, Consultative document, 1995.
13. International Chamber of Commerce, *Preparing for 1998 and Beyond,* Speech by Commissioner Karel van Miert, Working Party on Telecommunications, Document No. 373-21/65, Paris, September 1996.
14. Benton Foundation, *Broadcast Spectrum and the Debate on the Future of Television*, Benton Foundation, 1996.
15. Australian Bureau of Transport and Communications Economics, *Communications Futures: Final Report,* Australian Government Publishing Service, Canberra, 1995.

16. Federal-State Joint Board on Universal Service, *Recommended Decision*, Before the Federal Communications Commission, adopted 7 November 1996.
17. Canadian Government, *Building the Information Society: Moving Canada into the 21st Century,* Ottawa, 1996.
18. OFTEL,*Universal Telecommunications Services: A Consultative Document on Universal Service in the UK from 1997,* December 1995.
19. Australian Department of Communications and the Arts, *Report of the Standard Telephone Service Review Group*, December 1996. Accessed from the Internet site (http://www.dca.gov.au).
20. Broadband Services Expert Group, *Networking Australia's Future: The Final Report of the Broadband Services Expert Group*, Australian Government Publishing Services, Canberra, December 1994.
21. BT's response to OFTEL's consultative document *Universal Telecommunications Services in the UK from 1997.*
22. Australian Department of Communications and the Arts, *op. cit.,* December 1996.
23. Murroni, C, *Universal Service Obligations in Telecommunications*, Institute for Public Policy Research, UK, 1996.
24. Australian Department of Communications and the Arts, *op. cit.,* December 1996.
25. Australian Department of Communications and the Arts, *op. cit.,* December 1996.
26. For an indication of such benefits see endnote 1. It should be noted, however, that while the existence of external benefits may support an argument for payment of a government subsidy, it does not justify mandating provision of a loss-making service at supplier cost.
27. Australian Department of Communications and the Arts, *op. cit.,* December 1996.
28. See, for instance, UK Government, *Building the Information Society: A National Strategy*, HMSO, December 1996.
29. Australian Department of Communications and the Arts, *op. cit.,*December 1996.
30. For instance, the UK Cable Communications Association offers free broadband connection to every school passed. In the United States, in January 1997, *Time Warner Cable* unveiled a free educational package of material for bringing cable TV and high-speed Internet access technologies into classrooms in its service areas as it upgrades its network. In addition to free connections, *Time Warner* plans to provide workshops to teach educators how to use the new technologies (*Telecommunications Reports*, 13 January 1997). In Australia, the telecommunication carriers, Telstra and Optus, have implemented various initiatives in relation to the provision of higher-level services to particular community access points.
31. OFTEL, *Universal Telecommunications Services: Proposed Arrangements for Universal Service in the UK from 1997*, February 1997.
32. The Swedish approach is similar. The former monopoly, Telia is required by its licence to provide universal service while other operators do not have USOs. With Telia's net costs for universal service estimated to be fairly low (about 1 per cent of the revenues from the telephony service), despite the onset of competition, other operators will not be required to contribute to the financing of Telia's USO. However, if the situation changes, for example, if Telia's revenue from telephony services decreases significantly due to stronger competition, or if the USO becomes too big a burden for Telia,

other operators would be required to contribute to USO financing through a universal service fund.

33. OFTEL, *Information Highways: Improving Access for Schools, Colleges and Public Access Points*, report of OFTEL's Task Force on the Telecommunications Industry, February 1997. Other Task Force recommendations were that the telecommunication industry should:
    - Initiate discussions with representatives of the further education sector to better understand the telecommunication requirements of these colleges and to identify measures which help meet the needs of these colleges including access to appropriate bandwidth on terms which are affordable.
    - Initiate discussions with representatives of the Library and Information Commission and the Library Association to better understand the telecommunication requirements of public libraries and develop packages to meet identified needs.
    - Play its part in actively promoting and disseminating the benefits of external telecommunication links to schools, further education colleges and public libraries.
    - Develop charges which are predictable and controllable to enable effective budgeting of on-line expenditure (the inability to do so is currently seen to be a major impediment to many schools, colleges and libraries using on-line services).
    - Allow schools, further education colleges and public libraries to purchase network connections separately from services so that they are free to choose which company they buy services from and are not tied into taking service from the company providing the network connection.
    - Work in partnership with software producers, equipment manufactures and others to ensure that schools, further education colleges and public libraries have the full range of services they need and can access them in a user-friendly way.

    But, as the Task Force itself recognised, telecommunication links are just one aspect of what is required to use advanced services effectively. The public access approach raises questions about how the rest of any overall package for schools might be made available, including:
    - internal networking;
    - end user equipment;
    - user training, support and maintenance; and
    - applications and services.
34. The report of OFTEL's Task Force on *Information Highways: Improving Access for Schools, Colleges and Public Access Points*, (1997, *op. cit.*, p. 8) argues that providing schools, colleges and public libraries with telecommunication links to advanced services can bring significant benefits:
    - to the UK economy through the development of the technological skills base;
    - to learners through, for example, access to a rich variety of up-to-the minute material not available locally; access to interactive learning; access to remote specialist teaching; use of sophisticated software such as integrated learning systems which tailor work programmes to the needs of individual students which some studies have shown can lead to considerable learning gains; providing mainstream and other improved opportunities for those with special educational needs; and developing individual IT skills;
    - to teachers for training, advice and support, resource material for lessons and the sharing of ideas with peers;
    - to the management and administration of schools, colleges and libraries by, for example, enabling the two-way exchange of information with external organisations

on-line, organising timetables, improving security and providing remote management of information and communication technology when resources are not available on-site;
- to those without access at home who stand to lose out in the information revolution unless they can access services elsewhere; and
- to the telecommunication industry and other industry sectors involved in the provision of information and communication technology which stand to benefit from an expanded market.

Appendix

Global Information Infrastructure-Global Information Society (GII-GIS)

POLICY RECOMMENDATIONS FOR ACTION

I. INTRODUCTION

The Meeting of the OECD Council at Ministerial Level in 1995 requested the Committee on Information, Computer and Communications Policy (ICCP) to develop recommendations for policies that fully exploit the contributions of advances in technology in the context of Global Information Infrastructure-Global Information Society (GII-GIS). Although the recommendations (provided as italic text in boxes below) are addressed to OECD governments, the ICCP recognises that all social partners need to play an important role in the transformation of existing economic and social structures, and places importance on allowing the private sector to take the lead in the economic and commercial development and implementation of the GII-GIS. The development of a Global Information Society can help government contribute to further enhancement of public goals, while retaining responsibility for ensuring public safety and national security, the protection of citizens and the promotion of cultural diversity.

The concept of a Global Information Infrastructure-Global Information Society (GII-GIS) encompasses the development and integration of high-speed communication networks, and a set of services and applications in digital form, into global integrated networks capable of seamless delivery. Such networks provide fully interactive access to network-based services within countries and across national borders. The physical infrastructure of the GII-GIS is not limited to any one technology; on the contrary, implicit in the GII-GIS concept is the interconnection and interoperability of a range of competing and complementary infrastructures, applications and services made possible by digitalisation. A harbinger of the GII-GIS is the explosive growth of the Internet.

The development of the GII-GIS is expected to transform existing economic markets into a market-place where communication networks, bundling together transport, access and market transactions, will play a major role. The driving force behind economic growth and development in such a networked economy will be based on information.

The development of a network-based information economy requires:

- the availability and diffusion of high-speed interactive infrastructures;
- non-discriminatory access to and use of infrastructures for both customers and service providers;
- the interconnection and interoperability of infrastructures and services;

- growth and development of on-line services, especially digital applications across all sectors including multimedia services;
- safeguards which provide for universal service and ensure privacy, confidentiality of information and security of payments, and protection of intellectual property.

Governments need to respond in a proactive manner to GII-GIS developments and applications. They also need to take action now as new services and applications emerge and are being formulated. At the same time, it is important to understand that the dynamics of change are largely technology- and private-sector-driven. Government response needs to focus on ensuring that opportunities are opened up and available to firms, and that existing market structures, particularly where there are bottlenecks in supply, do not restrict growth and competition. At the same time governments need to play a role in stimulating and encouraging demand for the new services which the GII-GIS is making available.

Given the global nature of new communication technologies and activities, it is important to have in place international principles and frameworks to ensure the harmonious development of Global Information Infrastructures. In this context, three main policy areas need to be addressed:

- those directly related to the development and diffusion of information infrastructures, nationally and on a global scale;
- those related to the access and use of these infrastructures; and, linked to this,
- those related to existing and new services and applications, including multimedia applications and electronic commerce, using infrastructures.

The sea of change taking place in information and communication markets and the development of interactive applications is fundamentally based on three factors: convergence, globalisation and universal network access. The changes taking place are rapid. The shape of the Information Economy of the 21st century, and the Information Society which accompanies it, relies upon review, and where necessary revision, of policies and policy frameworks to be carried out now. The implications will be significant, not only as concerns stimulation of economic growth and job creation, but also because of the potential as regards social benefits and public services.

II. ACCESS TO THE GII-GIS

Dynamics of changing infrastructures and convergence

The possibilities opened up by recent developments, particularly in digital technology, mean that the segmentation of infrastructures for policy purposes by technologies or by service typology is becoming less and less valid. On the other hand, a regulatory distinction between content-service provision and provision of transmission facilities is becoming more relevant. The multiplicity of services also implies a need to attain direct customer access, which focuses attention on essential facilities and the constraints they may impose on access in the market.

Convergence of the telecommunications, broadcasting and computing industries is putting increasing pressure on the associated regulatory paradigms. By not adapting legislative frameworks, policy goals and institutions there is a risk of creating regulatory obstacles and retarding growth in the GII-GIS.

A progressive review of the traditional separation, as regards regulatory frameworks, including licence conditions, among telecommunication infrastructures, broadcasting facilities and cable television networks is recommended. The development of new regulatory distinctions between the issues concerned with pure carriage services from the policy issues concerned with content services might be considered in this context.

Whilst taking into account the specific nature of certain types of networks, it is recommended to examine the conditions and timing to extend the general principles of market and product competition to all communication infrastructure markets.

Access to the Information Society

While different regulatory and institutional solutions will suit different OECD countries depending upon varying legal and political traditions, the globalisation of information infrastructures and services is creating pressures for international co-operation and co-ordination of essential safeguard and access principles. The inclusion of basic telecommunications services and networks in the framework of the World Trade Organisation has already resulted in the development of a set of common regulatory principles on access rules which would be accompanied by relevant market access commitments. Furthermore, new services such as digital satellite and Internet defy territorial boundaries so that purely national solutions likely will become increasingly inadequate.

The general access principle for the success of the GII-GIS is that those having bottleneck positions, or controlling gateways to customers, should not be able to charge a monopoly price for their service nor give preferential treatment to their own affiliated or favoured service providers in the dependent market.

Governments should review whether the extension or adaptation of access principles, already being developed in many OECD countries as regards telecommunication networks, is appropriate for other parts of the GII.

A key general principle recommended for the success of the GII-GIS is that essential communication facilities should charge cost-oriented prices for access services and should provide non-discriminatory treatment to service providers.

Access scenarios: telecommunications, digital TV and on-line services

The local loop

Competition in the provision of communication access and service through the local loop is crucial in the success of the GII-GIS. Significant efforts must be made by regulators to stimulate competition especially through alternate technologies, regulatory measures and, where necessary, structural solutions.

Significant efforts must be made by regulators to stimulate competition at the local loop especially through alternate technologies, regulatory measures, accounting separation and, where necessary, structural solutions. Where access bottlenecks remain, obligations should be placed on access providers to ensure non-discrimination, transparency, cost-oriented pricing and, as far as possible, unbundled access to services and facilities.

Where cable infrastructure is undeveloped, governments need to first take into account the requirements and incentives for independent investment and establishment of alternate platforms for customer access, before going on to encourage the potential for convergence which can be realised once a competitive environment has been established. Where cable systems are established but controlled by the incumbent telecommunication operator, competition policy concerns may motivate governments to consider structural separation or divestiture of the cable business in the interests of establishing competition in multimedia networks.

Conditional access systems

Access between digital broadcasting services and the customer for new digital broadcasting services, terrestrial or satellite, may involve conditional access systems as the final link, including the related applications programmes and subscriber management services. In order to access services, customers may need to purchase digital decoders in the form of "set-top boxes". Competition is important to ensure that customers reap the benefits of this technology.

Competition in the provision of conditional access systems is important so that viewers can access a wide range of digital services and programmes regardless of the method of delivery to the TV screen and without the expense and inconvenience of multiple set-top boxes. Under certain market conditions, govern-

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ments may need to consider taking appropriate steps to ensure open access and ensure that the broadest possible range of suppliers can reach their prospective audiences.

Software operating systems

The final access point between information services and end customers is increasingly via browsing software and servers; and this is set to become increasingly integrated within the overall PC operating system. This can apply to the Internet, to electronic commerce applications, etc. The move towards greater vertical integration and concentration in the Internet industry by major operators may indeed be the result of market forces and pro-competitive strategies based on real, sustainable competitive advantages and synergies, but it may also raise concern for open access between services and customers. It is important therefore to ensure that competition for new products and new technologies remains sustainable.

In such a new and dynamic market as the Internet, it is recommended that government measures, when necessary, facilitate the development of the market while preventing anti-competitive practices on the part of dominant players regarding access.

Competitive safeguards and access

The areas and situations involving access to the GII include, *inter alia*, consumer equipment elements, software operating systems as well as various transmission networks. Furthermore, the structure and characteristics of these markets are particularly dynamic and fluid. The safeguards which are being developed for liberalising telecommunication markets will, as broadband communication infrastructures develop and as infrastructure convergence takes place, continue to be necessary, but will in many cases require review and possible extension to take into account new developments. Key areas include interconnection, numbering, licensing and interoperability.

Interconnection

Underlying the notion of information infrastructures is the concept of a number of interconnected networks – both competitive and complementary. The success of a competitive market structure for information infrastructures hinges on an effective framework

being in place for interconnection and non-discriminatory access to both networks and scarce resources. Different infrastructures will need to interconnect and the provision of different services on infrastructures will change concepts of cost allocation and determination of fair interconnect prices and conditions. It is also important to allow other content providers access.

It is recommended that governments give due priority to implementing effective and flexible competitive safeguards to facilitate entry by market participants in a timely fashion and provide the framework for the private sector to overcome access problems. Governments need to put into place as rapidly as possible interconnection frameworks with emphasis on non-discrimination, transparency and an effective arbitration process. Co-ordination is needed at the international level. In this context, governments should support the additional regulatory principles they each incorporated in their commitments on basic telecommunication services in the WTO.

Governments also need to take account of the fact that convergence and global alliances are creating new challenges as regards interconnection issues and requirements.

Particular consideration must be given to the problem of fair allocation of scarce resources, such as spectrum or rights of way, for new entrants to the market.

Numbering and addressing policy

The development of information infrastructures, new services and competition will require the implementation of a framework for management of numbering resources and number portability. Number portability – which enables customers to keep their existing numbers when they change from one carrier to another – fosters competition, especially at the local loop. The process of convergence is widening the "numbering" debate to include different addressing and identification systems. In the case of the Internet, because it is an international medium, addressing is a global issue since only one unique global domain name is provided at present. Present structures for management of Internet addressing are of concern in that there appears to be no proper administrative oversight at the national or international level. In the context of electronic commerce, addressing issues are raised in terms of name assignment and management services for names. Such name assignment is closely linked with use of names and certification of authenticity – and thus encryption issues. This issue needs close international co-operation in that electronic commerce will be transnational.

Governments should ensure, preferably through a consultative body including suppliers and users of number resources, that an effective, non-discriminatory numbering framework is established The management of numbering resources, number portability, operator selection and preselection, should be implemented as soon as possible.

Consideration needs to be given to frameworks based on private-sector co-operation for the co-ordination and management of Internet domain names and the identification systems for Internet sites.

Together with appropriate private-sector bodies, governments should begin examining international solutions for electronic commerce addressing in terms of name assignment and management services for names.

Licensing

As information infrastructures develop, it becomes increasingly important to lower market entry restrictions with a more open and efficient authorisation procedure so as to lower the barriers to the development of a global communication economy.

Existing national licensing regimes for infrastructures should be reviewed in order to ensure coherent and consistent policies which support multimedia development and diffusion, providing licences in a transparent and timely fashion. The separation of licensing of infrastructures and transport services from those providing authorisation for the provision of services, should be examined in countries where such licensing is bundled. Wherever feasible, governments should give consideration to introducing a system of general authorisation or class licences.

Limitations on the number of licences should be avoided except where justified for reasons of limited resources. The allocation conditions of scarce resources such as spectrum, and the way these resources are used can, nevertheless, be affected by the type of services diffused.

Interoperability and standards

The goal of seamless and efficient networking creates increasing demands for interoperability and common standards between an ever-wider variety of operators and service providers. The merging of the information and communication sectors and the rapid development of new technologies is also requiring new paradigms in the process of attaining consensus, particularly as regards networking the computing industry. Industry supports

both developing common open standards and the protection of intellectual property rights for proprietary standards.

The primary role of governments with respect to interoperability should be to provide encouragement towards consensus on appropriate standards, and in particular to encourage international initiatives in this area. Private-sector initiatives should be encouraged and actively supported by public procurement, while ensuring that these procurements are open to all market participants on a non-discriminatory basis.

The development of open standards by governments and the private sector, with appropriate emphasis on fair compensation, is important. Governments may need to maintain an oversight role to ensure conditions of non-discriminatory access.

Universal service and public access in the Information Society

As the Information Society develops and more elements of the economy, education, information and entertainment are linked to networks, it is increasingly important that the less advantaged and vulnerable members of society are not excluded or left behind through being "unconnected". The concept of universal service needs to be reviewed, and possibly developed and adapted, to reflect the shift from service-specific networks to multiple alternative networks, each capable of delivering an ever-broader range of services. The difficulty in expanding definitions is that it is not simple to provide service-specific definitions because of the wide and expanding range of services. Linked to the notion of a widened definition of universal service is the concept of "public access" to new services. The scope of such "public access" may well include a variety of resources, components and services which extend far beyond that which is commonly described as telecommunications.

As regards the scope of universal service, it is recommended that existing concepts be reviewed to consider what new services may be necessary for people as citizens and consumers in the Information Society. Particular attention must be paid to ensuring that all segments of society, and geographic locations within a country, have the opportunity to access advanced information services at a reasonable price.

Consideration should be given to setting up public access points in areas such as educational establishments, libraries, community centres and museums,

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providing new open gateways to the Information Society: these would provide access to computer terminals, software, applications and broadband links to the Internet and other on-line services.

In definitions of universal service, the identification of particular services with a particular network technology or infrastructure should be avoided. Subsidies for universal service provision, if necessary, should be transparent. Consideration should also be given to mechanisms of competitive bidding so as to guarantee that the best and most innovative operators and service providers are awarded associated subsidies and funding where appropriate.

Governments are encouraged to promote Information Society financing frameworks drawing on initiatives and support from various bodies concerned with, for example, education, health, the arts, information technology and computing.

As far as advanced telecommunications access is concerned, the industry should be encouraged to meet the requirements of public institutions and associated public access points commercially. In this context safeguards concerning open and competitive tendering and transparent contracts may be relevant.

Pricing

Pricing structures and pricing policies may be one of the most important policy areas with regard to national and global information infrastructures. Network-based applications will only develop if the correct pricing signals are provided to service providers and users. The only practical way of identifying efficient cost-oriented prices in an economy characterised by shared network resources is through competition. Non-competitive markets suffer from a lack of responsiveness to new demands and do not encourage innovative pricing packages. Pricing structures need to take into account the fact that usage patterns of communication networks are changing drastically, especially as regards significant increases in levels of use and decreased predictability in connect and peak times.

Inefficient international pricing structures have negative implications for the development and diffusion of new network-based applications and market development. In particular this concerns the system through which operators compensate each other for the termination of international calls.

Market opening should take place in conjunction with price rebalancing, but should not be unnecessarily delayed by such requirements. Since efficient pricing structures will be best achieved through competitive markets, governments should aim, primarily, to accelerate the process of competition. There may be reasons to maintain oversight on pricing issues until competitive markets have emerged.

New and flexible pricing structures need to be adopted to reflect the fundamental change occurring in network usage patterns, especially as regards time-based pricing.

Special efforts must be made to attain cost-oriented international accounting rates and pricing principles for international access, although adjustment periods may vary according to differences in the development of the countries concerned. It should also be recognised that alternative international interconnection arrangements will become increasingly significant. The rapid introduction of competition in the international facilities market would provide the best means to meet the urgent need to restructure international telecommunication pricing practices.

Institutional and regulatory structures

In order to be effective and coherent, regulatory structures need to mirror the market structures which they regulate. Radical transformations implied by the GII-GIS include both new relations between networks and services and the brand new technologies and applications which do not "fit" into most existing policy categorisations. Since it will become increasingly difficult to maintain technical or practical separation between broadcasting and telecommunication markets, and given the dynamics of convergence of infrastructures and services, governments may need to consider new relationships between existing legislative and regulatory frameworks.

A review of the institutional and regulatory frameworks governing licensing, access and use of infrastructures and provision of service may be required. Such a review would need, in particular, to take a fresh and forward-looking perspective on the implications of the changing relationship between the service of carriage or transmission of communications and those services which are essentially concerned with the provision of the content of such communications for public consumption.

Given the phenomenon of convergence, governments should review, if necessary, their existing regulatory structures in order to streamline them and ensure that they are adapted where necessary to continue to achieve in the most effective way, the given policy goals.

Developing economies

Access to the GII-GIS is a global issue which must encompass all communities and, in particular, the developing economies. Otherwise there is a risk that the development gap will increase. The concept of GII must be seen as a mechanism to enhance world-wide co-operation in developing infrastructures and applications.

As part of the GII-GIS policy framework, OECD governments must explore ways to enhance co-operation with governments and social partners in developing economies as a matter of some urgency. This needs to involve the co-operation of both local and foreign commercial interests.

OECD governments should provide regulatory training to developing economies, either bilaterally or through regional organisations. This must include exchange of information, know-how and experience as well as practical training.

III. APPLICATIONS AND SERVICES IN THE GII-GIS

Multimedia content and intellectual property rights

The legal framework within which intellectual content is produced, shared and traded will be even more vital in an information economy characterised by network-based production and consumption, and digital manipulation and reproduction. The practical complexity of managing the large number of copyrights in multimedia products is sometimes cited as a problem facing the development of new services. However, the problem of rights clearance for multimedia products has also been successfully surmounted in a number of cases by creators of multimedia products. The challenge for Internet-based products is that multimedia services incorporate content covered by different degrees and kinds of copyright. This is a particularly difficult question in regard to international trade in services, as rights for different contents differ between countries; greater harmonization of IPR regimes among countries would facilitate this process.

Governments should adapt intellectual property law as appropriate to reflect the changes which digitalisation of works has brought about. In this context, governments should bear in mind the interests of creators and of rightsholders in content for an effective copyright regime, as well as taking into account the interests of distributors and users.

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In adapting intellectual property laws, governments should also recognise and encourage new technological solutions becoming available to meet the challenges brought about by increasing digitalisation and network diffusion of content. Such adaptation should take account of the globalisation of networked digital content and the extent to which it can ignore physical territorial boundaries.

In this regard governments should take note of the recent WIPO Conference on Certain Copyright and Neighbouring Rights Questions whereby, in December 1996, two new Treaties were adopted: the WIPO Copyright Treaty and the WIPO Performances and Phonograms Treaty. The new WIPO framework provides a response to the new challenges raised by the GII-GIS.

Electronic commerce

The rapid development and diffusion of electronic commerce applications depends on ensuring the availability of the infrastructure and of access to and use of infrastructures for applications and services. There is also the need for system security, authentication software, processes to ensure confidentiality, message delivery reports, etc., which are not subject to repudiation. The concept of electronic commerce, although it includes payment issues, is a much wider concept encompassing a range of transactions which are embedded in modern society.

Without prejudicing existing frameworks for commercial transactions, mechanisms and legal frameworks, particularly concerning the requirements for trust and integrity, will need to be adapted for new network-based transactions and for the storage and manipulation of commercial data in digital electronic form.

The fast rate of technological change and innovative development of applications implies that policy frameworks regarding electronic commerce must remain flexible. There needs to be a continuous dialogue between government and the private sector on developments which impact on security and integrity of networks and commercial services.

Furthermore, given the global nature of electronic commerce and the difficulty of determining national jurisdiction in the event of legal disputes, dispute settlement mechanisms will be necessary at the international level. OECD governments need to encourage present international commercial bodies to formulate effective dispute resolution procedures for electronic commerce.

Transaction safeguards

Commercial transactions have different requirements: for example, some require anonymity, while for others it is important that they are well documented. Some require complex documentation, acknowledgement and registration, and others more simple processes. Thus the whole range of safeguards which already exist to protect buyers in the market, as well as those required by government to ensure proper record keeping, etc., need to be adapted for on-line transactions. Governments, as well as the private sector, have an important role to ensure security on networks both from the perspective of curtailing criminal and illegal activity, and to ensure confidence in economic structures and activities.

Companies should be encouraged to continue exchanging information with governments as appropriate on security and security solutions.

Security of services: cryptography

Cryptography provides a powerful tool to meet many of the requirements of electronic commerce and where properly implemented can allow for information to remain confidential, help maintain integrity of information, and provide a means for authentication. It is recognised that it is necessary to balance legitimate commercial needs for encryption against the requirements of law enforcement. Cryptography will be important to the provision of security, privacy and intellectual property protection in the GII and the growth of many applications, such as electronic commerce.

Market forces should serve to build trust in reliable systems, and government regulation, licensing and use of cryptographic methods may also encourage user trust.

Markets need to develop solutions for data security. However, in order to protect the public interest, such as the protection of personal data or electronic commerce, governments may need to implement policies requiring cryptographic methods to achieve a sufficient level of protection, while responding to the needs of law enforcement authorities. Nevertheless, it is important even in those circumstances to allow users and market forces to determine the appropriate safeguards, while respecting existing legislation.

It may be necessary for governments to play a role in determining with the private sector the appropriate technical structure to support global, interoperable

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digital signatures and time-stamps. OECD governments need to encourage relevant bodies to consider how to facilitate dispute resolution.

OECD countries should take note of the OECD Guidelines on Cryptography Policy in order to encourage the development of internationally compatible frameworks as soon as possible, and to facilitate the growth of electronic commerce and open global markets, taking into account the need for governments to maintain their existing responsibilities.

Protection of privacy and personal data

Privacy requirements in the development of electronic commerce are important because the development of new applications and services on Global Information Infrastructures will increase the amount of personal and business-related information gathered, stored and transmitted electronically by governments, public institutions and businesses. Development of the GII is making it even easier to collect, analyse, distribute and forward data across national boundaries, resell or reuse them, or integrate them with other databases collected for unrelated purposes. Thus, open networks, such as the Internet, may, without adequate safeguards, pose serious privacy problems.

Taking note of the complexity of dealing with privacy questions in the context of the GII, governments need to respond to increasing new concerns about privacy. At a minimum, governments need to ensure broad national guidelines or modifications of existing national guidelines on privacy in accordance with the 1980 OECD Privacy Guidelines. Guidelines should be based on the principle of protecting individual privacy without imposing unnecessary burdens on business and community. In particular: i) *transparency must be ensured as to use of personal data;* ii) *limitations, where required, should be imposed on the secondary use of personal data; and* iii) *rights to access and to correct one's own personal data must be clarified, and requirements to ensure accuracy of data must be set forth.*

In order to allow for open transborder transmission of legitimate and useful personal databases and to address the issue of restrictions on the export of data in general, consensus is urgently needed at the international level on whether the OECD Privacy Guidelines are up to the challenge which lies ahead on the GII and/or whether further international principles on the protection of the individual are required. This could constitute a first step towards development of more detailed international agreements and could encourage development of national and international business codes of privacy and other self-regulatory initiatives.

Illegal and harmful content

The development of the GII-GIS can significantly contribute towards the positive promotion of diverse social identities and values. But the ease of distributing content, copying it and accessing it has also raised concerns about the diffusion of material viewed as offending social norms. It is clear that the traditional means by which governments have attempted to regulate illegal and harmful content are being challenged by digital means of production and distribution. Experience has shown that, while necessary to implement policy responses to the use of networks in disseminating harmful and/or illegal content, these policies need to be proportionate to the problem and should ensure that the benefits that can derive from the development of new services are not jeopardised and are, in fact, encouraged in order to outweigh any negative aspects. Proposals have also been put forward for the OECD to provide an overview of national initiatives and examine the necessity and eventual possibilities for increased international co-ordination.

The issue of illegal and harmful content over global electronic networks needs to be addressed in a manner which is proportional to the problem and which recognises the importance of the principle of free speech. The identification and implementation of appropriate and effective global solutions requires international co-operation.

Although unfortunately open to certain forms of abuse in this context, it needs to be emphasized that the Internet is still in an early, formative stage. It is a fragile and highly dynamic medium whose growth and development, together with its promise of enhancing economic productivity and social well-being, could be severely stifled by excessive and/or premature regulations. Governments need to bear this risk in mind in carefully considering which regulatory tools are appropriate or relevant to the Internet.

On the other hand, positive developments which should be considered by OECD governments include self-regulation initiatives by Internet service provider associations together with software based classification systems which allow users to control access and impose their own restrictions . Furthermore, increasingly sophisticated technological means are available to track the "electronic trails" by which illegal activity in this medium can be identified. Serious consideration should be given to technical tools to filter out content that users might find offensive or that should not be accessed by minors.

Consideration should be given to the concept that information on the Internet should be allowed the same free flow as paper-based information and any restrictions should respect fundamental rights such as free speech and privacy.

Responsibility for dealing with illegal activity over the Internet should remain with the existing competent authorities such as the police and courts. These may be significantly aided by international co-operation and new technologies applicable to solving electronic crime.

Cultural and linguistic diversity

Media ownership restrictions in OECD countries have traditionally involved not only the goal of ensuring a degree of pluralism within the national boundary, but also that of protecting national and regional culture. Such ownership restrictions may be expected to come under pressure *vis-à-vis* their effectiveness in a Global Information Society. Open competitive markets must not be viewed as antagonistic to concepts of cultural and linguistic diversity. On the contrary, in these markets where there is vibrant competition, low prices and rapid service diffusion, domestic industries have an incentive to produce content at a much more rapid rate, and of higher quality, than in closed markets which tend to be limited in size.

Dynamic competition could be one of the important means to promote cultural and linguistic diversity and rapid development of new, networked multimedia services through enlarging the market base and through price effects. Cultural and linguistic diversity is important in the development of global electronic commerce.

Maintaining and enhancing cultural and linguistic diversity will also continue to be an important policy goal for governments. Current mechanisms may need to be progressively adapted for the GII-GIS environment. Initiatives and projects which provide positive inducements and support for content production in the context of dynamic competition are recommended.. In a competitive environment, the preservation and diversification of cultural and linguistic diversity may require use of different means amongst which it will be necessary to find an appropriate balance.

Pluralism, culture and cross-media ownership rules

Pluralism is normally perceived to be an essential element of society in OECD societies allowing for a level of diversity of opinions, ideas and information available to the public to enable them to make relatively informed choices. In nearly all cases policies for pluralism also include elements of competition goals and economic efficiency, especially in so far as these are often complementary to the pluralism goal. Pluralism concerns are often closely linked to limits on foreign ownership participation in national broadcast markets.

The review and, if necessary, the reform of cross-ownership rules is called for. This needs both to reflect and encourage the development of new multimedia markets. This does not necessarily imply simply lifting restrictions (although in

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many cases this may be appropriate), but rather a refocusing of instruments, particularly as regards the measurement of control and influence.

Over time, as convergence progresses, assumed distinctions between markets based on the technical nature of the transmission media could require revision. The implications of the distinction between broadcast and narrow or monocast service may need to be re-considered.

Government as a catalyst

The government's role in providing the optimal conditions for the development and deployment of infrastructures, applications and services is not limited to the establishment of the appropriate regulatory framework and safeguards. The government also has an important role to play as a catalyst for enhanced use and development of the Information Society. As a large potential user of information and communications services, the public sector itself has an important role to play in stimulating the development of and investment in new network-based services and information infrastructures through providing the critical mass for new applications.

Governments should play an important role as catalysts in promoting and encouraging investment by the private sector and in stimulating new demand. Governments should promote strategic research and development programmes, launch user-oriented pilot projects and promotional activities, provide test-beds for experimentation and promote international co-operation in these areas.

Governments are encouraged to use new electronic delivery systems and software to provide the means to significantly enhance the internal efficiency and productivity of public administrations. These should also be used externally to enhance public awareness of government programmes and facilitate filing and submission for citizens of government documents and applications.

Governments are also encouraged to use new electronic media to the greatest possible extent for the delivery of their core public services. In particular this would concern public information and cultural resources, databases for health services, web sites at local, regional and national levels, and public libraries and databases.

Governments have a role in stimulating public demand for on-line services and encouraging social adaptation to the new electronic environment via public

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information and training programmes on the increasing range of services and public access points available. This is central to the policy goal of promoting lifelong learning and improving health services and standards of living for all citizens and relates to the previous recommendations concerning universal access to public gateways and resources of the Information Society at public access points.

Stimulating new demand

Alongside considerations of supply side policy reforms for the development of the GII-GIS, demand side initiatives and concerns also need to be addressed. On the one hand, governments must adapt, both structurally and substantively, a broad range of policy areas and regulations in order to create the right conditions for the market to meet the already existing and growing demand for new consumer services and new ways of doing business. Governments may also find they have a role to play in stimulating and encouraging demand for the new services which the GII-GIS is making available.

Governments need to examine the issues which relate to conditions which may encourage or retard growth in the demand for GII-GIS applications and services, as a means of further accelerating the creation of wealth and employment in the Information Society. Since data in this area are limited at present, this implies the need for a greater priority to be put on further research and analysis in this area.

In this respect governments should strengthen the economic, regulatory and statistical analysis as regards demand. In addressing these issues the OECD can play a vital role. In this context the OECD has already established a new Working Party on the Information Economy and a statistical panel which is also focused on these issues.

A need for fundamental policy review

The economic and social benefits of information infrastructures and of multimedia services and content are dependent on the development of a market structure being in place which supports diffusion of new services, supports convergence of industries and services, supports efficient pricing structures, and supports employment creation and productivity growth. Governments need to take a proactive response to GII-GIS develop-

ments and applications. The challenge in the development of the Global Information Infrastructure and the Global Information Society is that nearly all areas of the economy are being impacted.

Given that it is and will be primarily the private sector providing the stimulus and investment in the GII-GIS, it is important for governments to devise and maintain policies in each application sector which will continue to promote robust business investment and development, and to progressively open all Information Society sectors more widely to all private investment.

It is, in general, recommended that governments begin a fundamental review of how developments in the GII-GIS can be harnessed in a number of different areas and industry sectors, and what policy changes may be required to facilitate change and use technological changes to optimally enhance economic welfare.

IV. CONCLUSION

There is recognition by governments that market competition must form the basis of the GII-GIS. Inefficient markets, high prices and insufficient competition will all slow down the development and diffusion of new applications and, in turn, significantly dilute the benefits of the GII-GIS. Present communication market structures and policy frameworks in many OECD countries are not yet conducive to support the rapid and efficient development of information infrastructures and multimedia applications or the development of electronic commerce. The development of a network-based information economy requires:

- the availability and diffusion of high-speed interactive infrastructures;
- fair access to and use of infrastructures for both customers and service providers;
- the interconnection and interoperability of infrastructures and services;
- growth and development of multimedia services;
- transaction and information safeguards which ensure privacy, confidentiality of information, and security of payments and protection of intellectual property.

Government action is important since the developments taking place in the Information Economy can be harnessed to better meet some of the key challenges they face, such as the need to stimulate sustainable economic growth, the need for greater social cohesion and issues arising from an ageing population. Above all, there is a need, in a large number of policy areas, to examine issues within the context of the development of global markets and thus in the context of international co-operation. The OECD, in its work provided to Ministers in 1996 on *Technology, Productivity and Job Creation*, argued that by facilitating the transition to a new growth model, OECD countries could stimulate long-term productivity growth and employment. It is this vision which can become reality by taking concrete and rapid changes to make appropriate reforms for implementing Global Information Infrastructures and the Global Information Society.

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These are some of the questions forcefully addressed in this issue of the STI *Review*. An Appendix provides a set of policy recommendations for the Global Information Infrastructure-Global Information Society, approved by OECD Ministers in June 1997.

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