ISSN 1018-5593

The Economics of the Information Society

Edited by Alain Dumort and John Dryden

Editorial Committee: Timothy Fenoulhet
Akio Onishi

EUROPEAN
COMMISSION

EUR 16676 EN

The Economics of the Information Society

Edited by: Alain Dumort & John Dryden
Editorial Committee: Timothy Fenoulhet & Akio Onishi

EUR 16676 EN

EDITORIAL NOTE

This publication, wich is a compilation of a selection of papers presented by participants during the first three of a series of six OECD workshops on 'The Economics of the Information Society' organised in association with the European Commission, is published by the European Communities by arrangement with the OECD.

A great deal of additional information on the European Union is available on the Internet. It can be accessed through the Europa server (http://europa.eu.int)

Luxembourg: Office for Official Publications of the European Communities, 1997

ISBN 92-827-9523-3

Printed in Belgium

Table of contents

Foreword
by
Donald J. Johnston

Secretary-General
Organisation for Economic Co-operation and Development

There is ample evidence that progress towards the development of the Global Information Infrastructure (GII) and the transition towards an emerging Global Information Society is likely to be rapid.

The gathering pace of technological development and economic globalisation has been accompanied, within the OECD countries and indeed in many countries outside the OECD area, by a reshaping of policies and regulatory regimes, to favour the development of competitive information and communications infrastructures. When interconnected, these will constitute the GII. Increasing competition, within an exceptionally vigorous and successful private sector, is speeding its deployment and the exploitation of its potential for productivity, job creation, economic growth and social and cultural enrichment.

Although the OECD has been drawing attention to the importance of information and communications technologies for the future socio-economic fabric of its Member countries for at least two decades, it is only recently that the vision of a true and just information society has caught the attention of policy-makers at the highest level. Moreover, the realisation of such a society within the OECD membership will lay much of the foundation for the rapid evolution of the developing world, the most daunting challenge of our time.

The OECD Committee for Information, Computer and Communications Policy (ICCP) is contributing by focusing its attention on these issues. It launched a series of Workshops on the Economics of the Information Society in mid-1995, in close co-operation with the European Commission, to encourage the development of the leading-edge economic research, data and analysis which is a prerequisite for informed policy discussions at the national and international level.

It is my hope that this book, drawn from material presented at the first three Workshops, in Toronto, Istanbul and Tokyo, will bring this expertise to a wide audience and encourage further reflection on the challenges posed by the information society. I would like to express my appreciation of the fruitful co-operation between the OECD and the Commission of the European Communities, and my best wishes for the success of the future Workshops.

Foreword
by
Martin Bangemann

Member of the European Commission
Industrial Affairs, Telecommunications, Information Technology

Around the world, citizens, corporations, and governments are affected by the transition to an information age. The technical ability to transmit sound, video, and text around the world in a matter of seconds across global communications networks is opening up new challenges and opportunities for everyone.

Within an adapted economic and social framework, businesses will be able to fully exploit the global opportunities of the new communications environment and develop the networks, services and applications of tomorrow, and society will benefit from an exciting choice of innovative services, new creative job opportunities, and reduced prices. However, if economic activity is to prosper in the face of profound changes brought on by informatisation and globalisation, radically new institutional, industrial, and organisational structures will have to be introduced.

Conscious of the seriousness and urgency of these challenges, the European Commission is pooling together its efforts in its various areas of competence to articulate a coordinated strategy which aims to establish a comprehensive framework for action in the European Union covering not only telecommunications issues but also a number of other policy areas. These efforts are also being pursued at a global level through the promotion of dialogue and cooperation with our neighbours and international partners. Having established a variety of different consultative fora, the Commission is also encouraging a wide range of actors to take part in the policy debate, in particular to tackle some of the more sensitive social and societal implications.

An important challenge for governments is to ensure that the information society is a job creating society. The G7 Summit in Detroit entrusted the OECD with the difficult task of studying and analysing in depth the impacts of technology on productivity and job creation. As this publication testifies, the European Commission is also lending its support to these activities. It therefore gives me great pleasure to see the joint efforts of the two institutions to draw on the considerable expertise of economic researchers from around the world embodied in this book.

Introduction
by
John Dryden

Head, Information, Computer and Communications Policy Division
Directorate for Science, Technology, and Industry, O.E.C.D.

The rapid progress of development and innovation in information and communications technologies, combined with the globalisation and interdependence of modern economies and the liberalisation of communications markets coupled with regulatory reform, has set the scene for the development of a "global information infrastructure", which will be the platform upon which the emerging "global information society", with all its challenges and opportunities, will be built.

Although the OECD has been drawing attention to the importance of information and communication technologies to the socio-economic fabric of its Member countries for at least two decades, the vision of an "information society" where integrated communication infrastructures and services would provide new opportunities in an enormous range of activities has only now begun to be generally grasped by policy-makers in the highest tiers of government.

Many national studies and plans for the development of information infrastructures have been developed, and there have been several important international initiatives in the context of, for example, the G-7, the European Union, the Asia-Pacific region and the OECD itself. At the annual ministerial meeting of the OECD Council in May 1995, the Member countries requested the Organisation to extend its existing work on the development of policies to foster the contribution of technological advance to innovation, growth and employment to a more wide ranging study of " the global information infrastructure and global information society". The latter was to address, notably, economic issues of the information society, encompassing theory, analytic methodology and state-of-the art empirical work. It goes without saying that an essential complement to such work is the development of measurement tools, statistics and indicators to assist in the understanding of the processes involved and to help formulate, implement and evaluate the appropriate policies.

Among the activities initiated by the OECD in response to this initiative are the "OECD Workshops on the Economics of the Information Society". These Workshops are the fora in which academics, national and international officials, private sector figures representing both user and producer communities and non-governmental organisations can discuss the key economic and social issues and take stock of the most current thinking on where these trends are taking our economies and our societies. The workshops are under the aegis and direction of the Information, Computer and Communication Policy Committee at the OECD. The European Commission has been a full and active partner in this process right from the beginning, with the first Workshop in Toronto in June 1995.

There are many important issues to explore concerning the development of the "information economy" and its impact on society. It is not difficult to compile a list of such questions, although most of them are difficult to answer. It is hoped that the Workshops will, at least, help make a start on answering some of them. Among them, ranging over the many levels and aspects of the economic and social landscape, addressed in the first three Workshops - Toronto, Istanbul and Tokyo - are:

In the macroeconomic context:

- How does the development of information infrastructure contribute to the economy?
- Can greater, more stable, growth be attained through the development of the information society?
- How much does productivity improve? What are the implications for employment and job creation?
- What are the impacts for industry and enterprise organization and structure?

In the microeconomic context:

- How should "network services" be priced?
- What do new network services bring to the organization? How will they affect the efficiency of markets?
- How do relationships among organizations change with the advent of network services and transactions?

Also, in the social and institutional context:

- How will the implementation of electronic transactions affect market rules and customs?
- What legal constituency or jurisdiction will apply to transborder electronic transactions?
- What are the new roles for skills and knowledge in the information society? How will human capital interact with technological development and regulatory reform in the new economic environment?
- How will the roles of education training and life-long learning change?

As can be seen even from such a short illustrative list it is necessary to bring together a wide range of areas of expertise to tackle the issues raised by the emergence of the information society. Clearly, inter-disciplinary efforts are required. Also, the continuity of such exercises is of paramount importance to explore so many rapidly evolving issues and to promote the on-going development of research and analysis. This is particularly important in areas such as the development of statistical indicators and reporting systems, where there is typically a long lead-time before usable results become available.

These concerns provided the initiative for launching the series of workshops. Taking the series as a whole, the activity contributes to the whole range of important issues arising from the development of the information society, though each individual workshop is, within this wider context, dedicated to a specific theme, gathering the views of leading experts. Thanks to the Member countries, various partner institutions, and the European Commission, the first three workshops were successfully organized between June 1995 and March 1996.

The first meeting took place in Toronto, Canada on 28-29 June, 1995, hosted by the Center for International Studies (CIS), University of Toronto. Institutions contributing to the organisation were ENSAE-CREST (Paris), WZB (Berlin) Brookings Institution (Washington, D.C.), MERIT (Maastricht), the Korea Information Society Development Institute (KISDI) and Industry Canada. The major theme of the discussion was the macroeconomic impact of the development of information society. Expert views on trends and driving forces and recent research results were presented on the issues of economic growth, productivity, and employment. The discussion also covered analytical methodologies and data issues.

The second meeting was held in Istanbul, Turkey, on 14-15 December, 1995. It was hosted by TUBITAK-BILTEN, the scientific and technical research council of Turkey, and co-organized with the Turkish Government. The focus of the meeting was network economics. The economic nature of network services, such as Internet, mobile telephone or other types of new network services, and their impact on the economy and society by their diffusion were the main discussion topics.

The third meeting took place in Tokyo, Japan on 4-5 March, 1996. It was co-hosted by the Japan Information Processing Development Center, and Posts and Telecommunications International, Japan, and co-organized with the Ministry of International Trade and Industry, the Ministry of Posts and Telecommunications of the Japanese Government. The focus of the workshop was the impact of electronic commerce. Impacts upon various economic entities and activities due to the growth and diffusion of electronic transactions were considered. Discussions covered issues such as the new activities and restructuring of firms arising from the intensive usage of electronic transactions, issues concerning institutional settings and legal implications, including the security, liability and regulations covering electronic transactions in the national and global economy.

In compiling this volume, the editorial committee had some very difficult decisions to make when selecting the papers to be included. The 29 chosen papers, intended to represent all the key issues and interesting perspectives presented at the three workshops were specially edited. Some special consideration has been given to the structure and presentation of the papers. The papers have been regrouped to cover the issues which were the major thrust of the three workshops: the first chapter representing the macroeconomic impacts; the second chapter the discussion of network economics; and the third chapter the impacts of ICT usage and network transactions.

Finally, one chapter is devoted to issues of measurement, data and indicators which was one of the common issues in each workshop.

The final session of each workshop involved a brainstorming among the experts and session chairmen on priorities for further research agendas. The outcome once again highlighted the magnitude of the task ahead. It is extremely difficult to reach an understanding of how the information society will develop and work, but we hope that the workshops, and the publication of this book, contribute in some small measure towards this goal.

Introduction
by
Christian Garric

Honorary Director
European Commission
DG XIII: Telecommunications, Information Market and Exploitation of Research

The introduction of interactive multimedia services and the convergence of the three sectors - telecommunications, information technology, and broadcasting - are key factors driving us towards the Information Society. This convergence is already giving rise to a thorough review of current regulatory systems. Policymakers and industry are engaged in a deep reflection on the industrial and market structures which can best meet the new challenges of an increasingly globalised and competitive economy.s

The contents of this book bring together the results of selected economic and statistical research on subjects which are central to the concerns of the policymakers in the field of telecommunications or, more broadly, the information society.

The European Commission has undertaken to stimulate the development of a coordinated framework for the European Union's entry into the age of the Information Society - a word aptly reflecting the dual concerns of the Commission on this issue. On the one hand, the introduction of the necessary infrastructures and applications (electronic highways or information infrastructures), on the other hand, mastering the inevitable societal changes. Among the measures related to the first concern is the drafting of legislation to establish the regulatory framework necessary to meet the target for the full liberalisation of the European telecommunications sector by 1998. The measures concern mainly interconnection, licensing, open network provision and universal service.

The evidence available so far indicates that the theoretical bases for shaping such measures are far from being clear and easily applicable in real life. It is therefore essential that the considerable efforts to carefully monitor the economic and social impacts are vigorously pursued so that findings can be taken on board as the legislation progressively produces its effects. It is therefore important to have access to accurate and consistent indicators. These efforts should in particular be targeted at investigating the structural impacts on the economy, on the diffusion of productivity gains, and on the evolution of employment, which is one of our key social concerns.

In an effort to associate the different parties concerned with its various Information Society activities and to benefit from the views of experts on social and societal issues, the

Commission has created two advisory groups: the Information Society Forum comprising of 120 representatives from a range of different sectors, including the social partners, and a High Level Group of Social Experts. In addition, a number of studies and stimulation activities are also being carried out, in particular in the field of education and training, and teleworking. Conscious of the fact that the market alone may not be able to develop and supply certain applications which are crucial for our society, such as in the fields of health and education, the Commission has launched its Trans-European telecommunications Networks action which aims at stimulating the implementation of applications of public interest (e.g. health care management, education and training, transport, etc.).

As we can observe today, the rapidly changing world continues to raise new issues for reflection, and new opportunities for action. This book gives us a first opportunity to consider, thanks to the analyses provided by the different authors, some of the lessons which can be drawn from the valuable work contributed so far in the framework of the OECD-European Commission series of workshops on the Economics of the Information Society.

In the light of the success of the first three workshops, held respectively in Toronto, Istanbul, and Tokyo, the OECD and the European Commission have jointly agreed to publish this first volume in order to validate the quality contributions and papers provided by the participants. It is also felt that such a publication would reach a wider audience and thereby help to promote the valuable work being conducted by the OECD and the European Commission in this field.

About this book

This book is structured in such a way as to present the leading perspectives on the key economic issues concerning the development of the information society. These issues have been grouped into four chapters. Firstly, the macro-perspective is presented with a discussion of the nature of the knowledge based economy and an investigation into the impacts of information and communication technologies (ICTs) on economic growth, productivity, and employment. The second chapter is devoted to the economic questions on the "characteristics of the networks", in particular in terms of investment requirements, costing and pricing. In chapter three, electronic commerce is identified as the key driver for changes in the economy and in the behaviour and structure of firms. In the fourth chapter, the need to re-appraise current statistical practices to enable policymakers and users to have access to internationally harmonised, reliable and accurate data is highlighted. Current initiatives in this domain need to be reinforced at an international level to inform policy makers on progress in the development of the information society.

As we move to a knowledge-based economy, new industries and new markets are expected to emerge, leading to the creation of new jobs. Productivity gains from the introduction of such technologies are expected. Knowledge is identified as a vital economic resource in such an environment. Clearly, new technologies are giving rise to dynamic economic activity, but a discussion of the impact of ICTs on the economy and society in general, reveals that many fundamental questions still need to be answered. Among those questions are:

- How the development of the information infrastructure will contribute to the economy (growth, employment, organisation, etc.)?
- How does ICT affect productivity?
- Is ICT directly responsible for productivity gains?

The answers to such questions will have strong implications for policy formulation aimed at the development of not only national but also the Global Information Infrastructure and Global Information Society (GII/GIS). Strong efforts are being made in academic research to find the answers to such questions. However, research results are not always consistent with the generally perceived intuitions. Hence, the so-called "Solow's paradox" shows us that it is difficult to statistically prove significant increases in productivity due to IT investment. Similarly, a well-defined relationship has yet to be shown between telecommunications investment and productivity gains, or economic growth.

To identify the impacts of such technologies on economic activities, it is also necessary to look at developments at the micro-level. In other words, changes in the activities and behaviour of firms should also be studied. Case studies are the typical method to analyse firm behaviour. Usage of ICT may alter the way people work, and the way firms are organised. Identification of such phenomena are necessary to answer the larger scope of the question.

Chapter One, entitled "The Dynamics of the Knowledge-Based Economy" presents the findings of leading researchers on the new economic relationships observed within the telecommunications sector, how telecommunications can improve economic performance, and what impact these changes are having on industrial and regulatory strategies.

To realise the global information society, it is clearly necessary to invest heavily in the development and deployment of the information infrastructure. It is also important to decide on the best ways to deliver the necessary communications services in an economically rational way. A vital part of that decision depends on the "pricing" of network services. Thanks to the rapid development of the technologies and investment activities, already many new network services are becoming available. And service providers and operators are offering those services a variety of different pricing strategies. Internet, mobile phones, and direct satellite broadcasting provide good examples. As a result of these issues, governments need to find answers to a range of important questions in order to formulate their policies. The communications industry in most of the OECD countries has in general been subject to strict regulatory controls. As a result the policy makers' decisions directly affect to the development of the information infrastructure. Therefore economic research on the nature of the "network" and "network services" are directly connected to the formulation of regulatory policy . The important questions which need to be answered are:

- What is the likely scenario for the development of information infrastructure?
- What is the "cost" of developing the infrastructure?
- How should the "pricing" of the networks services be considered?
- How should the "universal service" be treated in this new environment?

Finding answers to such questions against the background of rapid technological development is not easy. But the difficulty also stems from the particular characteristics of a "network" from the economic standpoint. An example is the so-called "positive externalities" generated by the network, i.e. the more subscribers to the network, the greater the value of the network to the existing users. However, it also contributes to the complexity of the development mechanism of the network and of estimating the benefits for users and suppliers arising from the expansion of network services. Also the "cost" which is associated with the benefit needs to be analysed. "Pricing", in a broader sense, therefore, would govern the development of the network or the availability of the network.

Chapter Two, entitled "How much will it Cost? Pricing, Costing, Invesment", presents some of the leading research results on measuring the scale of investments required and calculating access and service pricing.

Turning to the users' side of network services, one of the most attractive applications is for commercial transactions. Electronic commerce could be the one of the most influencial ways of using the network. Business entities have already been engaging in electronic transactions using such methods as Electronic Data Interchange. More recent technological devgelopments are giving rise to more advanced versions of such transactions, such as Computer-aided Aqcuisition and Logistic Support . Transactions between consumers and producers are also becoming possible on the "open network" such as Internet. Even payment on purchase of goods can be effected electronically. The Internet already opens the way for international transactions. These developments concerning network-based transactions are likely to give rise to significant changes in the relationships between firms, and between firms and consumers. The service provision of the firms is likely to change significantly. There is also evidence to suggest that networking is having an impact inside the firm as welll. ICT usage is giving rise to changes in the structure and functions of organisations. Offices or factories may be re-located; teleworking from home may reduce the need to commute to work. Electronic transactions may thus significantly alter the way industries are organised. The questions which need to be answered are:

- Are ICTs contributing to the economy and how?
- How are ICTs affecting the productivity of employees within anorganisation?
- How are ICTs contributing to the re-structuring of enterprises and their work processes?
- What organisational impacts can be observed?

Chapter Three, entitled "Working with New Technologies and Services in the Organisation of Tomorrow" shows, with the help of selected case studies, how organisations are achieving significant improvements in performance through ICT usage, how firms have used ICT's as an enabler for implementing business process re-engineering (BPR, how telecommunication technologies are drastically changing customer service provision in the banking sector, and the impact of teleservices in terms of spatial and organisational effects. The chapter also presents research results on the various impacts of electronic transactions and identifies electronic commerce as a key driver of the development of advanced communication systems. Indeed, a range of electronic commerce issues are examined from organisational, institutional, and financial perspectives, including: the affect on business processes, what are the obstacles to further development, the problems, such as network security, associated with the introduction of online payment systems, the role of intermediaries and how industrial structures are changing.

As seen above, the development of the information society is bringing about significant changes in economic and social activities. Against this background, it is the responsibility of policy makers to implement measures to allow timely management of change. To support the policymaking process, it is therefore essential to have access to reliable means to monitor the information society as it develops. The task of measuring these developments is made extremely difficult by the rapid pace of advances in technologies, products and services in the ICT-related industries. The available data and statistics are in most cases ill-adapted to the rapid changes occurring in industry, such as convergence and the increase in production of immaterial goods. Furthermore, international coordination and organisation of data is required in order to help make comparisons between countries, as well as sectors, at different stages of development.

Chapter Four, entitled "Monitoring the Development of the Information Society" is devoted to these issues and discusses the need to develop accurate and reliable indicators to support the policy making process. The difficulties of measuring the precise economic impacts of the information sector are examined. The European COINS project is presented, and some of the data sources at Statistics Canada and relating to the information society are examined.

In order to give further guidance to the reader, each chapter is preceded by an executive summary, providing an overview of the issues discussed and conclusions reached by the authors which follow. A selected bibliography is provided at the end of each chapter and the appendix contains a range of data and statistics on the information society.

The Dynamics of the Knowledge-Based Economy

CHAPTER 1

A key determinant of the economic system is its capacity to effectively and efficiently distribute knowledge. This will in part depend on the openness of the system and the form the information, as the essential commodity of the knowledge-based economy, takes, in other words the degree to which it is codified. **Dominique Foray** defines codification as the "process of conversion of knowledge into messages which can be then processed as information and that "codification is a strategic instrument available at certain costs for agents to pursue any strategy." Putting knowledge into a code enables knowledge to be shared within a certain group or it can be used to restrict its distribution. He looks at the microeconomic impacts of knowledge codification on technological learning and the institutional structure of innovative activities, and in particular how it affects the distribution of knowledge in innovation systems. Though there are considerable difficulties in actually measuring codification activity, Foray argues that as the use of IT as a means of processing, storage, retrieval and use of information intensifies, it can be safely assumed that the codification of knowledge and the knowledge-base itself must be increasing at a significant rate.

The changing role of telecommunications in the economy raises a set of fundamental questions, in particular to what extent IT and telecommunications contribute to economic growth. **Anna Creti's** analysis looks beyond the technological dynamics as a major cause for the restructuring of the telecoms sector, and examines the institutional and demand dynamics and the new economic relationships observed within the sector in order to draw conclusions on the broader societal impacts of the telecommunications sector. She adopts both a *new micro-economic perspective* in order to explore the factors affecting the new marketing and competitive strategies suppliers have to put in place in view of the technological, institutional and market dynamics the sector is facing, and a *new macro-economic perspective* which considers the use of telecommunications as a strategic input in production, increasing productivity, and consequently, economic growth. Anna Creti concludes that substantial time is required before the potential productivity benefit of these technologies is realised because of the need to engage in parallel reorganisation of production and societal arrangements. The advantages derived from telecommunications technologies stem in particular from their nature as interrelated technologies generating positive externalities which affect industrial performance and, via multiplicative effects, national performance.

Charles Hulten explores the implications of investments in IT infrastructures as a policy instrument for economic development and job creation. Hulten argues in favour of the new "Public-Investment Economics" approach which involves stimulating the demand for labour by raising the marginal productivity of the workforce through increased spending on public infrastructure capital and human capital. In his discussion of different evaluation techniques, Hulten argues that the extrapolation of results based on infrastructures which are clearly institutionally distinct ("the infrastructure hypersector approach") should be avoided, and that infrastructure projects should be evaluated on their individual merits and characteristics through recognised procedures such as cost-benefit analysis. This new approach can also help take into account important *spillover benefits* that are felt beyond the individual sector or jurisdiction concerned. He warns that even if IT investments have strong growth externalities, the job creation objective may be frustrated by the fact that the adoption of IT technologies may only raise the productivity of high-wage, high-skill workers and render the low-wage, low-skill workers increasingly redundant, therefore reinforcing the very effect that such a jobs policy initially set out to reverse.

Cristiano Antonelli demonstrates how his research on changes in telecommunications usage as a result of innovation and the relationship between telecommunications cost share and marginal productivity levels tends to support the concept of interoperable and interconnected networks. He also shows how radical innovations in the usage of telecommunication services have drastically changed the role of telecommunications in the economy. Today, usage of telecommunications services is associated with the opportunity to extract significant quasi-rents, he argues. Antonelli's analysis based on empirical evidence of the Italian case in the mid-80s confirms the significant difference between telecommunications cost share and marginal productivity levels. Antonelli observes that the opportunity to reap transient quasi-rents has in turn pushed large users to innovate so as to become major players in the arena of technological change in telecommunications and information technologies. In such a context, he concludes, if telecommunications operators reduce their tariffs, users would draw considerable benefits and the consequent increase in demand and in revenue would more than compensate for the impact of the tariff reduction.

Hans van Meijl and **Luc Soete** focus on the intersectoral spillover effects of IT investment referred to in Charles Hulten's paper and seek to apply their spillover model to the knowledge field referring, like Foray, to the significance of the increased codification of knowledge. IT is identified as the key technology influencing all sectors of the economy. IT investments in particular are expected to have a considerable influence on the productivity level in every sector. However, so far, many empirical studies based on the production function approach have failed to identify a statistically significant relationship between IT and productivity. This is often referred to as the "IT productivity paradox". The authors are able to exploit data based on French evidence (sectoral data from the INSEE, France) covering the period 1977-1992 in order to investigate this "lag" hypothesis and to study the existence and magnitude of spillover effects related to IT and their influence on productivity growth, by investigating the magniture of these spillover effects over time. The investigation is based on the authors' spillover model whereby the productivity growth of a firm is dependent on own R&D expenditures and three kinds of spillover effects: "rent spillovers" related to investment and intermediary goods, and "pure knowledge spillovers". They are able to show that, besides internal R&D, R&D spillover effects are important for productivity growth, especially those spillover effects related to IT capital goods (e.g. computers). Furthermore, they found that the impact of IT spillover effects on productivity has spread in recent years in those areas where higher levels of IT penetration in society have been observed, thus concluding that the " IT productivity paradox" is vanishing.

Timothy Fenoulhet discusses some of the key regulatory and policy implications of the development of information infrastructures by examining, in particular, the impact of ICTs on market structures in the telecommunications and broadcasting industries, and analysing the consequences for regulation. He refers to a range of regulatory reforms that have recently been implemented in OECD countries or which are currently under discussion and sets the context for some of the policy issues raised by some of the other contributors to this publication. He refers to the impacts of convergence and globalisation on communications markets and how this is putting pressure on the formerly rigid and separate market structures and influencing changes in user demand patterns. He concludes that faced with the need to adapt to a multi-network and multi-service environment, there is already evidence to suggest that the scope of regulation is changing and that it is possible to observe the convergence of regulation itself as content distribution becomes network independent. He points out that the role of regulators must be to strike a balance between, on the one hand, providing appropriate market incentives to stimulate investment infrastructure and the development of applications, and on the other hand, introducing regulatory instruments to safeguard the new competitive environment, ensure pluralism and diversity of content, and provide adequate protection for citizens and organisations against various forms of content abuse.

Using "the digital chain of multimedia", **Christian Micas** explores how the advent of multimedia is transforming industrial structures and corporate strategies. He looks in particular at industrial convergence and vertical integration in both the audiovisual and telecommunications sectors and observes that market trends point towards the emergence of a vertically integrated multimedia industry offering the consumer one-stop-shopping for a range of services. Micas identifies the software developers as playing an increasingly strategic role through their presence at different levels of the digital chain. In his sectorial analysis of the impacts of multimedia he identifies a number of influential factors: the growth potential of multimedia; the rising number of strategic alliances and cross-industry joint ventures aimed at sharing assets and investment in the face of high development costs and market uncertainties; the impacts of Internet growth in terms of the restructuring of firms' activities, the emergence of new business opportunities and increasing consumer choice. He observes a steady annual increase since 1994 in the total value of acquisitions which is likely to intensify as a result of telecoms liberalisation. In conclusion, he presents policy makers with the dual challenge of fine-tuning anti-trust policies in a liberalised environment and, at a macro-economic level, responding to the often negative impact on jobs of firms directing finance into acquisitions rather than into more tangible investments.

Jerry Hausman and **Tim Tardiff** answer the question of how to value the introduction of new service in telecommunications. This question has potentially important economic consequences and equally important public policy implications. By demonstrating how to value new telecommunications services, the authors allow for a more reasoned approach to the necessary benefit-cost calculations which can help guide public investment in telecommunications infrastructure and also to evaluate the effects of regulation. They apply the methodology introduced by the Nobel prize winning economist Sir J.R. Hicks. This economic approach uses market demand to value new goods and serivces since the market establishes what consumers are willing to pay for the new good or service. They examine the consumer welfare gains from the introduction of voice messaging services by local telephone companies in the U.S. beginning in 1990. By 1994, using this methodology, the authors estimate the gain in consumer welfare from these new services to be between $800 million and $1.4 billion per year. Thus, very significant gains to consumer welfare can arise from the introduction of new telecommunications services. Government actions which either speed up or delay the introduction of these new services can therefore have important welfare effects on the economic welfare of its citizens.

Francisco Caballero Sanz and **Amparo Urbano Salvador** explore the economic rationale for the liberalisation of telecommunications infrastructures by examining the economic arguments for and against infrastructure competition. They points out that in the UK market, despite large investments by cable TV operators, only a small fraction of the UK population has access to alternative infrastructures, whilst OECD empirical evidence shows that the average price for leased-line access to the Internet in countries with monopoly telecommunications infrastructure provision is 44% more expensive than in countries which allow competition. The authors consider the different approaches to the question of which market structure - natural monopoly or open competition - is best suited to creating an environment favourable to investment whilst minimising social costs. They point out that there is a growing consensus that this is not an "all-or-nothing" question since the different components of the telecommunications network have different degrees of the "natural monopoly condition". The segment connecting each consumer to the network accounts for approximately 70% of the cost of the network and has a very low frequency of usage on average. Long distance connections present large economies of scale. But the distinction between these two generic parts of the network is changing constantly. Past certainties are therefore being increasingly challenged and in such a changing environment, definitive answers can be elusive.

The Regulatory Dynamics of the Information Society[1]

Timothy R. Fenoulhet

European Commission

Digital technologies are transforming the communications landscape from both an industrial and a policy point of view. It is now technically possible to provide telephone and content services (i.e. video, multimedia, on-line information services) point to point on a single network. The ability for broadband technologies to handle vast quantities of data at low cost is expected to foster growth in service diversification. Consequently, the arrival of "information infrastructures" means that the formerly rigid and separate regulatory frameworks for telecommunications and broadcasting, which were largely based on a single network-single service environment, need to be transformed into a system which is sufficiently flexible to address the different characteristics of the bearer network (transmission and switching capacity), basic services (voice, access to databases and electronic mail), terminal equipment, and applications ("content").

Against this background, the issue of what market structure can best facilitate the efficient delivery of communications services has drawn increasing attention from policy makers. Indeed, the communications policy environment is now changing dramatically with technological innovation giving rise not only to new services and equipment, but also to new entrants and alliances between companies with experience in a wide range of information industries including telecommunications, broadcasting, computer hardware and software, and publishing. Action is all the more urgent as industry looks to governments to create a stable and predictable environment in which they can invest and exploit the new business opportunities of the emerging multimedia sector. Meanwhile, OECD governments are seeking to cooperate in order to realise their common vision of a global 'network of

---

[1] The ideas presented in this paper are those of the author and do not necessarily represent the official positions of either the European Commission or the OECD.

networks' upon which the economic development of the planet will depend in the next century.

In this paper some of the key regulatory and policy implications of the development of information infrastructures are discussed with reference to a range of responses from OECD countries. The aim is to present the regulatory challenges, examine some of the consequences and trends, and to set the context for the policy issues raised by some of the other contributors to this publication.

1. From Ancien Régime to Digital Revolution

These regulatory changes have been nowhere more apparent in recent years than in the telecommunications sector. Up until the late 1970s, several economic, technological and political factors contributed to a telecommunications environment that could be characterised in most nations by "one policy, one system, one universal service" *(AT&T slogan, 1907)*. The telecommunications sector was essentially in the public domain with little or no competition. The situation would characteristically comprise of a single state-owned telephone company with exclusive rights to offer services to the public in a nationally delimited market. The only major regulatory constraint faced by the monopoly operator was the obligation to provide a universal service (national coverage, affordable rates, free emergency calls, public telephones).

This regulatory picture began to be questioned in the first half of the 1980s, both in Europe (the UK, in particular) and in the US. The wisdom of maintaining a regulatory system whose rules simply no longer applied to the newly emerging technological environment began to be challenged under the dual impact of increased **convergence** between computing, telecommunications, and broadcasting, and the **globalisation** of markets.

Digitisation and convergence are effectively multiplying the number of services that can be offered. The original set of complex rules were designed to ensure the so-called basic services only (essentially telephone and telex) and the application of these rules to the management of an array of new services increasingly appears to be unrealistic and potentially detrimental to their full development. In short, the technological, economic, and political factors upon which the former regulatory system had been based, were undergoing radical change.

The expansion of international trade and the development of efficient and significantly faster and efficient methods of transporting goods and services has heightened economic interdependence between nations and given rise to the globalisation of products and markets. In parallel, the industrialised economies have undergone a process of restructuring with information intensive services taking over from agriculture and manufacturing as the dominant and fastest growing sector in the economy. As a result, a major proportion of international trade involves the exchange of information and knowledge in the form of electronic data which are not subject to the rules that govern traditional international trade flows. The financial markets have already demonstrated the revolutionary effects of globalisation. Global communication networks have revolutionised the way the financial community works, and their impact on economic systems is growing. But finance is only the first sector affected by changes that will gradually extend to almost every area of economic and social life. As the key mode of transport for information, telecommunications are playing a fundamental role in the globalisation of economic activity in general.

In the future, it is widely expected that demand for **electronic commerce**, believed by many to be the so-called "killer application", will drive the rapid development of information infrastructures and spread their impacts across all sectors of the economy. Electronic Commerce will intensify the effects of globalisation by allowing SMEs in particular to extend their commercial reach to address global markets.

The globalisation of business activity is driving the re-structuring of the telecoms sector itself. Business users operating internationally increasingly require the same telecommunication applications support that they receive at national level. In the past, large users of telecommunications services found it cost-effective to build and operate their own private networks to ensure reliable, high quality network services. However, today, large multinational corporations needing to transfer large amounts of information around the globe, prefer to "outsource" these activities on a 'one-stop-shop' basis to global operators able to provide seamless international communication networks rather than being in the network business themselves. These developments explain the creation of "global alliances" such as the AT&T-Unisource "Uniworld" venture, BT-MCI's "Concert", and France Télécom, Deutsche Telekom and Sprint's "Global One" initiative. Telecommunications are thus being transformed from a supply- to a demand-led industry with PTOs following their major customers into international markets and seeking greater regulatory freedom to meet user requirements nationally and internationally.

The proliferation of ways to send, receive and manage information over telecommunications networks, and the resulting new products and services has indeed meant that it is increasingly difficult for the public telecommunications operators (PTOs) to satisfy all types of users under traditional monopoly arrangements.

These developments have placed challenging tasks before policy makers at a time when greater recognition is being given to the importance an efficient telecommunications system can have in overall economic development. Indeed, the major policy drive towards full liberalisation of the telecommunications sector observed over the last decade is aimed not only at providing a boost to the telecommunications industry by allowing the full deployment of international strategies, but to stimulate economic activity as a whole, and thereby promote growth, competitiveness, and job creation well into the 21st Century.

In the last decade telecommunications policy within OECD countries has undergone a series of changes, mostly involving the gradual introduction of competition into the sector, which can be divided into four phases as described in the box below.

Box 1: Telecommunications Competition: Four Phases

- In the early 1980s the PTOs began to explore ways to extend their control over new emerging services (mainly value-added network services - VANS). These efforts triggered a process leading to the increased questioning of monopoly provision of telecommunications services;
- The second phase (1984-1989) is marked by the first efforts to introduce competition into the sector. These initial steps towards liberalisation were characterised by an increased requirement for PTOs to facilitate and tolerate competition for VANS and terminal equipment;
- The third phase (1990-1994) has been characterised by the increase in independent regulatory control and the extension of competition to new services, in particular cellular services. Monopolies have been limited to infrastructure and real time voice services, with general acceptance that existing market structures need to change;
- The fourth phase (1995-1999) is likely to be marked by further liberalisation of infrastructures and voice services and the adjustment of the regulatory framework in order to facilitate the smooth transition to the information society and the dynamic development of global markets for information infrastructures and multimedia services and applications.

2. The Regulatory Challenges of the Information Society

In the coming years, further efforts to eliminate monopolies and quasi-monopolies will be undertaken. However, the regulatory phase upon which we are embarked today is likely to be especially marked by the merging and reform of regulatory frameworks governing telecommunications and broadcasting in order to bring them in line with the realities of the new emerging market structures and allow them to be adapted to new requirements associated with the transmission and use of new information services and content. Above all, this means removing the traditional regulatory model based on strict service boundaries and parallel non-substitutable networks and services and replacing it with a new system which addresses the new challenges we face today whilst leaving plenty of scope for flexibility as the landscape evolves in line with technological, economic, and social changes.

A first and crucial step involves, as we have seen, the introduction of competition within and between the different communications-related sectors ("de-regulation"). However, the transition to the information society also requires the writing of new rules ("re-regulation") which can help to safeguard the newly liberalised environment to avoid, for example, the emergence of private monopolies and discrimination, and to ensure diversity and pluralism in the supply of content to the public.

These safeguards may be all the more urgent if current trends in the media sector, where large-scale consolidation is being aggressively pursued (e.g. Disney-Capital Cities/ABC, Westinghouse/CBS, Time-Warner/Turner Broadcasting, Viacom/Paramount, Bertelsmann/Canal Plus/CLT), spread to telecommunications where consolidation on a global scale can already be observed (e.g. AT&T-Unisource, BT-MCI, France Télécom-Deutsche Telekom-Sprint). Sooner or later, these entities are likely to join forces thereby merging production and distribution functions. This would result in the emergence of deeply vertically integrated global media and communications "mega-companies". Such a development may require regulators to reappraise anti-trust policies.

Table 1: Regulatory Issues for the Information Society

Areas	Issue
Telecommunications Infrastructure	Competition and Safeguards Interconnection and Open Access Ownership and Licensing
Telecommunications Services	Competition and Safeguards Universal Service Interoperability Pricing
Broadcasting, Media and Content	Cross-Ownership Pluralism and Diversity of content Privacy, Security and IPRs Censorship

2.1 Content

Media Ownership

In the media and broadcasting sectors, the advent of electronic media means that new regulations have to be drawn up to cover the production and distribution of interactive multimedia content. Current laws limiting cross-media ownership in particular will have to be revised in the light of the convergence of the telecommunications, computer and media industries, as new technologies open up new possibilities for both the production and distribution of programmes and liberalisation opens up the markets to new actors. Such legislation will need to strike a balance between safeguarding competition and pluralism in the media and at the same time take into account the imperative for industry to withstand fierce global competition and exploit the new possibilities opened up by technological convergence.

The revision process has already begun in a number of countries. The former media ownership restrictions in the USA which stood at 12 TV stations and 25% national coverage were respectively eliminated and raised to 35% by the new Telecoms Act[2]. Restrictions on cable and broadcast network cross-ownership have also been removed by the new legislation.

Several European governments are also reforming their media ownership rules. French legislation announced at the end of 1993 raised the percentage of issued shares one person can own in a TV company from 25% to 49%. The lifting of the 25% restriction was justified on the grounds that it responded to the realities of the TV business: ownership restrictions were a barrier to the (global) competitiveness of firms and to competition in the market place. In the UK, a new Broadcasting Bill (amending the Broadcasting Act of 1990) is currently before parliament. The amended bill, published in December 1995, sets out a proposed new regulatory framework to amend existing media ownership rules to allow greater cross-holding between newspapers, television and radio companies, subject to 'public interest' criteria being satisfied. For example, the bill proposes to remove the current 2 licence limit on control of independent television licences, which would be replaced by a television ownership limit of 15% share of the total television audience. At a European level, the Commission launched a policy debate on the question of pluralism and media concentration in its Green Paper[3] published in December 1992 in which it assesses the need for Community action in the context of the Internal Market.

Security, Privacy and IPRs

The wide-scale use of information infrastructures for economic and social transactions and exchanges depends on the deployment of reliable systems that can guarantee ***security*** and ***privacy***. Without 'air-tight' systems to guarantee the confidentiality of credit card information, transaction processing, inter- and intra-organisational communications, as well as an effective technical and legal framework for protecting personal data (e.g. medical data) irrespective of the medium used, many of the benefits of the information society could be lost. The security and integrity of network systems and an adapted legal framework for the protection of individuals as well as data, is the condition *sine qua non* for the development of commercial services on the Internet and electronic commerce in general.

---

2 Title II, Section 202 "Broadcast Ownership"

3 "Pluralism and Media Concentration in the Internal Market", COM(92)480 final

In democratic society where freedom of expression and protection of the individual are highly valued, regulators face the enormous challenge of protecting people and organisations from electronic crimes such as fraud without infringing on their privacy. Sophisticated encryption techniques already exist but raise questions about state interference on national security, crime prevention, or anti-terrorism grounds. Further challenges are raised by the global nature of information and communication systems. As electronic commerce and new interactive teleshopping services take off, governments may be confronted with an increase in electronic fraud often carried out internationally. These developments may require a re-appraisal of current legislation governing the detection and tracing of criminals, jurisdiction, and extradition arrangements.

Efforts to introduce new legislation in these areas are fairly advanced in Europe. The European Union has already issued a Directive on the protection of personal data.[4]. The Directive, which is to be applied independently of the technique used (conventional or electronic), lays down common rules to be observed by those who collect, hold or transmit personal data as well as providing individuals who are the subjects of such data with a set of comprehensive rights to protect themselves against possible abuse. Although this general Directive applies to all sectors, a specific proposal for the protection of individuals and their privacy in the context of digital telecommunications networks and services (e.g. ISDN, and personal mobile communications) is now before the Council of Ministers.

The widespread use of information infrastructures in modern societies will also present major challenges for the definition of ***intellectual property rights*** (IPRs) which provide the right balance between protecting the rightful owners of content, on the one hand, and the free circulation of information and knowledge, on the other. In February 1996, the European Union adopted a Directive on the legal protection of databases[5]. The Directive is designed to protect those who have invested considerable human, technical, and financial resources in the creation of databases from those who copy, extract or use such content illicitly and at a far lower cost, giving rise to serious economic consequences. The Directive aims to grant databases copyright protection and protection by a new specific "sui generis" right. The Directive's provisions will apply to both electronic and paper-based databases.

2.2 Distribution

Liberalisation

There is widespread agreement that the transition to an information society and the development of information infrastructures will need to take place in a competitive market-

---

4 EU Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data.

5 European Parliament and Council Directive 96/9/CE on Legal Protection of Databases adopted on 11.03.96

based environment. But, as the experiences of countries such as the UK, Sweden, and Finland have shown, the introduction of competition in information infrastructures is a complex process involving a number of different steps including measures to facilitate multiple market entry, elimination of restrictions on cross-sector service provision (and a review of cross-sectoral ownership limitations), a review of existing policy and regulatory frameworks, and the separation of facilities (infrastructure) regulation from services regulation. There is also some question as to the effectiveness of new competition to bite into the incumbents' markets, particularly whilst they remain dependent on interconnection with the latter's own network. This raises further questions about how to calculate the correct level of access charges.

Access Charges, Costs and Pricing

The vision associated with information infrastructures proclaimed by government and industry alike consists of an interconnected "network of networks". This vision rests upon the development of suitable frameworks in which the principles and conditions for interconnection and equal access are defined: **efficiency** (cost-based access charges), **transparency** (terms and conditions for interconnection are made public and are open to scrutiny), and **non-discrimination** (interconnection under equitable terms and conditions). The key issue for interconnection and upon which effective competition in information infrastructures depends, is the question of **access charges**. These are the tariffs new entrants must pay to the incumbent for the conveyance of traffic and use of its network.

Regulators are insisting on transparency and the unbundling of costs to facilitate the identification of interconnection and other network component costs. However, in an integrated multi-network/multi-service environment it may become increasingly difficult to unbundle costs. Stimulation of end-user demand for the new services and applications of the information society will largely depend on pricing structures upon which costing will necessarily have an impact. Therefore diversity in costing will need to be reflected in pricing strategies that can be differentiated according to the characteristics of the application and its method of delivery (e.g. pay-per-use, time-based, or subscription schemes).

Competition Safeguards

It is also recognised that the new competitive environment cannot work effectively as a "free-for-all". The transition to a fully competitive environment requires an effective regulatory framework with adequate safeguards designed to counter anti-competitive practices and ensure fair and dynamic competition. This process is complicated by the merging of a number of different sectors showing different market and regulatory characteristics. The costs associated with network expansion and upgrading and the consequent need to generate new revenue streams is leading market actors to diversify and vertically integrate. Infrastructure providers are diversifying into application areas (e.g. PTOs entering video markets), and the content industries, in their efforts to control distribution of services and have direct access to customers, are diversifying into network provision. These tendencies may have serious consequences for market structures and competition - especially since telecommunications (network provision) and broadcasting (applications) are sectors with monopolistic or oligopolistic backgrounds.

Regulators must therefore decide whether or not to allow telecommunications operators to enter other market segments (e.g. video and entertainment services) and how to prevent them from retaining exclusivity of access to networks for the provision of interactive services. On the other hand, to what extent should cable TV operators providing telephony services be allowed to possess the content they distribute? On the industry side, it is often argued that vertical integration is necessary to help generate revenues to pay for costly investments in network and software upgrading and the development of broadband services. However, most governments and regulators agree that allowing full vertical integration in an industry which, until recently, had monopolistic market structures, is not conducive to a competitive environment and, furthermore, would counteract policies aimed at promoting diversity in applications development. In the early stages of competition, regulators are therefore tending not to support integration without **unbundling** through measures such as accounting or structural separation, which can help to prevent bottlenecks and cross-subsidisation.

Universal Service

Another challenge faced by regulatory authorities is whether it is still feasible, in a competitive environment, to guarantee universal services - easy to implement in a single-supplier environment, but considerably more complex in the new multi-operator/multi-service landscape. This gives rise to questions related to funding, implementation, and scope of universal services. Furthermore, there is a risk that universal service obligations may constitute a new barrier to competition in the form of a costly burden on new (and vulnerable) market entrants. In terms of funding, the most common proposal is the establishment of a **universal service fund** to which all operators would contribute and payments would be re-distributed to compensate those who supply services in uneconomic areas. Another scheme would take the form of a **supplementary charge** added to the interconnection charge.

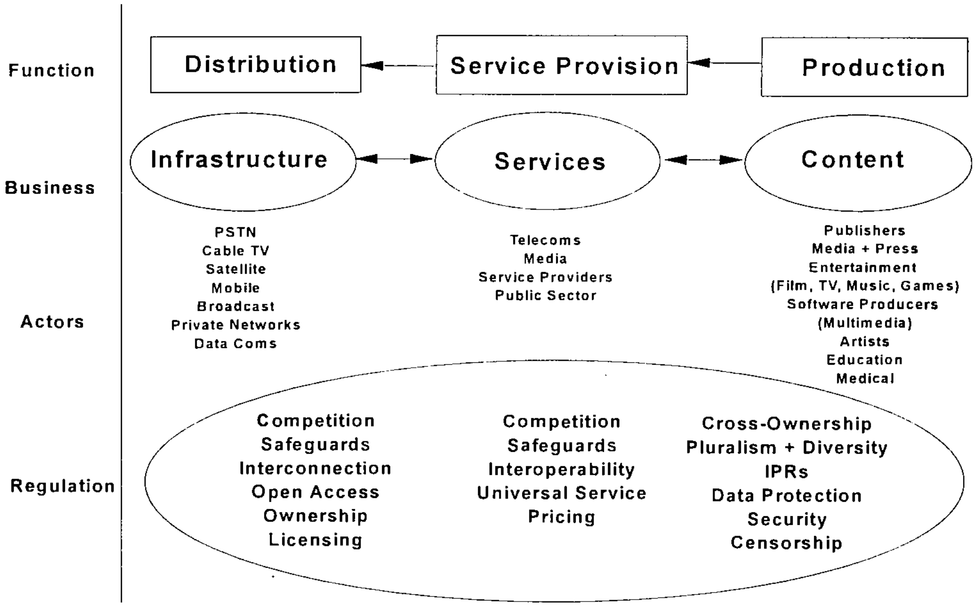
2.3 "Regulatory Convergence"

Convergence between the telecommunications and audiovisual sectors is likely to contribute to pressure for existing regulatory frameworks to merge, as it becomes necessary to include provisions governing content-based issues such as IPRs, privacy, security and censorship in telecommunications legislation and vice-versa (see Figure 1). This is already occurring in the

United States where new legislation on telecommunications, contained in the Telecommunications Act of 1996, also includes provisions on media ownership[6] and violent and indecent content[7]. Similarly, in the European Union, legislation plans are underway to extend existing regulations on privacy[8] and on broadcasting[9] so that they can apply to digital telecommunications and new interactive services.

In particular, regulations are having to be adapted because the concepts of point-to-point and point-to-multipoint communications are becoming less distinct today. As a result, the classification of new services such as video-on-demand, home shopping, and educational services cannot be considered as broadcasting, but rather are "narrow cast", even though they are provided on the same transmission medium as television programmes. It is precisely this issue which is at the root of an on-going disagreement between the Council of Ministers and the European Parliament (EP) over the revision of the EU Broadcasting or "Television without Frontiers" Directive.[10]

Figure 1: The Regulatory "Melting Pot"



---

6 Title II, Section 202 "Broadcast Ownership"

7 Title V - "Communications Decency Act of 1996"

8 Proposal for an EU Directive on the protection of personal data and privacy in the context of digital telecommunications networks

9 Revised EU "Television without Frontiers" Broadcasting Directive, full adoption pending

10 The disagreement over whether or not broadcasting rules (including broadcasting quotas) should apply to "new special individual call-up services", including video-on-demand and teleshopping, came to a head in February 1996 when the EP, on first reading, voted in favour of including new services in the Directive. The European Commission is expected to launch a wide-ranging debate on the subject in its forthcoming (1996) Green Paper on new audiovisual services.

Conclusions

The task for regulators is to remove regulatory obstacles preventing the fusion and interconnection of networks (public switched telephone network, cable television, broadcasting) and the merging of services based on different technologies and structures. They must also aim to strike a balance between, on the one hand, providing appropriate market incentives to stimulate investment in infrastructure and the development of new applications, and on the other hand, introducing regulatory instruments to safeguard the new competitive environment (e.g. abuse of dominant positions), ensure pluralism and diversity of content, and provide adequate protection for citizens and organisations against various forms of content abuse (e.g. privacy, security, IPRs).

Among the greatest regulatory challenges will be to transform two separately regulated and traditionally monopolistic or oligopolistic markets: telecommunications and broadcasting. Furthermore, these are markets that have been characterised by intensive regulation in terms of market entry, limitations on service provision, and pricing. Such a major transformation, comprising of market restructuring, increased competition, and regulatory reform, will require broad political, public, and industry support. Different market conditions will also mean that the various measures discussed above need to be introduced at different stages and to varying degrees of intensity, involving transition periods and fine-tuning to allow healthy competition to take hold in what may be a long and drawn out process.

As restrictions are lifted on the type of services offered on different infrastructures it is likely that the different regulatory frameworks for broadcasting and telecommunications will merge. This would mean that the different laws and regulations, and decisions on access, interconnection and regulatory safeguards with respect to infrastructure investment, operation and service provision, as well as on the content of those services (IPRs, security, privacy, pluralism, diversity), would be governed by a single undifferentiated decision making process and be subject to a single legal and regulatory system.

The Economics of Codification and the Diffusion of Knowledge in the Information Age

Dominique Foray

Research Fellow at the Centre National de la Recherche Scientifique (CNRS) Paris, France

Robin Cowan

University of Western Ontario

The process by which knowledge or information evolves and spreads through the economy involves changing its nature between tacit and codified forms. Typically, a piece of knowledge initially appears as purely tacit - a person has an idea. Often, though, as the new knowledge ages, it goes through a process whereby it becomes more codified. As it is explored, used, and better understood, less of it becomes idiosyncratic to a person or few people, and more of it is transformed into some systematic form that can be communicated at low costs. In some cases, as the principles underlying the piece of knowledge come to be understood, they can be written down, and the piece of information can be described as an instantiation, under certain initial conditions, of a general phenomenon. In other cases, a procedure that was developed to produce some end becomes routinized, and repeatable, which implies that it can be broken down into component pieces, each of which is sufficiently simple that it can be described verbally, or embodied in a machine. This, again, is a process in which tacit knowledge becomes codified.

There is currently a significant convergence among economists interested in macro-economic phenomena towards the argument that the so-called "cumulative expansion of the codified knowledge-base" has serious implications, altering the form and structure of economic growth and modifying dramatically the organization and conduct of economic activities (Abramowitz and David, 1996; Soete, 1996; OECD, 1996; Eliasson, 1990). If, on the other hand, some authors have explored the micro-economic implications of knowledge codification, as entailing changes in technological learning and in the institutional structure of innovative activities (Arora and Gambardella, 1994; Dasgupta and David, 1994; Cowan and Foray, 1995; David and Foray, 1995; Ergas, 1994), the bridge from those micro-economic changes to macro-economic facts is not at all clear. And even if more economists share the view that "codification is becoming the essence of economic activity" (Steinmueller, 1995), some scepticism still prevails with regard to the pervasiveness and revolutionary nature of this particular technological change. Indeed, it is rather difficult to know what is the actual magnitude and scope of diffusion of the tendency towards knowledge codification; who is bearing the costs and who is sharing the benefits of codification; and what kind of characteristics (in terms of size, space, particular coordination requirements, and so on) a system must exhibit (whether it is a firm, an industry, or a scientific community) in order to increase the value of codification for the organization and conduct of its activity. A last question, which in a sense dominates but also obscures the debate, is about the changing nature of the relation between codified and tacit knowledge. Information technology is now coming to dominate the technological paradigm to such an extent that it seems that the codification of knowledge must be increasing at a fantastic rate. After all, information technology is about processing, saving, and transmitting information or codified knowledge. This might be thought to suggest that the ratio of codified to tacit knowledge is increasing.[11] This, it is argued, comes hand in hand with the new "knowledge-based economy" which is built on the cumulative expansion of the base of codified knowledge. On the other hand, some claim that the distribution of knowledge between tacit and codified has not changed. (See Senker, 1995, Dosi, 1996, for example.) It will always be true that tacit knowledge is needed to use codified knowledge. Thus if there is an addition to the codified knowledge base, there must also be an addition to the tacit knowledge base by which agents can use the new codified knowledge and thus give it economic value. It is unfortunate, though possibly of necessity, that there is little empirical evidence on either side of the debate.

At least some of the difficulty in the debate is that it has taken place before certain fundamental (terminological) difficulties have been sorted out.

A clear distinction must be made between the medium and the message. A message is expressed in a certain code (some language) and in principle can be stored, at least temporarily, on some medium, such as paper or a diskette. This does not deny that there is a relation between the types of languages, and thus the types of storable or codifiable information, and the nature of the medium. But it is worth distinguishing clearly between them in order not to conflate technological advances of very different natures. There are on the one hand for example, increases in storage capacities of a medium, or the development of new media; and on the other hand developments of new languages. Running together medium and message can also conduce to the neglect of advances in codification for the reason that no changes are visible at the level of media. One example here might be the development of quality assurance standards which today represent a significant example of

---

11 Given the obvious difficulties of measuring how much knowledge exists, no matter whether codified or tacit, and particularly since it is not obvious that a measure could exist even in principle, it is not clear exactly what such a claim would actually mean or imply.

codifying knowledge, entailing simplification and rationalization of information systems, without involving new types of media. Traditional, existing media are used to hold information written in new forms about production processes in order to facilitate the transmission of this information among agents.

There is a further confusion between advances in codification and advances in knowledge access and distribution through electronic network channels. In certain places, the best example perhaps being a library, the major changes over the last two decades concern not codification but rather the medium and means of access. Libraries are by definition storehouses of codified knowledge. In that sense they have not changed since Alexandria. What has changed is the technology by which the information is stored (the medium in some, though certainly not all, cases), and managed. A point to be made in this regard is that the most important way in which information technology has affected libraries is not in the nature of codification but rather in the media of codification and thereby in the way in which the information is stored, retrieved and used.

Missing from the debate on codification is a discussion of a particularly ambivalent aspect of its nature. The process of codification can be used to share knowledge collectively and to transfer it at a minimal cost among the members of a network. On the other hand, it can also be used to maintain this knowledge in the private domain if the code cannot be understood by others. In other words, a code can serve the objective of the marketing department of a company which wants its advertising messages to be read and understood by everyone; but it can also serve the objective of the traditional alchemist of the Middle Ages who has written a book of "secrets" as a way of allowing himself (or perhaps a select few) and no one else access to his past discoveries. "The esoteric language of alchemy was never intended to be understood literally, but was deliberately used to protect divine secrets and to guarantee their possession by a small circle of initiates" (Eamon, 1985, p. 324). Most frequently putting knowledge into a code serves both objectives: sharing the knowledge among a certain group (of firms, of scientists) and keeping (intentionally or unintentionally) other agents out from the club. Thus, codification does not necessarily reinforce the public good character of knowledge.

Finally, there are several different types of knowledge which can be codified [12]. This variety in turn entails a diversity of codification forms, which are difficult to encapsulate within a general taxonomy.

---

12 It is perhaps useful to use here the taxonomy of knowledge-type elaborated in Lundvall and Johnson. They differentiate between know-what (referring to knowledge about facts); know-why (referring to principles and laws); know-how (referring to skills); and know-who (referring to the knowledge supporting indirect access to knowledge). Using this taxonomy, we can identify different logics and trends of codification (see Foray and Lundvall, 1996). It is interesting to make a further distinction within the know-how category, between doing know-how (referring to the generation of consistent pre-established prescriptions for action in specific contexts), understanding know-how (referring to the generation of plausible interpretations for some questions); and combining know-how (referring to the generation of a sequence of prescriptions allowing to reach some performances). If the current codification movement on know-how takes the generic form of expert-systems, there will be very specific types of codification with regard to the particular kind of know-how to be codified.

In light of the difficulties listed above, we would like to propose a very supple (minimalist) definition: Codification is the process of conversion of knowledge into messages which can be then processed as information. This definition does not say anything about the public-private-collective nature of the codes. At this level of analysis, all situations are possible; codification is a strategic instrument available at a certain costs for agents (or groups of agents) to pursue any strategy. That this information will be kept secret, or fully disclosed, or shared among a certain group of people is, at this stage of elaboration, not part of the definition.

Considering these difficulties, we will not enter the debate about the changing nature of the relations between codified and tacit knowledge. Rather, our inquiry concerns the incentives to codify knowledge, and the conditions under which codification of knowledge has an increasing value. In particular, we will argue that increasing the value of codification pre-requires particular characteristics of the system of agents under consideration. Only "stable" systems, characterized by initial irreversible investment required to build a community of agents who can understand the codes, and having specific needs of communication, memory or coordination, will fully realize the productivity potential of codification. Further, systems in which the knowledge environment is in flux often bear the costs of making codification possible for stable systems. We note also that the process of codification is likely to be a path dependent one and this implies that efficiency is not an intrinsic attribute of the codification of a certain type of knowledge, but is rather the result of the dynamics and emergent properties of the system under consideration.

How ICTs Affect the Economy

Anna Creti

Research Fellow at CREST-Laboratoire d'Economie Industrielle, France

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

Market and competition effects of ICTs in industry organisation

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

Technology adoption decisions are likely to be affected by the direct/ indirect network effects and their consequences for market size equilibrium. For example, the demand for a telecommunication network is a typical function of both its price, and the expected size of the network.. These are *direct network effects*. The presence of adoption effects profoundly affects market behaviour and performance. Since social marginal benefits exceed private marginal benefits the equilibrium size is smaller than the socially optimal network size, and the perfectly competitive equilibrium is not efficient. In such a market we will be confronted with the existence of multiple equilibria, even restricting attention to rational expectations equilibrium (Economides and Himmelberg,1994).

The concept of *indirect network effect* is best discussed for hardware/software systems, the typical system market where one consumer's adoption decision (to buy the system or not) has no impact on the other consumers, given the prices and varieties of software available. In the market equilibrium, it is likely that inefficiencies explained in *static* hardware/software models are attributable to traditional market power, not to network effects. The situation will change if we allow *dynamic effects*, when the supplier cannot be committed to prices in advance and has to influence buyer expectations. The monopolist will lock-in the consumer promising low prices and raising them after the purchase. Thus the basis on which consumers form their expectations of the software price becomes a critical issue for market *performance* (Katz and Shapiro, 1992 and Economides,1994). But as with communication networks, problems of positive feedback effects and multiple fulfilled expectations equilibrium can arise.

Both direct and indirect effects have welfare implications. One interesting question is how to decentralise the welfare maximising solution in the presence of **network externalities**. Clearly, the welfare maximising solution can be implemented through perfect price discrimination, but typically such discrimination is unfeasible. Subsidisation can be a remedy. For example, in the case in which hardware is supplied competitively at marginal cost, total surplus (profits plus consumer surplus) can in some circumstances be increased by offering hardware buyers a (small) subsidy. How can it be optimal ? The indirect network externalities arise because software is not priced at marginal cost. If all goods were priced at marginal cost, these network externalities would merely be pecuniary externalities, and market equilibrium in the hardware/software market would be efficient. A small subsidy can also increase welfare for a good that is complementary to the monopolist product. The ownership structure can help internalisation, but monopoly ownership will not reach full efficiency. Direct users transactions or joint ownership may also help.

Social benefits and costs of **compatibility**, as well as the effects of compatibility on price competition, quality and innovation are important characteristics of "system goods". The analysis of social benefits and costs of compatibility is the basis to examine the private and social incentives to achieve "horizontal" compatibility (between two comparable rival systems) and "vertical" compatibility (between successive generations of similar technology) (Besen and Farrel, 1994).

For systems that are incompatible, the focus of competition shifts from the overall package (including the network size) to the specific cost and performance characteristics of each component individually (Matutes and Regibeau, 1988). This general principle implies that if one firm has a distinctly superior overall package, including its products offering, its installed base and its reputation, that firm is likely to prefer incompatibility. However, if each firm has a superior component, firms may prefer compatibility and may spend resources to achieve it. Under some hypotheses (parallel vertically integrated firms, where each firm produces every type of the complementary products) profits and prices are higher in a regime of full compatibility.

The standard literature of the "mix-and-match" model assumes that the utility from a component is added to the utility of a complementary component and then is accrued. However, in some network, including telecommunications, the utility of the composite good is not the sum of the respective qualities. Thus, significant quality co-ordination problems arise in a network with fragmented ownership. " The lack of vertical integration leads to a reduction in quality. Note that this is not because of lack of co-ordination between the bilateral monopolists in the choice of quality, since they both choose the same quality level" (Economides, 1994).

A clear implication of the network externality literature is that often we cannot move from one technology to another, from one standard to a better one, from one kind of network to a better one. Some theoretical models focus on the *excess inertia* phenomenon, i.e. when in a system market users tend to stick with an established technology even when total surplus would be greater if they adopt a new but incompatible technology, because today's consumers may be reluctant to adopt a new technology if they must incur in the switching costs. But also the opposite can happen: the market may be biased in favour of a new, superior but incompatible technology (the *insufficient friction*, Katz and Shapiro, 1992). In any case, one key factor in determining whether a given market exhibits excess inertia or insufficient friction involves possible asymmetries in sponsorship between old and new technologies.

ICT effects on national economic performance

One of the major areas of interest that can explain ICT effects on the national macro-economic performance is the analysis of their productivity and growth effect. The telecommunication effect on development and growth can be considered in both the traditional neoclassical of growth and in the new endogenous growth theory.

In the *neoclassical model of growth*, the standard production function is :

$$Y=Ae^{\mu t}K^{\alpha}L^{1-\alpha}$$

where Y is gross domestic product, K is the stock of human and physical capital, L is unskilled labor, A is a constant reflecting the technological starting position of society, and e^{μ} represents the exogenous rate at which that technology evolves. In this specification, called the "Solow model", α indicates the percentage increase in gross domestic product resulting from a 1 percent increase in capital.

In the neoclassical model μ can be interpreted in many ways: as improvements in knowledge such as organisation routines, rearrangement of the flow of material in a factory, better management of inventory, or other changes that do not require knowledge to be embodied in new equipment. A different view holds that changes in knowledge are embodied in equipment.

In both cases, the ICT effect can be included as improvement in knowledge, embodied or disembodied in new equipment. ICT can be viewed as a "shift factor" of technological progress or as a determinant of the size of μ.

Within the exogenous neo-classical growth model, the effect of ICT on the aggregate performance can be analysed in the following theories:

- the theories stressing the role of telecommunications in the total factor productivity growth, allowing a better national performance (Cronin and alii, 1991, 1992, 1994);
- the theories linking network infrastructure and regional performance (Capello, 1994; Kellerman, 1993)

The central issue from the viewpoint of the neo-classical analysis is that the determinants of the size of μ, the rate of growth of income per capita, is left *exogenous*, within the model. The new *endogenous growth theory* seeks to remedy this question.

The essence of many endogenous growth theories is reflected in the equation Y=AK (Lucas, 1988; Romer, 1986). Here, A should again be understood as an expression representing factors that affect technology, while K includes both human and physical capital; this is achieved by invoking some externality that offsets any propensity to diminishing returns. Investment (whether physical investment by a firm, or human capital investment by a firm, or human capital investment by an individual) leads to an increase in productivity that exceeds the private gain. This model leaves open the possibility that an increase in the investment rate could lead to sustained growth if strong external economies were generated by investment itself so that α in the Solow model becomes unity. It offers an interesting alternative to the diminishing returns and absence of any sustained impact on growth that is characteristic of the simplest version of the Solow model.

Within the endogenous growth models, telecommunication infrastructure can be the source of external economies, lowering transaction costs of ordering, gathering information, searching for services (Norton, 1992).

Moreover, telecom infrastructure investments and the derived services provide significant externalities; their presence allows productive units to produce better. The importance of externalities increases as the information content of production increases, that is, as the telecommunication intensity of the production process increases.

The impact of improved communications infrastructure on the economy is similar to the impact of increased innovation. An improvement in the telecommunications sector is, to firms who use telecom services, akin to a shift out of their production function, as the exogenous growth model suggests. In addition, the endogenous growth model allows analysis of the *social returns to telecom infrastructure investment* . They are much greater than the returns just on the telecom investment itself. Many of the benefits of telecom investment are not attributable to the firm or to the sector-the lowering of transaction costs, the ability to search widely, the ability to control a greater span of productive activities.

Since this link exists between the economics of telecommunications networks and endogenous growth, it is very interesting to overview the most recent theories which do a first attempt at explaining this relationship. In particular, we will analyse Norton's (1992) model on transaction costs, telecommunication and growth.

Using the **"total factor productivity"** approach[13] , Cronin et al. (1991, 1992, 1994) show that a causal relationship between telecommunication infrastructure and productivity does exist. Furthermore, analysis relying on a combination of sectoral translog production functions and inter-industry economics is employed to measure the magnitude of the effect of telecommunication infrastructure investment on aggregate productivity growth rates. The authors find that the portion of aggregate productivity growth due to improvements in telecommunications productivity and consumption efficiencies was about 25 per cent over the late 1970 to 1991 interval. Finance, transportation, trade, real estate and petroleum refining are among the individual sectors where telecommunications has significantly contributed to productivity growth.

What is new in Cronin's approach is the shift from the static view of telecommunications as a "general public good" toward a consideration of telecommunications as a production factor. The analysis of industry-specific telecommunications intensity[14] provides insight into

---

13 The term *"total factor productivity growth"* is defined as changes in final output per unit of combined labour, capital and material inputs. It asseses the dynamic relationship between inputs(labour, capital, materials) and output, taking into account the joint effect of many factors, including new technology, economies of scale, the changing composition of the labour force and changes in the organization of production. The measurement of TFP can measure if telecommunications industry has improved its productivity and then lowered its prices.

14 The telecommunication intensity by industry is defined as millions of 1991 dollars purchased telecommunications as a percentage of total output.

the importance of telecommunications to individual industries and to sectoral and wide state productivity.

In several **regional development theories** telecommunications is considered as an "engine for growth". The first group of studies are the *general development theories*, including both the export base theory and the classical growth theories. The second kind of theories dealing with *regional growth and infrastructure* develop the idea that infrastructure is the regional engine for growth, one of the most strategic production factors. The third group of theories refer to the *development theories based on transport systems.*

Theoretically, telecommunications allow two kinds of "economic advantage". The first, in common with other kinds of infrastructure, is related to the fact that infrastructure may generate various economic effects in terms of value added, productivity and employment. The second advantage stems from the nature of networks. They physically link different regions together, which benefit from those advantages generated by synergies among regions operating in different economic environments, by the availability of more information flows, by exploiting possible network-based innovation, and by achieving previously unknown markets (Capello, 1994). This latter effect raises a problem: less developed regions can be excluded from leading the network and thereby from participating in the definition of the "rules of the game", because of their low capacity for exploiting network effects. IT may then also play a role in regional disparities.

Toward a model of telecommunication and endogenous growth: the transaction cost theory

The transaction costs theory looks at firms as organisations in terms of efficient short-term and long-term contracts; in practice these contracts are fairly incomplete, owing to "transaction costs"[15]. In the Norton paper (1994), the "transaction costs" are defined from a macro-economic point of view, as simply the equilibrium gap between the buying and selling prices, due to the imperfect information at which the market transactions occur.

Norton's empirical analysis is a simple growth regression for 47 countries from 1945 to 1977. Growth is related to standard variables (mean annual population growth, standard deviation of real output shocks, standard deviation of money supply shocks, mean growth of exports as a proportion of output...) and additional variables for telecommunication infrastructure.

---

[15] For the transaction costs theory, see Handbook of Industrial Organization, ed by Schmaleense, R. and Willig, R., vol 1 cha.3, North-Holland, 1989 Transaction Costs Economics, by O. Williamson; Tirole, J.The theory of Industrial Organization, MIT Press, 1988, cha. 1. Coase and Williamson have distinguished four types of transaction costs. First, some contingencies which the parties will face may not be foreseeable at the contracting date. Second, even if they could been foreseen, there may be too many contingencies to write in the contract. Third, monitoring the contract may be costly. Finally, enforcing contrasts may involve considerable legal costs.

All the results of the Norton analysis are consistent with the hypothesis that telecommunications lower the cost of capital markets and perhaps that the efficiency generated by lower capital costs is more important than the investment ratio per se. When the telecom infrastructure variables are included in the regression, the data raise some important points regarding the previous research in the growth literature. First, the convergence hypothesis is not only more evident for the richer countries, but also this hypothesis is more robust when the telephone variables are included. Second, there is a significant impact of population growth, with a coefficient very near to 1.0, as implied by the neo-classical theory. Third, the inclusion of telecommunications lower the negative effect of the monetary instability on growth.

Suggestions for a new research direction and Conclusions

Up to now, as we showed in the review of the literature on network economics, two fields of economic theories, i.e. telecommunications as the motor for economic growth on the one hand, and network externality theory on the other, seem to be completely separated in the literature. Our suggestion is "a merger" of the two approaches, as an attempt to explain the micro-foundation of some important growth effects stemming from advanced telecommunication services.

While product and process innovation emphasized in some strands of endogenous growth theory are clearly important contributors to long-term growth, so is the organisational ability to take full advantage of such innovations as emphasized by Schumpeter. Ironically, the new generation of growth models relies on externalities and R&D at precisely the time that a sense is emerging that one of the important factors determining intermediate and perhaps long-term productivity growth is organisational[16]. Indeed, the earliest growth models, which viewed μ as reflecting disembodied sources of productivity growth, conform more to the spirit of the new focus on organisation than models emphasizing externalities.

However, differences in organisation probably help to explain how a sustained difference in income levels can occur between two countries, even if capital (measured in whatever augmented fashion) is identical. On the other hand, organisational structures are unlikely to explain differences in growth rates, since countries with very different structures have experienced similar declines in total factor productivity growth in the post-1973 years (Pack, 1994).

ICT can represent one of this organisational factors that allows endogenous growth. If growth came from R&D-based innovation alone, then the major breakthroughs in information and

---

16 For an analysis of the implications of organisational structure for productivity, see Stiglitz, (1988).

communication technologies in the last two decades might have prevented the OECD-wide slowing of productivity growth from occurring. David and Blum (1987) argue, however, that substantial time is required before the potential productivity benefit of a new technology such as micro-computers is realized by the reorganisation of production and societal arrangements.

The research direction we suggest can be regarded as part of the general theoretical reflection on the role of endogenous technological change on the one hand, and on the role of telecommunications in economic development, on the other hand. The advantages derived from telecommunications technologies stem not only from the technological changes taking place in the sector or the availability of a public service, but also from their *nature as interrelated technologies*. This is because when a new subscriber joins the network, the marginal costs of his entry are lower than the marginal benefits he creates for people already networked. This positive externality affects the industrial performance and, via multiplicative effects, national performance.

An interesting research direction is then to prove that telecommunications have a good contribution to economic growth. The literature on endogenous growth theories based on innovation processes and the relationship between capital accumulation, investment and growth will offer a framework in which the micro-economic model with network externalities can be "imported" as micro-foundation of a macro-economic growth theory. In this framework, the telecommunication networks are analysed as a particular kind of technological progress, because of the existence of three effects (i.e. innovative processes effects, economies of scale, and network externality effects). Although the effects of innovative processes and economies of scale are similar, the nature of production network externality effects is more complicated, because their advantages stem from the difference between the marginal costs and benefits of being networked. This is not true for positive effects generated by innovative processes, or by economies of scale. Moreover, the network externality mechanism explains the investment process and the positive effects on the production function, via the productivity effect and the so-called network effect. In fact, telecommunications networks are not only characterised by consumption network externalities, but also generate production network externalities, since their advantages may be measured in terms of the performance of the firms.

Increasing returns stemming from production and distribution facilities with significant indivisibility in their capacity, network externalities, economies of scale and interdependence among the system's component are the elements which suggest an interesting "bridge" with the new theories of endogenous growth based on innovation processes.

Localised Technological Change in Telecommunications and Productivity Growth

Cristiano Antonelli

Professor of Economics at the University of Torino, Italy

Telecommunications constitute an essential component of the emerging information and communication technological system. New uses of telecommunications services are strongly associated with the introduction and diffusion of new information and communication technologies. Innovative uses of information technologies are in fact more and more associated with systematic networking of computers by means of telecommunications services.

Our hypothesis is that the output elasticity of telecommunications services is in fact much larger than their cost share because the increase in the use of telecommunications services is strongly associated with the introduction of new information technologies (Antonelli, 1993) so that itself is a reliable proxy for the extent to which firms are able to command the introduction of the radical technological innovations in the production process, in the organization and in the product mix made possible by the diffusion of computers and telematics (Antonelli, 1988)

A first attempt to assess empirically the effects of the uses of telecommunications services as an indicator of the introduction of new networking technologies can be based on the well known residual methodology. It consists in estimating the residual of a standard growth accounting procedure, based on the usual evaluation of the direct effect on output growth of all increase in the capital stock and the workforce. The residual of output growth, that is the portion of output growth not explained by the increase of the two fundamental factors, can be attributed to all factors of increase in the general efficiency levels, as well as to errors in the measurement in the proper contribution of capital and labour to the increase of output. The next step consists in assuming that the changes in the levels of usage of telecommunications services can be considered a reliable indicator of the extent to which new networking technologies have been introduced and with them of the broader positive effects on the general efficiency of the production function. Hence the residual can be "explained" by the changes in the uses of telecommunications services.

Formally this discussion leads to the following equations:

(1) $Y_i(t) = A_i(t) (K_i(t)^a L_i(t)^b)$

where Y = output of the ith firm in terms of added value at time t, K = capital used by the ith firm, L = labor used by the ith firm at time t, A = general efficiency parameter and a, b, c are the partial efficiency of respectively capital, labour of the ith firm.

With a few passages total differentiation of equation (1) leads to:

(2)(dY/dt)/Y= (dA/dt)/A + (a (dK/dt)/K+ b (dL/dt)/L + c (dITS/dt-n)/ITS)

The residual generated by the empirical estimate of equation (2) can be considered a reliable proxy for the value of dA/dt which can be considered to be a dependent variable of ITS, the increases in the levels of usage of telecommunications services:

(3) dA/dt =f (dITS/dt)

A model of productivity growth can be built on a standard Cobb-Douglas specification drawing on the technology production function approach elaborated by Griliches(1979). The Cobb-Douglas specification imposes a constant elasticity of substitution between inputs, but as Griliches notes it should not make a critical difference in estimating the marginal products of the factors considered.(Griliches, 1986:342) With respect to the technology production function our hypotheses lead to a specification which focuses attention on "telecommunications services" as a distinct production factor:

(4) $Y_i(t) = A_i(t) (K_i(t)^a L_i(t)^b ITS_i(t)^c)$

where Y = output of the ith firm in terms of added value at time t, K = capital used by the ith firm, ITS = telecommunications services used by the ith firm , L = labor used by the ith firm at time t, A = general efficiency parameter and a, b, c are the partial efficiency of respectively capital, labour and telecommunication servicesfor the ith firm. With a few passages total differentiation of equation (5) leads to:

(5) (dY/dt)/Y= (dA/dt)/A + (a (dK/dt)/K+ b (dL/dt)/L + c (dITS/dt-n)/ITS)

With this methodology a direct value of the productive efficiency of telecommunications services, as measured by their product elasticity, can be directly computed and empirically estimated.

Data on the usage levels of communications services directly by the productive system, for the Italian economy, have been gathered from the input/output tables for the most recent years available: 1985 and 1988. The communication industry, as traditionally measured by the input/output methodology, accounts all expenses of industries to acquire the postal and telecommunications services. In the aggregate the ratio of postal to telecommunications services is 20%: hence we can consider the data on the interindustrial distribution of the extent to which firms use communications services a reliable indicator of the extent of usage of telecommunications services.(ISTAT 1988(a) and 1988(b)) To test our hypothesis equation (1) has been specified as follows:

(6) log dY(1988-1985) = a + b log dK(1988-1985) + c log dL(1988-1985)

where log dY is the natural logarithm of the growth of added value in the years 1985-1988 for the 30 sectors available in real terms; dK is the natural logarithm of investments in the years 1985-86-87; dL is the natural logarithm of absolute increase in total labour costs between 1985 and 1988 in real terms. The OLS estimates of equation (6), provide satisfactory results:

(7) log dY(1988-1985) = 3.945 + 0.516 log dK(1988-1985) + 0.473 log
(3.389) (7.479)
dL(1988-1985)

R^2 0.749; F = 47.162

(t of Student between parentheses)

The residuals have been computed. The distribution of the residuals across sectors can now be considered as a proxy for the distribution of the portion of the growth of output not properly accounted for by the two production factors: hence an indicator of the "unexplained residual" that can be considered to be also the outcome of the increase of the general efficiency of the production process that has been taking place in the years 1985-1988. As already anticipated we put forward the hypothesis that the increase in the levels of usage of communications services can be now considered a reliable indicator for the more general level of adoption of new information and communication technologies and the complementary and interrelated innovations in the organization and in the production process of firms. Hence we have specified the following regression equation:

(8) RE = a + b dCOM/dt (1985-1988)

where RE are the residuals from the estimate of the production function of equation (6) and dCOM/dt (1985-1988) measures in natural logarithm the absolute increase in the levels of usage of communications services in the years considered across the 30 sectors. The results of OLS estimates of equation (8) read as follows[17]:

(9) RE = - 1.39 + 0.128 dCOM/dt (1985-1988)
(2.196)

---

17 t statistics for all independent variables are given in parentheses.

R^2 0.116; F = 4.823

(t of Student between parentheses)

The independent variable performs quite well statistically. Adjusted R squared reach the 0,116 levels and the t statistics for the independent variable is 2.2. On the basis of these results we can claim that a significant portion of the residuals is strongly associated with the increase in the levels of usage of communication services in the years considered.

A more direct assessment of the "causal" relationship between the increase in the absolute levels of usage of communication services and the increase in the levels of output has been provided by the econometric estimate of a "technology production function". Now dCOM/dt (1985-1988) enters directly the equation, so that we have:

(10) log dY(1988-1985) = 3.153 + 0.491 log dK(1988-1985) + 0.398
\- (6.805)

log dL(1988-1985) + 0.151 log dCOM(1985-1988)
(3.205) (2.265)

R^2 0.797; F = 38.928

Total variance explained reaches in terms of adjusted R squared the 0.8 levels. All the variables are statistically significant in terms of the t statistics. More specifically it appears an important result when we focus attention on the estimated value of the elasticity of output growth to the increase in the communications usage levels. The value of the estimated parameter is in fact 0.151 and it is significant at the 0.968%. This result confirms first that the increase in the usage of communication services is strongly associated to the growth of output, under the control of the rate of increase of the two basic production factors, and second it shows that the marginal productivity of communication services, as a strategic intermediary input, is very high. Third and most important, our results confirm that a strong discrepancy between marginal productivity and cost share of telecommunications services for users exists.

In sum our empirical evidence supports the hypothesis that lead-users in late eighties had the opportunity to earn significant quasi-rents (Melvin, 1969; Hulten, 1978). These results can be read in fact as an indicator of the extent to which the increase in the levels of usage of communication services can be considered as a reliable proxy of rates of adoption and effective implementation of the wide array of technological and organizational changes that are part of the more general process of diffusion of new information and communication technologies (Antonelli, 1993).

Conclusions

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

Because of the significant discrepancy between the cost shares of telecommunication services and their high marginal productivity, confirmed in our empirical analysis, it seems clear that telecommunications services are used by firms as a radical innovation in the mix of production inputs, to induce a significant increase of the overall levels of output and total factor productivity. In fact users have become more and more active innovators in the telecommunications arena.

In this context the present characters of the organization of the innovation process and of the market structure of the telecommunications network in most European countries, where it is respectively based on high levels of horizontal and vertical integration among switching, transmission and distribution for both data and voice communication and state-owned monopolies, are far from ensuring that the conditions for dynamic efficiency in the telecommunications network are actually in place. In the United States however the centralized structure of networks is more and more under pressure. Here the increasing plurality and variety of operators risks to undermine the coherence of the network based upon interoperability and interconnectivity and the related advantages stemming from network externalities.

The blending of these two extremes can lead to a new model of network: "the network of networks". This is possible when plurality and entry in the network are enforced, but the conditions of interconnection and interoperability, both between networks and on the networks, are clearly defined. The network of networks can accommodate both the centrifugal and the centripetal forces that we have analyzed and identified by allowing the variety of sources of innovation and yet preserving their coherence. So far the adoption of a network of network approach can enhance the implementation and diffusion of further technological and organizational innovations in telecommunication networks.

In the approach implemented by the European Union, the model of the network of networks is based on the entry of a number of firms which are technically and organizationally complementary and compatible both in horizontal and vertical terms. Within the network of networks firms operate in a variety of differentiated markets which have no entry barriers in terms of differentiated access to the primary intermediary input such as basic infrastructure services. Ownership of the infrastructure of the network is characterized by non-exclusiveness.

The network of networks can be considered as an integrated and yet pluralistic structure of specialized and complementary networks, which are either virtual and/or infrastructural. As ownership rights on every section of the network are not exclusive, transfers and access and use can be considered as an intermediate productive factor which should be supplied to any service provider either in final or in intermediary markets. Hence some customers could be service firms which may be directly competing with their own suppliers of intermediary services.

The principle of non-exclusive ownership and mandated interconnection (See Antonelli 1995c), together with freedom of entry and the search for ex-ante technical and organizational compatibility, based respectively on mandatory standardization (See Antonelli 1994) and regulation, should encourage the formation, from the bottom, of an advanced multitechnological network which includes a variety of local multipurpose distribution systems, transmission systems using cables, satellites and fibers, signalling technologies based upon intelligent network. The network of network thus should avoid dominant positions being formed and the renewal of un-natural monopoly.

Because the model of the network of networks values complementarity and compatibility between sections of the network and it guarantees the right to interconnection between networks and between sections of a network, it seems to provide the best way forward to introduce elements of technological variety, flexibility and competition into the system of traditional networks which have long been characterized by a monotechnological monopoly.

In conclusion, it is possible to argue that the model of the network of networks, as it is implemented in the European Union, offers the best conditions which can lead to the transformation of the present structure of the telecommunication system so that it becomes a flexible structure able to adjust every now and then to the stimuli produced by the evolution of demand and technology. The network of networks appears also as the institutional outcome of an intensive search for compromise between: i) the overwhelming pressure of network operators that are traditionally strong state-owned corporations; ii) the attempt of large information equipment manufacturers to grab a share of the new promising market; iii) the increasing sensitivity of users to large and fast increasing telecommunications bills based upon tariffs far above unit costs.

The Macro Policy Environment of Information Society Investments

Charles R. Hulten

Professor of Economics, University of Maryland

The Macro Policy Environment and the General Role of Infrastructure

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

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

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

With all these problems, one solution to the "jobs" problem virtually jumps out of the policy makers' tool kit. This is the proposal to increase the demand for labor by raising the marginal productivity of the work force through increased spending on public infrastructure capital (roads, etc.) and human capital (worker training, education). This new "Public-Investment Economics" is primarily focused on social-overhead types of investment, i.e., those categories of investment that form a background for direct investment in the private sector. This new policy would, in effect, attempt to pick winners among different types of social-overhead investment, instead of trying to pick winners among different industries with an industrial policy. However, unlike the old industrial policy, the new policy would largely complement the working of the market place rather than act as a substitute for it.

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

These attractions are buttressed by studies which purport to show that the return to infrastructure investment is much larger than the corresponding return to business fixed investment - as much as 70 percent per annum in one study by David Aschauer[18], and even greater in some other studies. According to Robert Reich, writing in the February 1991 issue of the Atlantic magazine,"His [Aschauer's] calculations imply that a one-time increase of $10 billion in the stock of public capital would result in a permanent increase of $7 billion in annual [U.S.] GNP." Aschauer's results are sufficiently large that they can explain as much as two-thirds of the productivity slowdown in the 1970s and 1980s.

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

Skeptics have challenged the magnitude of these estimates, noting both econometric and intuitive problems (example: a 70 percent annual rate of return on a $1 million infrastructure project compounded over a 30 project life yields almost $5 trillion!). Recent research, which corrects for some of the obvious statistical problems of the earlier literature, has tended to

---

[18] ***Public Investment and Productivity Growth in the Group of Seven,*** Economic Perspectives, Federal Reserve Bank of Chicago, 13, 1989.

find much smaller rates of return to infrastructure investment. The newer estimates tend to be in line with the return to private fixed investment, thus suggesting that fears of a massive infrastructure deficit in the U.S. are exaggerated. The equality of rates of return also suggests that implementation of the New Public-Investment Economics would, insofar as it leads to a dramatic increase in traditional public works spending, push the return to infrastructure below the return to other types of investment.

This should cool some of the ardor of infrastructure enthusiasts. However, the new results should not be over-interpreted. Other research has found selected instances of inadequate investment (e.g., in rapidly growing regions and in fiscally distressed cities). This, in turn, implies a selective role for traditional infrastructure investments as a pro-active policy.

Implications of the Macro Policy Environment for IT Investments

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

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

There are also good reasons for viewing IT investments as an integral part of a national infrastructure investment strategy. Telecommunications and associated IT services are often provided through networks which require large investments to establish, and which may throw off important externalities. For these reasons, this sector traditionally has been treated as part of the "infrastructure hypersector" in development economics (viz. the 1994 World Development Report by the World Bank), and analyzed as social overhead capital. This report also notes that IT investments represent a larger share of the infrastructure hypersector in developed economies, and in the highly developed economies of the OECD, the information super-highway is often cited as an alternative to conventional infrastructure systems like highways and air travel. Any macro assessment of "The Economics of the Information Society" needs to acknowledge this "infrastructure" policy environment.

Some Remarks on The Empirics of IT Infrastructure

It is one thing to acknowledge the role of telecommunications and IT investments in the larger infrastructure debate. It is another to translate this debate into operational policies for telecommunications and IT technology per se. In this regard there is a risk that a general enthusiasm for infrastructure investment as the solution to the jobs problem will substitute for hard analysis, not stimulate it. Indeed, the very notion of an "infrastructure hypersector" invites this substitution, since it implicitly suggests that infrastructure systems share enough common features that one may extrapolate estimated rates of return from one type of system to another. In fact, the "gestalt" approach to infrastructure policy tends to blur important institutional distinctions and, more dangerously, provides a cover for weak projects, especially those that are politically motivated.

These dangers suggest that every infrastructure project - IT or otherwise - should be justified on its own right, using accepted project evaluation procedures like benefit-cost analysis, and not by a process that imputes to each individual project an average historical rate of return, often inflated by enthusiasm, political opportunism, or boosterism.

This said, it is also important to acknowledge the dangers that lurk on the other side of the proposition. There are, indeed, many shared features of infrastructure investment, including some IT investments: they are often congestible public goods ("clubs") and they tend to come in the form of capital-intensive networks. The "hard" analysis of individual IT investments- at the project or industry level of detail - may miss important economic benefits because of these characteristics. For example, the ambit of the benefits from a network investment is often wider than the jurisdiction of the competent authority. Sub-national governments may be charged with the decision power over many roads, water-treatment, and telecommunications systems, and may only count as benefits those gains accruing to residents of their jurisdictions. Benefits that are more widely distributed may be ignored, resulting in under-investment. A similar remark applies to enterprises that operate and only consider benefits that can be appropriated.

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

The network feature of public infrastructure helps explain why there is such a large payoff to new infrastructure systems, and why this payoff diminishes as the network expands. The first network links constructed tend to be mutually complementary (and may be complementary with other inputs), and can thus have a very large payoff. But, the potential for large complementarities becomes exhausted at some level of network development and subsequent additions are (increasingly) substitutes for existing capacity. As this happens, the impact of infrastructure on economic growth becomes progressively weaker. This evolutionary process should be taken into account when using rates of return based on historical data to forecast the desirability of future investments. It should also raise a danger flag about the practice of comparing returns across different types of infrastructure systems that are in different stages of maturity.

To summarize, there is a two-way link between the micro-economics of IT investments and the macro-economic infrastructure debate. Moving from macro to micro, IT and telecommunications capital are defined as part of the "New Fiscal Economics," and seen as policy instruments for economic development and job creation. Moving from micro to macro, there is a suspicion that micro analyses lead to under-investment because they miss important spillover benefits. This, in turn, leads to a "top down" approach project evaluation. This approach is valid if it is recognized that the macro perspective should complement, but not supplant, traditional "bottom-up" approaches like benefit-cost analysis. The top-down approach is not valid if it replaces careful analysis with loosely-reasoned optimism about the general value of infrastructure systems.

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

"IT Spillovers and Productivity Growth: an empirical application to France"

Hans van Meijl & Luc Soete

Researcher and Professor of economics at the Maastricht Economic Research Institute on Innovation and Technology (MERIT)

A crucial feature of the knowledge creation process is the existence of externalities or spillover effects. The existence of such spillover effects has been shown to be crucial for the long term growth rate of an economy. Authors both of the "new" growth theory (Romer, Grosman, Helpman) as well as those with a more evolutionary perspective on technological change (Dosi, Freeman, Nelson) have stressed that the cluster of new technologies (Freeman, Clark and Soete, 1982) or general purpose technologies (Bresnahan and Trajtenberg, 1992) is expected to create important spillovers for the economy. This paper analyses the existence and magnitude of spillover effects related to the current general purpose technology: Information Technology (IT).

Following Griliches (1979), we first distinguish two types of research and development (R&D) spillovers. On the one hand, externalities may occur because downstream users do not pay the full value of the input. This type of spillovers can be called **pure rent spillovers.** Rent spillovers are "embodied" in purchased goods and therefore can be measured by using the capital and intermediate inputs purchases matrix weights (Terleckyj 1974 and 1980, Wolff and Nadiri 1993). On the other hand there exist **knowledge spillovers**: ideas discovered in one sector can be used by research teams in other sectors. Knowledge spillovers increase the productivity of your own research efforts and may be related or unrelated to good purchases. Knowledge spillovers related to good purchases can again be measured by capital and intermediate inputs purchases matrix weights. We call these **input related knowledge spillovers.** Knowledge spillovers unrelated to good purchases or **pure knowledge spillovers** are considered to be dependent on the "technological" closeness of the sector. Griliches (1990) identified five possible methods to measure this technological distance. We use here the one developed by Evenson et al. (1988) based on the Canadian cross-classification of patents by industries of "production" and industry of "use". This so-called "flow-thru" or technology flow matrix corresponds in our view closely to a measure of the technological closeness of sectors. Previous studies which measured spillover effects examined only one of the spillovers concepts. The major contribution of this paper is that we develop and measure an analytical framework which treats these three spillover concepts: "pure rent spillovers", "input-related knowledge spillovers" and "pure knowledge spillovers" at once.

The second major contribution is that these spillover concepts are being analysed for Information Technology. The magnitude of spillovers of a certain general purpose technology are expected to be large. According to Freeman and Soete (1987 and 1994), Freeman and Perez (1988) and David (1992) information technology corresponds today to the major new key technology pervasive accross all sectors of the economy. Investments in IT goods, for example computers, are expected to have a large influence on the productivity level in every sector. However, many empirical studies, who used the production function approach as we do in this paper, have searched for the influence of IT on productivity and haven't found a statistically significant relationship.[19] In this paper we investigate this so-called "IT productivity paradox" by splitting the various spillover effects into IT and non-IT spillovers.

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

This paper is organised into a number of sections. In the next section a limited version of the model including all spillover concepts is developed. Section 3 contains a description of the data and section 4 shows the estimation results.

1. The Spillover Model [20]

In this model the production function is represented by:

$$Y_j = A_j \, . \, F(L_j, \, K^e_j, \, M^e_j) = A_j . L^\alpha_j . (K^e_j)^\beta . (M^e_j)^\sigma$$

where Y_j, A_j and L_j are respectively the output, the total factor productivity (TFP) and the labour input of industry j. The other two inputs, capital (K^e_j) and intermediate goods (M^e_j), are measured in efficiency units. We measure these purchased products in efficiency units to account for pure rent spillovers (quality improvements may not be reflected in price indices).

19 See, e.g. Loveman (1994), Morrison and Berndt (1990) and Brynjolfsson 1993 (review).

20 In this section only a very limited version of the theoretical model is described. For the full model description see van Meijl (1995), chapter 7 and 8.

The purchased amount of efficiency units by an industry is the number of physical units times an efficiency index. It can be expected that the efficiency index and therefore the pure rent spillovers are dependent on the amount of embodied R&D.

The productivity generation process for an industry is:

$$A_j = \left[\; \eta_0 . e^{\eta . t} . S_j^{\theta_1} . S_{k,j}^{\theta_2} . S_{m,j}^{\theta_3} \; \right] . R_j^{\theta}$$

Industries can increase their productivity by engaging in R&D (R_j is the R&D stock of sector j). The productivity of own R&D with regard to the productivity generation process (expression between brackets) is dependent on the accessibility to a general knowledge pool. We divide the knowledge spillovers into knowledge spillovers that are related to capital ($S_{k,j}$) and intermediate ($S_{m,j}$) input purchases and "pure" knowledge spillovers that are not related to input purchases (S_j).

The knowledge spillover variable related to inputs are associated with the purchase of goods and are therefore closely linked to the concept of pure rent spillovers. In an empirical study it is therefore difficult to separate the influence of input-related knowledge spillovers and "pure" rent spillovers. We redefine the spillover concepts and include both "pure" rent spillovers and input-related knowledge spillovers in one concept called rent spillovers. The rent spillover intensities of IT and non-IT investment goods for sector j ($RENTKIT_j$, $RENTKN_j$) are:

$$RENTKIT_j = \frac{\sum\limits_{i \in IT} \frac{I_{i,j}}{Y_i} . RD_i}{Y_j} \quad , \quad RENTKN_j = \frac{\sum\limits_{i \neq IT}^{n} \frac{I_{i,j}}{Y_i} . RD_i}{Y_j}$$

where $I_{i,j}$ is the investment delivery of good i to sector j and n is the number of sectors. $RENTKIT_j$ represents rent spillovers received from purchasing investment goods from the sectors that produce IT goods. $RENTKN_j$ measures investment rent spillovers from purchasing all other investment goods.

Rent spillovers received by purchasing IT and non-IT intermediate goods (respectively $RENTMIT_j$ and $RENTMN_j$) are calculated in the same manner. The only difference is that $I_{i,j}$ in equation (3) is replaced by $X_{i,j}$ (the intermediate delivery of good i to sector j).

The "pure" knowledge spillover variable unrelated to inputs is a weighted R&D stock of other sectors R&D, industries "use" different amounts of knowledge from other industries dependent on their technological distance from them. The IT and non-IT "pure" knowledge spillover intensities ($KNOWIT_j$, $KNOWN_j$) for sector j are calculated as :

$$KNOWIT_j = \frac{\sum_{i\_IT} \omega_{i,j} \,.\, R\&D_i}{Y_j} \quad , \quad KNOWN_j = \frac{\sum_{i \neq IT}^{n} \omega_{i,j} \,.\, R\&D_i}{Y_j}$$

The weighting factor which represents the technological closeness of the sectors i and j, ω_{ij}, is approximated by the Yale technology flow coefficients.[21]

The equation to be estimated in this empirical study is (for a full derivation see van Meijl 1995):[22]

$$\left(\frac{\hat{Y}_j}{\hat{L}_j}\right) = \eta + \pi_{crs}.\hat{L}_j + \beta.\left(\frac{\hat{K}_j}{\hat{L}_j}\right) + \sigma_j.\left(\frac{\hat{M}_j}{\hat{L}_j}\right) + \rho.\frac{R\&D}{Y_j} + \rho_{it}.KNOWIT_j + \rho_n.KNOWN_j$$

$$+ \rho_{kit}.RENTKIT_j + \rho_{kn}.RENTKN_j + \rho_{mit}.RENTMIT_j + \rho_{mn}.RENTMN_j$$

where $\pi_{crs}=\alpha+\beta+\sigma-1$, $\hat{Y}_j / L_j$, $\hat{K}_j / L_j$, $\hat{M}_j / L_j$ are respectively the growth rate of labour productivity, the growth rate of the capital-labour ratio and the growth rate of intermediate goods-labour ratio (it is also possible to express this equation in terms of the capital productivity growth rate). If we assume constant returns to scale ($\alpha+\beta+\sigma=1$) and optimal choices of factors of production, we can directly measure the TFP growth rate by calculating the labour and intermediate good elasticities (α and σ) by the share of the costs of labour (wages and related charges) and intermediate goods in total variable costs.

---

21 The available pool of "pure" knowledge spillovers (not related to input purchases) is constructed using the Yale technology flow matrix set up by Evenson et all (1988), based on approximately 200.000 patents granted in Canada during the 1972-1989 period. Canadian patent data are cross-classified by industry of manufacture and industry of potential use. The Yale matrix predicts technology flows to user industries, given the industry of manufacture of the patent.

$$\rho.\frac{R\&D}{Y} = \rho''.\frac{\frac{R\&D}{Y}}{\frac{\overline{R\&D}}{Y}} \quad - \quad \rho'' = \rho.\frac{\overline{R\&D}}{Y} = qe$$

22 Using the Terleckyj (1974) transformation implies that we can use R&D intensities in stead of the more difficult to obtain R&D capital stocks. With this transformation we estimate the rates of return in stead of the elasticities. However, the height of the rate of return of a spillover variable does not say much about the influence of this variable on the productivity growth of a sector, because the magnitude of this spillover variable can be low. Therefore we will normalize the various R&D intensities by dividing the observations by their sample means. Instead of estimating the rates of return, we estimate the rates of return times their mean value which is equal to the "quasi-elasticity". This concept indicates the influence of a spillover variable with respect to productivity growth. We now illustrate this for the R&D variable which is the fifth term on the right hand side of equation (5).

Instead of the rate of return, ρ, we estimate ρ'' which is equal to ρ times $\overline{R\&D}/Y$ (sample mean of the R&D intensity) and therefore a "quasi-elasticity". In this paper we will estimate quasi-elasticities so that we can compare the influence of the various spillover effects.

The total factor productivity growth is then dependent on own R&D expenditures, "pure" or non-input-related knowledge spillovers from IT and non-IT sectors, rent spillovers embodied in purchased IT and non-IT intermediate goods, rent spillovers embodied in IT and non-IT investment goods, and an exogenous trend term.

In this paper we estimate the quasi elasticities of own R&D and the various IT and non-IT spillover concepts (see footnote 4).

2. Data

The importance of internal R&D, and IT and non-IT spillovers with regard to productivity growth will be assessed with cross-sectional data on thirty French sectors which cover the total economy (industrial as well as service sectors).[23] These data are drawn from several sources. The core data are from French INSEE data. Production, gross value added, investment supply and input-output data are available in constant and current prices for 1977-1992. Investment matrices are available in constant prices from 1977-1988. The SEC2 database of EUROSTAT contains labour and investment demand data from 1967-1991. The total R&D expenditures by sector are taken from the OECD database (STAN).

This database will be used to estimate the importance of IT and non-IT spillovers with regard to productivity growth. We identified three IT producing sectors. The first one is called "IT1" and produces "office and data processing machinery" which is classified as S27 in the INSEE classification and N330 in the NACE-CLIO classification. The second one is called "IT2" and produces mainly telecommunication equipment (S291 or N344) and the third IT producing sector produces mainly electronic equipment (S292 or N345) and is called "IT3S".

The IT producing sectors together represented an average of 1.87% of total actual production over the 1978-92 period. In 1978 this percentage was equal to 1.48% and in 1992 this percentage had increased to 1.95%. Although of little direct importance in a production sense, the IT producing sectors perform 26.2% of the total R&D. This indicates that these small sectors provide an important contribution to the total amount of knowledge created in an economy. If spillover effects are present and significant, then the IT sector may be important for an economy.

---

[23] A detailed description of these thirty sectors is given in appendix 1. The construction of the investment matrices for the period 89-92 and the construction of the capital stocks is described in van Meijl (1995).

R&D activities are very concentrated. The two largest R&D performers (transport and telecommunication equipment) perform almost 50% of total R&D and represent only 5.5% of total actual production. If we include more sectors it turns out that the sectors responsible for 10% of actual production perform 74% of total R&D activities.

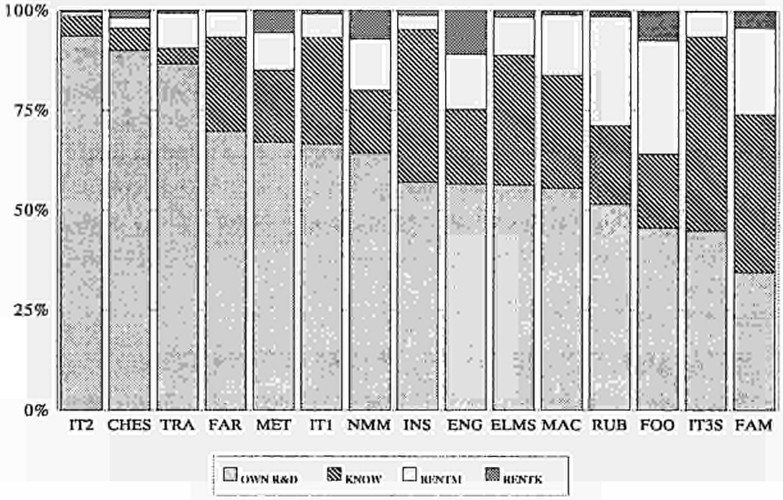


Figure 1: Shares of own R&D and the various spillover sources in total R&D used by a sector

However, sectors perform not only R&D themselves but also benefit from R&D performed in other sectors. They receive knowledge via their economical (rent spillovers from investment and intermediate goods) and technogical ("pure" knowledge spillovers) networks. The magnitude and influence of own R&D and the various spillover concepts differ largely between sectors. Figure 1 shows the relative magnitudes of own R&D, and the three spillover concepts for 15 French sectors (the magnitudes are constructed by a simple accounting method). Estimation results obtained by van Meijl (1995) showed the different influence of different knowledge sources for different groups of sectors; for the high-tech sectors own R&D and "pure"knowledge spillovers were significant, rent spillovers embodied in capital goods were significant for the service sectors and for the medium and low tech sectors rent spillovers of intermediate goods were significant.

Figure 2 shows the relative magnitude of the six IT and non-IT spillover effects for 15 French sectors (again this is a simple accounting method, we estimate the importance of the spillover concepts in section 4). "Pure" IT knowledge spillovers are relatively important in the IT sectors themselves and in the instrument sector (INS) and electrical machinery sector (ELMS). This can be expected as "pure" knowledge is especially valuable in industries that are technologically "close".

Non-IT "pure" knowledge spillovers are linked with two other technologically related clusters. First, the chemical cluster (CHES, FAR and CHTS) and second the mechanical cluster (MAC, FAM and MET). The black areas represent the IT spillovers in intermediate goods. These are important in, for example, the transport industry (TRA) and paper and printing industry (PAP). IT capital spillovers are relatively important in the service sectors (e.g. telecommunication services (TEL), financial services (FIN) and enterprise market services (SME)).

In general we can say that the magnitude of the various knowledge sources is different for each sector. The knowledge base for a sector is a mixture of different types of spillovers. It is important to recognise that a sector is not isolated in the economy but is a part of several inter-related networks. An investigation of the importance of internal R&D performance for productivity growth must therefore also take spillover effects into account, because besides a firms' own R&D expenditures, knowledge generated by other sectors is also important.

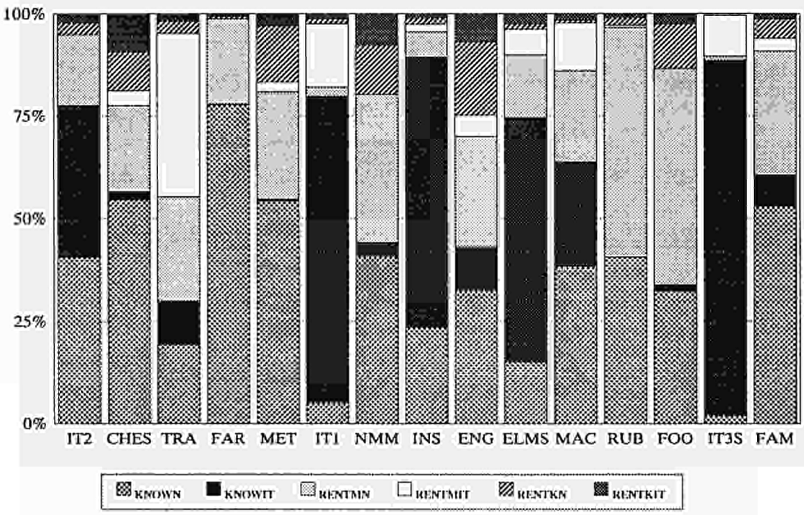


Figure 2: Shares of the various spillover sources in total R&D received

3. Estimation Results

Measuring the importance of the current general purpose technology, information technology, for productivity growth is central in this section. We investigate whether the various IT spillover variables contribute to technological change. In addition to the IT effects, we measure the influence of internal R&D and the non-IT spillover effects on productivity growth.

The database in this sub-section contains the mean values of the variables over the period 1978-1992 for 30 sectors. The correlation matrix which is given in table 1 shows that the IT spillover variables have the strongest correlation with TFP growth. Rent spillovers of IT capital goods show a correlation coefficient of 0.67 and "pure" knowledge spillovers and rent spillovers in intermediate IT goods have a correlation coefficient of 0.46 and 0.42 respectively. These are all higher than the correlation coefficients of own R&D and the non-IT spillover variables. These correlation coefficients also give an indication of possible multicollinearity between explanatory variables. Possible candidates are marked with an asterisk in table 1. There is a strong positive correlation, 0.96, between "pure" knowledge spillovers from the IT sector and rent spillovers embodied in IT intermediate goods. To avoid multicollinearity we add these two spillover effects and create a new variable: RKIT = RENTMIT + KNOWIT.

Table 1: Correlation Matrix

	TFP	Y	R	RENTKN	RENTKIT	RENTMN	RENTMIT	KNOWN	KNOWIT
TFP	1								
Y	0.42	1							
R	0.35	0.37	1						
RENTKN	-0.03	-0.17	-0.16	1					
RENTKIT	0.67	0.50	-0.10	-0.05	1				
RENTMN	0.08	0.05	0.17	-0.15	-0.18	1			
RENTMIT	0.42	0.33	0.62*	-0.13	0.03	-0.08	1		
KNOWN	0.21	0.38	0.27	0.08	0.08	0.60*	-0.08	1	
KNOWIT	0.46	0.32	0.61*	-0.12	0.03	-0.06	0.96*	-0.04	1

* possible threat of multicollinearity between explanatory variables

It is apparent that almost no correlation exists between own R&D, IT "pure" knowledge spillovers and IT intermediate rent spillovers, with the rent spillovers of IT capital goods. A possible explanation is that service sectors with high investments IT capital goods do not perform much R&D themselves. Less pronounced but still a possible caveat is the correlation coefficient of KNOWN and RENTMN, 0.60. We can again create a new variable: RKNT=RENTMN+KNOWN.

We turn to the estimates of the equations developed in section 2. The estimation results of equation (5) and the TFP version of this equation are shown in table 2. Regressions 1 to 3 show the results for the three-factor TFP growth. In regression 1 we included "own" R&D and all the spillover concepts. In regressions 2 and 3 we add some concepts together, according to the method proposed earlier, to reduce the problem of multicollinearity. It is apparent that rent spillovers of capital goods from the IT sector (RENTKIT) are highly significant in all cases. The estimated value of the quasi-elasticity is about 0.0037. The combined variable RKIT, which represents IT "pure" knowledge spillovers and rent spillovers of IT intermediate goods is also significant in all cases and has an estimated quasi-elasticity of 0.0012. The various non-IT spillovers are insignificant.

The estimated coefficients of equation (5) are given in regressions 4 and 5 We can make the following two general observations before discussing spillover effects: First, all equations indicate decreasing returns to scale, because the coefficient of the capital growth (K) is negative. Second, relaxing the assumption of constant returns to scale improves, in almost all cases, the statistical significance of the estimated quasi- elasticities.

Compared to the TFP growth estimates the estimated quasi-elasticity of own R&D has become significant and its value is 0.0025. With regard to the spillover effects, the high significance and high value of the estimated quasi-elasticity of rent spillover effects on IT investment goods is again apparent. The influence of IT is measurable on an economy wide scale. These results suggest therefore that the "IT productivity paradox" has lost its "paradoxical" characteristics.

Another interesting result is that the rent spillovers of non-IT capital goods are significant. In the case of actual production the estimated quasi-elasticity is high (0.0041-0.0048) which also implies a large influence of spillovers on non-IT capital goods. However, the estimated influences of the IT and non-IT spillovers are average values over the total period and don't say anything about the development of the influence of the spillovers over time. It can be expected that especially the IT related spillovers have become more important in the most recent period (this hypothesis is investigated in the van Meijl (1996) article that is included in this volume).

Conclusion

This paper investigated the influence of information technology spillovers on productivity growth. As in most other OECD countries, the IT sectors are small in economic terms. They only represent 1.87 per cent of actual French production. However in R&D terms they perform 26.2 per cent of total R&D (BERD). Our estimation results indicate that besides internal R&D, R&D spillover effects are important for productivity growth. Especially spillover effects related to IT capital goods turn out to be significant and large in magnitude.

Table 2: Regressions of the three factor TFP growth rate and capital productivity growth rate (actual production/capital), (t-ratio's in parentheses)

	CON	L/K gr.	M/K gr.	K gr.	"own" R&D[1]	RENTKN	RENTKIT	RENTMN	RENTMIT	KNOWN	KNOWIT	$\overline{R}^2$ DW
Dependent variable is the three-factor TFP growth rate												
1 TFP	-0.005 (-1.16)				0.0017 (1.51)	0.0036 (1.07)	0.0040*** (6.39)	0.0026 (1.70)	-0.0017 (-0.88)	-0.0007 (-0.49)	0.0023 (1.66)	0.66 1.81
2 TFP	-0.0029 (-0.74)				0.0013 (1.11)	0.0021 (0.65)	0.0037*** (6.13)	0.0016 RKNT[2] (1.34)	0. 0012* RKIT[3] (2.37)			0.65 1.78
3 TFP	-0.0032 (-0.83)				0.003*** RRKIT[4] (4.16)	0.0023 (0.70)	0.0037*** (6.38)	0.0012 RKNT (1.09)				0.66 1.76
Dependent variable is the capital productivity growth rate												
4	-0.0036 (-1.16)	0.08* (1.79)	0.53*** (15.84)	-0.34*** (-7.66)	0.0025*** R (4.03)	0.0048* (2.74)	0.0037*** (12.31)	0.0015* (1.92)	-0.0002 (-0.16)	0.0019* (2.68)	0.0015* (2.05)	0.96 1.86
5	-0.0033 (-1.13)	0.08* (1.93)	0.53*** (16.27)	-0.34*** (-8.20)	0.0025*** R (4.11)	0.0047* (2.79)	0.0037*** (12.62)	0.0014* (1.93)	0.0014*** RKIT (5.88)	0.002** (2.91)		0.96 1.87

1 All R&D intensities are expressed in terms of actual production.

2 RKNT=RENTMN+KNOWN, 3 RKIT=RENTMIT+KNOWIT, 4 RRKIT=R+RENTMIT+KNOWIT.

*, ** and *** Significant at the 0.10 level, 0.01 level and 0.002 level (two-tailed test).

AGR	=	Agriculture, forestry and fishery products
ENG	=	Energy sector
MET	=	Metals and ferrous and non-ferrous ores
NMM	=	Non-metallic mineral products
CHES	=	Basic chemical products and artificial and synthetic fibres
FAR	=	Pharmaceutical products
CHTS	=	Para-chemical products
FAM	=	Fabricated metal products (except machinery and transport equipment)
MAC	=	Agriculture and industrial machinery
IT1	=	Information Technology 1, Office and data processing machines
ELMS	=	Electrical machinery without IT2 and IT3S
IT2	=	Information Technology 2, Telecommunication equipment, meters and measuring equipment, electro medical equipment
IT3S	=	Information Technology 3, electronic equipment, television receiving sets, sound reproducing and recording equipment
TRA	=	Transport industry
INS	=	Precision and optical instruments
FOO	=	Food, drink and tobacco products
TEX	=	Textile, footwear and leather products
OTH	=	Wood, cork and furniture and other manufacturing products
PAP	=	Paper and printing products
RUB	=	Rubber and plastic products
BUI	=	Building and construction
COM	=	Commercial sector (wholesale and retail trade)
REP	=	Recovery and repair services
HOT	=	Lodging and catering services
TRS	=	Transport services
TEL	=	Telecommunication services
OMS	=	Other market services (e.g. health, recreational)
SME	=	Market services for enterprises (e.g. lawyers, real estate, accountants, tax advisers, management consultants, computer and data processing services and market services of education and research)
FIN	=	Services of credit and insurance institutions
NMS	=	Non-market services

Industrial alliances in the new digital information era: the strategic path

Christian Micas

European Commission

Invariably, each major technological breakthrough generates vast industrial reorganisations. The same is expected to happen with the advent of multimedia. The purpose of this article, which is based on an analysis of the database ALLCOM[24], is to understand how the development of multimedia could impact on the structuring of the information and communication-related industries as well as on corporate strategies. We will particularly focus on the role played by alliances in the evolution of industry.

Although multimedia development is led by a logic of vertical industrial alliances all along the digital chain of information, the current trend is rather focused on horizontal acquisitions, inside a single market segment. This is in particular the case for the audiovisual sector and for the telecommunication services industry, spurred by the on-going liberalisation process and the need to roll out global networks.

After having reviewed in section 1 how multimedia can transform the relations between companies from the information and communication sectors and impact on their strategy we will try to describe in section 2 the major trends in industrial alliances.

---

[24] ALLCOM is a database developed by the author comprising of more than 1,700 industrial alliances in the field of telecommunications and multimedia-related industries, over a two year period at the European Commission-DG XIII.

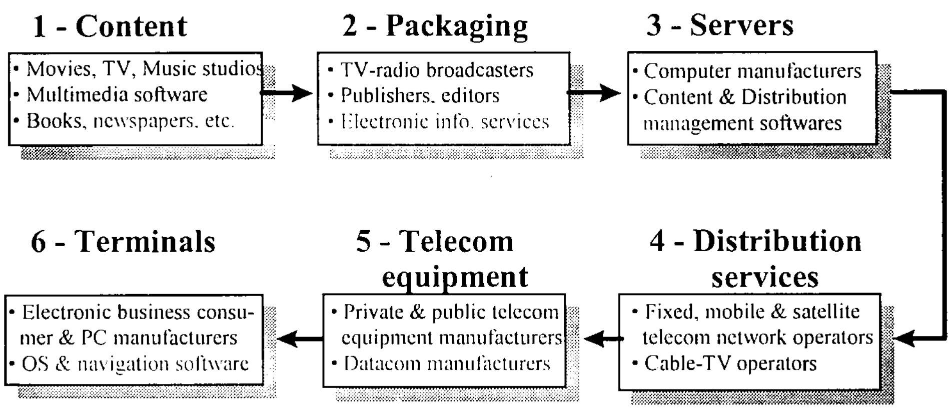
1. The Impact of multimedia on industrial structures and corporate strategies

The advent of digital technologies in telecommunications in the early 1980s led many analysts to announce the merging of computers and telecommunications industries. The recent spin-off of AT&T GIS (ex-NCR) from the AT&T group, after several years of financial difficulties, demonstrates that the change from technological convergence to industrial convergence does not obey written rules. The development of multimedia puts more pressure on the issue since it covers industries beyond information and communication technologies (ICT).

1.1 Digital continuity and industrial convergence: pros and cons

The advent of multimedia can be characterised by the end-to-end digitisation of information, from its early period of creation to its display on a PC, a television or a game console. Each stage of the information process corresponds to a category of industry players, as shown in the following diagram.

Diagram 1: The digital chain of multimedia: functions and industries



This approach is very close to the value added chain concept developed by Michael Porter[25] but is applied in this case to a group of industries rather than to the analysis of functional relations inside a company. Also, the representation of a vertical flow linking «upstream» and

---

25 M.E. PORTER: *Competitive Strategy*, The Free Press, 1980

«downstream» industries reminds us of the French notion of «filières de production» that was in vogue at the end of the 1970s and at the beginning of the 1980s[26].

Although it has been chosen not to follow at this stage of our work the analytical frame provided by the two former concepts, it can be observed that there are classic input-output relations between neighbouring levels in our representation: this is typically the case in the field of audiovisual industries, the content being bought by the programmers/broadcasters and then sold, as part of packages, to distributors (however in some cases the programmers pay to be distributed on very famous cable or satellite networks). Another classic input-output relation is the one linking telecom equipment manufacturers and telecom operators.

The input-output relations between the different levels of the digital chain have already led to the creation of vertically integrated industrial groups as we can observe in the audiovisual field . Some of the major US audiovisual groups such as Time Warner or Disney have their own studios, TV channels and distribution networks. In contrast, the model of vertically integrated industry in telecommunication is progressively breaking down with the introduction of competition.

It is interesting to point out that a category of players appears at different levels: the software developers. There, we should make the distinction between multimedia CD-ROM software, application software (word processor, spreadsheet etc.), development tools (CAD/CAM, programming languages), operating systems and graphic interfaces (MS-DOS/Windows, Navigator etc.) The existence of central competencies in software development has lead to the appearance of companies such as Microsoft that are present on different levels of our presentation model.

1.2 Opportunities and threats generated by multimedia

Faced by the opportunities and threats generated by the new digital technologies, the firms have been reshaping their strategy in a relatively short period of time to keep and enhance their competitive advantage. The following table presents the majo r opportunities and threats generated by multimedia for the different industries participating in the digital information chain.

---

26 For more information about his concept: J TOLEDANO, «*A propos des filières industrielle*», in Revue d'Economie Industrielle, n°7, 1978

Table1: Threats and opportunities generated by multimedia: a sectorial approach

Industry	Opportunities	Threats
Audiovisual production	•Valorisation of copyrights through new media services	•Introudction of digital technologies in the creation process (cost and learning)
Audiovisual broadcasting	•Multiplication of available channels capacity (fiber optic, digital TV satellites etc.)	•Reallocation of traditional financing flows (advertising, premium TV etc.) in a context of herzian spectrum profusion •Internet based broadcasting
Electronic information services	•Hype on interactive on-line content •Increasing installed base of PCs equipped with modem	•Internet
Cable-TV networks	•Development of two-way services on cable networks: cable-telephony, video on demand, Internet services etc.	•High costs required to go multimedia (multimedia servers, switching facilities) •Digital TV satellite, video on telecom infrastructure (ADSL, FTTH etc.)
Telecom operators	•Traffic increase generated by multimedia heavy files •Video broadcasting on telephony infrastructure (ADSL)	•New entrants using alternative infrastructures and technologies (from cable-TV networks to fixed wireless telephony) •Internet-based long distance telephony
Software developers	•Increasing need to manage digital interactive content (development, storage and distribution, navigation and presentation tools)	•Competition between emerging de-facto market standards
Network equipment manufacturers	•Network infrastructure modernisation required to go multimedia	•Compression technologies delaying investments in high capacity hardware •Competition between public networks and LAN equipment manufacturers
Computer manufacturers	•New growth cycle based on servers and multimedia home PCs	•Consumer requirements for low cost terminals (<500 US$) •Competition from consumer electronic terminals (TV set)

Several lessons can be drawn from this table:

- For most of the industries, multimedia represents an important growth potential.

- Vertical complementarities to exploit this potential are very important: content owners need new distribution networks to get more value from their catalogues, new multimedia content will increase telecommunication traffic and will prompt households to buy more sophisticated terminals.

- Getting revenues from this new developing markets implies massive investments in the development and the acquisition of new digital technologies, multimedia servers, intelligent and broadband networks, but also to get new technological and commercial know-how. The uncertainties that still remain about the new markets and consumption patterns regarding multimedia create very favourable conditions for the constitution of strategic alliances to share risks.

- The success of Internet, on which not many people would have bet only 18 months ago, is disturbing the activities of most of the different categories of actors but is generating in the meantime huge opportunities. For instance, the Internet pricing bypasses the telecommunication long distance services activity but creates an important market for the backbone networks. Internet represents an important competition for the big electronic information services such as CompuServe or America On-line but increases their attraction by setting bridges in between. To a certain extent, Internet is increasing the freedom of choice on the customer side and is leading to a reallocation of revenues for the firms.

2. Industrial alliances in multimedia: a new paradigm for corporate strategy

Alliances, going from cooperation agreements to acquisitions and mergers, turn out to be one of the favourite solutions chosen by firms to prepare for the new information age. To a certain extent, we can say alliances are becoming the new paradigm of corporate strategy, especially for the firms involved in the information and communication sector. In this section, we will pay particular attention to alliances supported by financial links such as majority and minority interests acquisition and joint-ventures.

2.1 Acquisitions and minority stakes

The majority and minority interest acquisitions constitutes the strongest category of company's alliances. They correspond to the need to strengthen strategic links (eg: BT's 20% acquisition of MCI or Deutsche Telekom and France Télécom's 20% acquisition of Sprint), to consolidate the activity (acquisition of Turner Broadcasting by Time Warner), to get a specific know-how or leading technology (acquisition of Lotus IBM) or to diversify activities (MCA acquisition by Seagram).

The table below presents a sectorial breakdown of 193 acquisitions and minority stakes in information and communication industries from 03/93 to 06/96.

Table 2: Major world-wide acquisitions and minority stakes realized in the multimedia related industries during the period 03/93 to 06/96* (US$ million)

	1994	1995	03/93-06/96
Telecom services	14,792	17,945	96,197
Audiovisual industry	20,168	40,716	72,335
Cable-TV	9,930	10,535	34,902
Softwares	2,743	5,537	11,054
Datacom	1,120	1,853	7,494
Telecom equipments	2,435	458	4,059
Computers	382	1,372	2,533
On-line services	1,715	124	2,170
Total	53,784	78,538	230,744

* Alliances' dates correspond to their public announcement rather than to their implementation

Source: Allcom

We can observe a growing trend of acquisitions and minority stakes since 1993. However, the annual sums are greatly influenced by the «mega deals» that contribute in some cases to more than 50% of the totals for a given year. Many of them are located in the USA. Nevertheless, the evolving market conditions are very favourable to the continuation of this trend: the liberalisation process in the field of **telecommunications and cable-TV** is playing a particularly important role. In the USA, the new Telecommunications Act of 1st February 1996 has started to generate a new wave of very important deals. Few weeks after its adoption by the US Congress, five regional telecom operators are involved in acquisition and merger transactions superior each to US$ 10 billion: US West announced the acquisition of Continental Cablevision for an amount of US$ 10.8 billion, SBC Communications and Pacific Telesis announced their merger in a US$ 16.7 billion deal as well as Bell Atlantic and Nynex for a US$ 20.5 billion transaction. In Europe, the progressive liberalisation of telecommunications services is also generating important deals, but more in the form of minority stakes.

The second most active industry in terms of acquisitions is the audiovisual sector, especially in the USA. The biggest acquisitions and mergers since 1994 were:

- January 1994, acquisition of Blockbuster by Viacom : **US$ 8.4 billion**
- July 1994, acquisition of Paramount Communications by Viacom: **US$ 9.6 billion**
- May 1995, MCA (Universal Studios) sold by Matsushita to Seagram: **US$ 5.7 billion**
- August 1995, acquisition of CBS by Westinghouse: **US$ 5.4 billion**
- August 1995, acquisituion of Capital Cities ABC by Disney: **US$ 19 billion**
- September 1995, acquisition of Turner Broadcasting by Time Warner: **US$ 7.25 billion**
- Avril 1996, merger of CLT and Bertelsmann TV broadcasting activities: **US$ 6.4 billion**

The logic of acquisitions in the audiovisual sector obeys traditional capitalistic factors: concentration strengthens transaction power vis-à-vis distributors and generates economies of scale and economies of scope. Multimedia contributes to hasten this process of consolidation: the new available channel capacities offered by the information superhighways will require more programmes to be broadcasted, new content production facilities and more agressive marketing strategies.

The rush on creative activities concerns also the **software** industry. From 1994 to 1995 the total of acquisitions in this sector has been multiplied by two, amounting to US$ 5.5 billion. The specificity of this business lies in that as soon as they become popular, software becomes very quickly a de facto standard, operating a key function in the customer's information and communication system. Replacing it is technically difficult and very costly because many past investments rely on its technical specifications. Also is it better in many cases for a group to buy a software developer rather than try to impose its own product on the market. The most significant acquisition of a software developer during the years 1994-

1995 was that of Lotus by IBM which totalled US$ 3 billion. However, this investment, which was mainly justified by the market leadership of Lotus in this area with its software Lotusnotes, is jeopardised by the success of the Internet which also provides access to groupware.

In the hardware industries, the acquisition trend is characterised by the low dynamism of the **telecom equipment** industry that has reached an optimal stage of consolidation, after several years of concentration to cover very heavy R&D costs in digital switching and transmission technologies. The **datacom equipment** industry is the most active hardware industry in terms of acquisitions. Datacom (data-communication) covers all the communication hardware for Local Area Networks (LAN) and for their interconnection to the public network or to other LANs. Most of the industry in this area is US-based. This industry has been boosted by the growing connectivity needs of PC users and the domination of the client/server network architectures. This business has generated many start-ups and some of them are now overtaking the US$ 1 billion landmark: Bay Network (Synoptics-Wellfleet merger), 3Com, Cisco, Cabletron. The biggest deal of the datacom industry is the acquisition of Stratacom by Cisco for US$ 4 billion in April 1996. Both of the companies are American.

The **electronic information services** industry is characterised by the world-wide domination of two US companies, CompuServe and America On Line, and of course the advent of the Internet. Besides the two world-wide generalist electronic networks, many transactions have been realised in the market segment of specialised corporate databases. The US$ 1 715 million total for the year 1994 is largely explained by the US$ 1.5 billion acquisition of the US company Mead Data Central (MDC) by the European Reed Elsevier. MDC is the editor of the legal databases Lexis and Nexis.

2.2 Other categories of alliances

A growing number of **joint-ventures** have been registered in the past years. The success of this kind of alliance in information and communication industries can be explained by several factors:

- It is better not to "go-it-alone" whilst uncertainties remain regarding technology, markets and regulation.
- The need to share the digital technologies development costs.
- Gathering of key assets that would have been impossible to obtain alone: Financial investment capacities, commercial know-how, technical know-how, access to local markets etc. The mobile sector provides some good examples of such alliances combining different competitive advantages.

The financial quantification of joint-ventures is very difficult because the investments, when they are announced, are always spread on several years and are subject to important modifications.

A typical category of alliance generated by the development of multimedia are those based on **experimentation**, also called test-beds or trials. Experimentations generally gather all the players of the digital chain and are in many cases lead by the companies that sell the services directly to the end users: telecom network operators, cable-TV operators, premium TV broadcasters. Multimedia experimentation is the last step before launching a new service. They allow the testing of technology and the customer's reactions vis-à-vis the new interactive services. Widely publicised since the second half of 1993, they all lag six months to one year behind schedule because of technical problems which made costs prohibitive.

The following table provides a synthesis of the different alliance's objectives between the different industries participating in the digital chain of multimedia.

Table3: The different goals of cross-industry alliances

Company B - Target

Company A - Predator

	Audiovisual Production	Audiovisual Broadcasting	Electronic Information Services	Cable-TV Network Operator	Telecom Network Operator	ICT hardware & software providers
Audiovisual Production	Consolidation Co-production Copyrights	Distribution Vertical integration	Distribution	Distribution Vertical integration	Multimedia trials	Digital effects Technology know-how Standardisation
Audiovisual Broadcasting	Copyrights Product differentiation Vertical integration Production financing	Consolidation Product differentiation Co-production	Distribution Acquisitions	Distribution Vertical integration	Multimedia trials	Multimedia trials Standardisation
Electronic Information Services	Copyrights Multimedia trials	Product differentiation	Consolidation	Distribution Multimedia trials	Distribution	Multimedia trials Acquisition
Cable-TV Network Operator	Copyrights Multimedia trials	Vertical integration Product Differenciation	Product differentiation Multimedia trials	Consolidation	Interconnexion Networking know-how	Multimedia trials
Telecom Network Operator	Minority stakes Production financing Copyrights Multimedia trials	Minority stakes Multimedia trials	Product differentiation Acquisition	Acquisition Local loop access	Consolidation Interconnexion Distribution R&D Standardisation Commercial know-how	R&D Standardisation
ICT hardware & software providers	Multimedia trials Standardisation Copyrights	Multimedia trials Standardisation	Distribution Multimedia trials Licensing Product development	Multimedia trials Licensing	Distribution R&D Standardisation Licensing	Consolidation (datacom & software) R&D Standardisation Manufacturing Integration Distribution Licensing

An horizontal reading of the table corresponds to what company A tries to get through the alliance ; a vertical reading to what company B brings to the alliance.

Conclusion

The existence of strong input-output economic relations between the different industries participating in the digital chain of information, as well as the important set of alliances gathering key competences, clearly favour the development of a vertically integrated multimedia industry. Packages including multimedia interactive content, Internet access, long distance, local and cellular telephony should have the favour of the consumer because they offer one stop shopping, discounts and can be marketed through a single solid brand image. Players having the best marketing and technical skills, deepest pockets and experience of competition are the best positioned to win huge market shares.

However, the industry has not yet reached this stage, due particularly to technical problems delaying the availability of new products and services and to a lack of information regarding demand characteristics. Meanwhile, the current acquisition trend, favoured by the release of competition, is rather focused on horizontal concentrations leading to the emergence of global players especially in audiovisual and telecommunications sectors. The strengthening of market share on a given level of the digital chain is turning out to be the prerequisite for the implementation of vertical strategies. It increases the cash capacities to fund the heavy investments required by multimedia and secures investment by reducing consumer choice. The Microsoft on-line strategy, developed from a quasi monopoly on the PC operating system market, provides a good example of the synergy between horizontal dominant position and vertical strategy.

Although it is quite clear now that the development of multimedia will be mainly led by the private sector, public authorities will be soon faced by two important issues arising from this new situation:

1. The importance of fine tuned antitrust policies in a liberalised environment: the formation of dominant positions, although required by costly digital technologies, can hamper the development of new services. Horizontal bottlenecks appear more threatening than vertical concentrations, the latter following the logic of the digital chain of information.

2. The increasing allocation of firms' investment capacities in majority and minority acquisitions rather than on tangible assets might be job costly at the macroeconomic level. In the short range, acquisitions do not create jobs (rather the opposite) and do not impact on the other industrial branches as generally tangible investments tend to do. The question is to know if positive effects resulting from these massive branch reorganisations will overcome negative short-term effects

VALUATION OF NEW SERVICES IN TELECOMMUNICATIONS

Jerry Hausman & Timothy Tardiff

Professor of Economics and Researcher, Massachusetts Institute of Technology, USA

Much public discussion has centered on the evolving "information super highway" as well as the many new services which may be offered as high capacity fiber optic transmission networks are extended into the telecommunications infrastructure. In the U.S., Pacific Telesis has begun construction of a fiber optic network which will reach 80% of California households by 1998. Numerous cable companies, e.g. Time Warner, have announced plans to upgrade their current coaxial (coax) based networks to combined fiber/coax networks. This increased transmission capacity will allow many more channels of entertainment, high speed access to information, as well as new two way interactive services.

How can society establish the value of these new services and increased choices? This question has potentially important economic consequences and equally important public policy implications. Because of the network structure of telecommunications, public policy has always played a large role in its production and regulation. Indeed, in the majority of OECD nations, basic telecommunications services are provided by the public sector. In countries such as the U.S. and Canada, very strict regulation (which is only slowly being loosened) has limited the ability of companies to compete freely in telecommunications. By demonstrating how to value new telecommunications services, we allow for a more reasoned approach to the necessary benefit-cost calculations which can help to guide public investment in telecommunications infrastructure and also to evaluate the effects of regulation.

The introduction of new telecommunications services can lead to very large gains in consumer welfare. We consider the introduction of voice messaging services by local telephone companies. These services were introduced in 1990. By 1994 we estimate the gain in consumer welfare from these new services to be between $800 million and $1.4 billion per year.

1. The Economic Valuation of New Goods

Sir John Hicks (1940) made one of the first attempts to develop the theory of the evaluation of new goods. Hicks stated that for rationed goods the index numbers need to be altered so that the price used would lead to the amount of the ration. This higher price can be considered the "virtual price" which when inserted into the demand function leads to the observed amount of rationed demand. For new products Hicks stated that the "virtual" price for periods in which the goods did not exist would "just make the demands for these commodities (from the whole community) equal to zero". Given the demand function we can solve for the virtual price and for the expenditure function (or the indirect utility function) and do correct evaluations of social welfare without needing to use the index number formulae discussed by Hicks.

We adopt the modern approach of using expenditure functions. In period 1 consider the demand for the new good, xn, as a function of all prices and income, y:

$$x_n = g(p_1, \ldots, p_{n-1}, p_n, y). \qquad \textbf{(1.1)}$$

Now if the good were not available in period 0 we solve for the virtual price, p^*_n, which causes the demand for the new good to be equal to zero:

$$0 = x_n = g(p_1, \ldots, p_{n-1}, p^*_n, y). \qquad \textbf{(1.2)}$$

Instead of using the Marshallian demand curve in equations (1.1) and (1.2), we use the income compensated and utility constant Hicksian demand curve to do an exact welfare evaluation. In terms of the expenditure function we solve the differential equation from Roy's identity which corresponds to the demand function in equation (1.1) to find the (partial) expenditure function:

$$y = e(p1, \ldots, pn\text{-}1, pn, u1). \qquad \textbf{(1.3)}$$

The expenditure function gives the minimum amount of income, y, to achieve the level of utility u1 which arises from the indirect utility function which corresponds to the demand function of equation (1.1) and the expenditure function of equation (1.3). To solve for the amount of income needed to achieve utility level u1 in the absence of the new good, we use the expenditure function from equation (1.3) to calculate:

$$y^* = e(p_1, \ldots, p_{n-1}, p^*_n, u^1). \qquad \textbf{(1.4)}$$

The change in consumer welfare when the price decreases from the virtual price level, p^*_n, to the actual price level, p_n, keeping utility at the level u^1 is $y^* - y$. The techniques of Hausman (1981) or Vartia (1984) in the parametric case or the method of Hausman-Newey (1995) in the non-parametric demand function case are used to compute y^*.

2. Estimation of the Demand Curve and Expenditure Function for Voice Messaging

In 1994 local telephone company (LEC) voice messaging demand in the U.S. exceeded 7 million subscribers. LEC provided voice messaging offers advanced voice mail features through the local central office switch. In addition to the usual voice mail features, other features include the ability to receive messages while the line is otherwise in use, partitioned mail boxes for various family members, and a broadcast facility to a group of numbers which is useful for organizations or for schools. Voice messaging, along with on-line information services, has been the great success story of enhanced services offered in the past 15 years. The average monthly price of LEC voice messaging service in 1994 was approximately $8.00. We now estimate the demand curve for voice messaging using aggregate state level panel data over the period 1991-1994.

Data on demand for BOC voice messaging was available for 14 states over a 4 year period, 1991-1994. These states were in the Midwest and West regions of the U.S. The left hand side variable is the log of demand in units of subscription while the primary right hand side variable, log of price, was deflated using the CPI. A log-log demand specification was used. Fixed effects for each state were included, as well as state specific time trends to allow for the growth in demand of voice messaging as potential customers become increasingly aware of the service. Furthermore, voice messaging was introduced at different time periods so that each state could be at a different point along a diffusion curve which is captured by the state specific time trends. To account for potential joint endogeneity of demand and price, we use the Hausman-Taylor (1981) approach of prices from different markets as instruments for prices in a given market. The results for a fixed effects specification estimated by both OLS and IV are given in Table 1.

Table 1: Panel Data Instrumental Variable Estimates

	OLS	IV
1 Log of Monthly Price	-0.821	-1.607
	(0.243)	(0.634)
2 Log of Income	4.912	4.805
	(0.407)	(0.418)
3 Log of Population	0.945	0.960
	(0.066)	(0.068)
4 Intercept	6.790	7.255
	(0.541)	(1.672)
5 Other Variables:		
State Fixed Effects		
State-Specific Time Trends		
Number of Observations	46	48
Standard Error	0.0515	0.0490
R^2	0.9998	–

Note: Standard Errors are in parentheses.

As demonstrated in Table 1, the value of the demand elasticity for this IV estimate is greater (in magnitude) than the corresponding OLS estimate of the demand elasticity. This increase in the demand elasticity is consistent with the use of an instrument which removes joint endogeneity of the price variable.

The IV fixed effects specification fits quite well, with the standard error estimated to be 0.049.[27] The estimated price elasticity is -1.61, with an asymptotic standard error of 0.63. Thus, the estimated t-statistic is 2.56, which indicates quite a precise estimation. To estimate exact consumer welfare which arises from a new telecommunications service, we also need to estimate the income elasticity. We use the estimated fixed effects for each state and use minimum chi square estimation to find the income elasticities.[28] The results are given in Table 1. We estimate a relatively high income elasticity of 4.81 (s.e. = 0.42) and a population elasticity of 0.96 (s.e. = 0.068). While the estimated income elasticity is relatively large, the

27 In terms of an R2 measure for an OLS regression, the R2 would be 0.999, although this measure is not appropriate for an instrumental variable estimator.

28 Minimum chi square (or minimum distance) estimation is similar to GLS estimation, see Malinvaud (1971) or Rothenberg (1973). We estimate the model in two steps to ensure that the price elasticity, which is the primary parameter needed for consumer welfare calculations, is consistently estimated. See Hausman-Taylor (1981) for a further discussion.

result is to be expected since voice messaging is likely to be a superior good, and our consumer welfare results are not particularly sensitive to the estimate.

Once we have estimated the demand function for voice messaging, we now turn to the expenditure function to estimate the value of voice messaging to consumers. To estimate the overall effect on consumer welfare, we use an exact consumers surplus approach using the expenditure function for the log linear demand curve. First, we use the expenditure function calculated in Hausman (1981), equation (23):

$$e\,(p,\bar{u}) = [(1-\delta)\,(\bar{u} + A\,p^{1+\alpha} / (1+\alpha))]^{1/(1-\delta)} \quad 1 \qquad \textbf{(2.1)}$$

where A is the intercept of the demand curve, a is the price elasticity, and d is the income elasticity estimate. The compensating variation is calculated from equation (2.2) where y is income:

$$CV = \left\{ \frac{(1-\delta)}{(1+\alpha)}\; y^{-\delta}\; [\,p_1 x_1 - p_0 x_0\,] \;+\; y^{(1-\delta)} \right\}^{1/(1-\delta)} - y \quad 2 \qquad \textbf{(2.2)}$$

For the case of a new good, the expenditure function from equation (2.1) is used to calculate the compensated (Hicksian) demand curve, and the "reservation" or "virtual" price is calculated; see Hausman (1994). Using the consumers surplus formula from equation (2.1) we estimate the consumer welfare from voice messaging services provided by the LECs to be between $800 million (a.s.e. = 312) and $1.4 billion (a.s.e. = .428). Thus, new telecommunications services can create significant value for consumers. Government actions which either speed up or delay the introduction of these new services can have important welfare effects on the economic welfare of its citizens.

Is there an Economic Rationale for the Liberalisation of Telecommunications Infrastructures? [29]

Francisco Caballero Sanz

European Commission and University of Valencia, Spain

Amparo Urbano Salvador

University of Valencia, Spain.

There is a generalised consensus nowadays that the provision of telecommunications services should take place under competitive conditions. Throughout the world, liberalisation processes are being released on the traditional monopolies of PTOs which have been providing telecommunications services for decades.

The liberalisation of telecommunications has sparked a good deal of theoretical work to study competition conditions in markets of final services where there is a common network provided by one network operator and other suppliers of services have to interconnect and use the same network in order to provide the final service. The most significant body of that literature considers the problem of pricing access to the network for competitors or the leasing of lines by the network operator. In the case of liberalised infrastructures, the problem arises when different operators have to interconnect their networks, offering inter-operable networks to other companies using them to provide final services.

---

[29] The ideas presented in this paper are those of the authors and do not represent in any way the position of their employers.

That strand of the literature has produced interesting pieces of work with practical implications for the industry such as Baumol and Sidak (1994) and Lafont and Tirole (1995).

However, most of this work has not taken into account the impact of access pricing (and other problems that appear when one firm supplies an intermediate input to its competitors downstream), on the development of the network. The large majority of these theoretical models are essentially static and do not look into the implications of access pricing and the interconnection of networks on some dynamic issues such as investment and the rate of growth of the network capacity available for competition in the provision of final services. These dynamic issues are very important as determinants of competition in the supply of telecommunications services. Entry will largely depend on the capacity available and its price. Other questions such as the level of investments carried out by network operators to maintain the networks operational or the quality of the infrastructure made available to competing service providers are also important determinants of competition conditions in practice.

In addition, these dynamic issues are extremely important for the development of the information society. If network operators do not carry out the necessary investments, bottlenecks can appear in the provision of services that will slow down demand for new services and in fact, delay the arrival of the information society. The rate of increase in the number of users of new services is also dependent on the prices of those new services. Competition in the provision of services to consumers will drive prices down and speed up the diffusion of new services.

Furthermore, decisions on pricing access to networks are not independent from the decisions to carry out the necessary investments to increase the capacity available to competing service providers. When firms fix access prices, they are indirectly determining the degree of entry by downstream competitors, and therefore, the capacity demanded. On the other hand, when they decide the capacity made available to other service providers, they are determining the maximum output level of final services downstream and to a certain extent, the price of those services as the latter depend on how much competitors will be willing to pay for access to the network.

From the point of view of competition, the issue of capacity availability is as important as the problem of access prices or the existence of non-discriminatory access. If network operators are not ready to carry out the necessary investments to make sufficient capacity available to other service providers, in quantitative and qualitative terms, there will not be effective competition in the market place.

This paper aims at discussing some of the problems that arise when pricing access to networks and the size of the network are considered as variables simultaneously determined by the network operator. The recent literature on access pricing relies on the idea that incumbent network operators will use access prices as a strategic variable to influence competition conditions in the downstream market for final telecommunications services.

High access tariffs could deter entry by new competitors. Cross subsidies could help to keep them at bay by lowering the prices of services open to competition to deter entry.

However, this presumed behaviour of traditional operators and network owners is based on the assumption that capacity for new entrants is not a strategic variable for the operator. For instance, little is known about the optimal strategies open to network operators when they decide at the same time about access prices and the total capacity made available to competitors. In that setting, an alternative strategy to keep potential entrants from becoming effective competitors might be limiting the size of the network to leave them no room to compete. Moreover, we do not know much about the behaviour of the entrants, which is also essential to learn about the performance of the industry. Will they accommodate the conditions established by the incumbent? Or, will they undercut the incumbent in order to gain market share?

All these questions are extremely important to learn what can be expected in terms of performance in the markets for liberalised services and to better re-regulate those markets. But that is not all. If the behaviour of the network owner and operator leads to a poor performance in terms of entry and competitive prices in the market for telecommunications services and in terms of the rate of growth of the network -and therefore, the development of the information society-, one could also question the economic rationality of the monopolistic condition of the network operator. If the existence of a single network owner and operator hinders the overall performance of the sector, one could question the persistence of a natural monopoly in the telecommunications infrastructure. The social advantages of having just one network would have to be compared with, and might even be offset by, the social burden derived from the poor market performance due to the strategic behaviour of the network owner. If the net effect is negative in terms of social welfare, the existence of network duplication might be justified. Moreover, this could foster entry and the development of the information society. In that case, the natural monopoly in telecommunications infrastructure would be questionable and the liberalisation of network infrastructure would be justifiable on economic grounds.

In the following sections we shall explore these issues from different perspectives. Firstly, we shall look at the empirical evidence from the European Union and OECD countries. Given that the deregulation of telecommunications services has gone ahead of the liberalisation of telecommunications infrastructure we can see how access prices and network expansion have evolved when the network operator has faced competition in the markets for services. Secondly, we shall look at some new theoretical work shedding light into the strategic choices open to network operators who have to face competition downstream and decide on access prices and capacity constraints at the same time. Finally, we shall review some arguments recently put forward for and against the consideration of telecommunications infrastructures as a natural monopoly and their liberalisation.

1. The recent experience after deregulation of telecommunications services

The European experience in the process of liberalisation of telecommunications is quite illustrative of the response by the traditional monopolistic PTOs to the new competitive environment for service provision when infrastructures remain under the control of a simple operator.

After the progressive liberalisation of different telecommunications services, it was considered that competition in the newly liberalised markets could be ensured by the joint application of standard competition rules and the so-called "Open Network Provision" directives. The Open Network Provision directives of the EC were introduced in 1992, before the review of the liberalisation of telecommunications. Those directives did not question the monopolistic provision of infrastructures. They established that the network operator should facilitate access to competing service providers under non-discriminatory conditions. For instance, directive 92/44/EEC requires that leased lines be offered on a cost-oriented basis. The "natural monopoly" arguments for the minimisation of the social costs for the provision of telecommunications infrastructure were not challenged at that time. It was assumed that the opening of services to competition could be ensured by the application of the ONP directives and an effective enforcement of Directive 90/388/EC for the application of competition to the telecommunications markets.

From a legal and economic perspective, this was considered an optimal solution. On one hand, a single network to be shared by all service providers would ensure a minimum social cost and avoid "wasteful duplications of infrastructure". On the other hand, competition rules could assure that prices of final services to consumers would be kept down. ONP directives and the application of articles 86 and 90 of the Treaty would take care of market conditions in the intermediate market for leased lines. Basically, it was considered that as long as there were no discriminatory access conditions and access prices were not abusive, overall market performance would be satisfactory.

With some local differences, the logic of this market arrangements was based on the anglosaxon legal doctrine of "essential facilities" and its economic counterpart, Third Party Access (TPA). A development of Antitrust practice, the essential facilities doctrine has been at the origin of a common approach in the regulation of different public utilities such as gas, telecommunications, electricity and railways, where free and non-discriminatory access to networks was essential to ensure competition.

However, the logic of TPA and ONP underestimates, in our opinion, the potential impact of the strategic behaviour of the network operator. Recent empirical evidence from the EU and the OECD tends to support our point of view.

In the Green Paper on the liberalisation of telecommunications infrastructure, the Commission published data about the conditions prevailing in the markets for telecommunications leased lines in European countries. Table 1 below reproduces data from the first part of the Green Book showing how rental prices for leased lines diverged considerably between Europe and the USA in a ten to one proportion. Within the EU, prices of leased lines were significantly higher in those countries with liberalised infrastructure like the UK and those maintaining a monopoly in that industry segment.

Table 1: High Capacity Leased Circuit Prices in ECU (at 1.1.94)34

EU half circuits	Rental to nearest EU	Rental furthest EU
B	21,793	29.380
DK	17,658	19,865
D	27,889	33,422
GR	26,15	33,174
E	30,192	30,821
F	24,185	31,815
IRL	4,027[35]	30,312
I	27,685	33,769
L	16,739	27,170
NL	18,700	24,933
P	21,117	31,777
UK (BT)	10,041[36]	40,778
UK (MCL)	8,817	23,958
EU	20,461	29,901
EU Total circuit price37	40,922	59,802
US	4,60138	6,236

source : Coopers & Lybrand, 1994

34 Rental charges are in ecu for monthly rental of a 2 Mbit/s line on 1-year contracts. Some TOs offer discounts for longer term contracts. High volume discount shemes offered by some TOs have not been taken into consideration.
Note : these tarriffs are subject to change and therefore for further details refer to national regulatory authorities.

35 Irish circuits to the UK are distance-dependent. The charge is made up of a fixed cross channel charge and a mainlink which is distance-dependent. A link from Dublin has been taken in this instance.

36 BT's charges to Ireland are distance-dependent and the cost is for a link from London to Nefyn, the UK charging point, with an approximate distance of 340 km.

37 Sum of two EU average circuit halves.

38 Figures represent AT & T's charges for a 1.5 Mbit/s circuit (T1) from New York to Washington (320 km) and from New York to Chicago (1,100 km)

But the performance of monopolised networks did not differ just in terms of access prices. One of the main arguments presented by the Commission for the liberalisation of infrastructure was the lack of availability of the basic infrastructure over which liberalised services are operated or provided to third parties. High prices and limited availability of network capacity were considered responsible for the delays in "the widespread development of high speed corporate networks in Europe, remote accessing of databases by both business and residential users and the development of innovative services (such as tele-banking, distance learning, etc.)".

These views had already been expressed in the report on "Europe and the global Information Society". A high level group chaired by Commissioner Bangemann recommended to "accelerate the on-going process of liberalisation of the telecom sector by opening up to competition infrastructures and services still in the monopoly area; removing non-commercial political burdens and budgetary constraints on telecommunications operators, and setting clear timetables and deadlines for the implementation of practical measures to achieve those goals".

Further empirical evidence about the unsatisfactory performance of monopolised telecommunications infrastructure markets has been recently provided by the OECD. Taking the market for the provision of Internet services, the OECD working party on telecommunications and information services policies has been able to provide evidence on the market performance in OECD countries. This interesting study shows that the average price for leased-line access to the Internet in countries with monopoly telecommunications infrastructure provision is 44% more expensive than in countries with competitive provision of infrastructure. These conditions in the intermediate service market are reflected in the prices for final services. On average, Internet Access Provider's prices for dial-up services are nearly three times less expensive in countries with telecommunications infrastructure competition than in those with monopolistic markets. For a basket of 30 hours per month of dial-up Internet access (i.e. public switched telecommunication networks plus Internet Provider charges) seven of the eight countries with infrastructure competition are below the OECD average while 12 of the 17 countries without infrastructure competition are above the OECD average.

The OECD study gives also interesting information related to another aspect of the performance of the market for access to networks. They indicate that there is a danger that monopoly PTOs, by maintaining high underlying charges for capacity, could restrict the growth of dial-up and leased line Internet access services until they are ready to enter the market or because they view some new Internet services as threats to traditional sources of revenue. The persistence of monopolistic conditions at the infrastructure level could thus hinder the development of the information society.

Table 2: Ranking Internet Access Provider Charges (Dial-up), August 1995

OCDE Countries (Infrastructure competition exist in shaded countries	20 hours per month (1), US$PPP	30 hours per month (1), US$PPP	Average	Possible extra charge based on usage
Autralia (November 1995) (2)	10.45	16.54	13.49	
UK	14.67	14.67	14.67	
NZ	15.26	15.26	15.26	YES
Finland	18.85	18.85	18.85	
US	20.64	20.64	20.64	
Netherlands	21.13	21.13	21.13	
Canada	15.96	27.96	21.96	
Iceland	24.35	24.35	24.35	
Sweden	25.10	25.10	25.10	
Australia (November 1995) (3)	29.41	29.41	29.41	
Spain (November 1995) (5)	35.10	35.10	35.10	
Norway	35.69	53.07	44.38	
Switzerland	46.95	55.95	51.45	
Portugal	42.25	67.25	54.75	
Autria	59.32	59.32	59.32	
Australia (August 1995) (3)	51.74	77.21	64.48	
Japan (November 1995) (4)	53.04	86.19	69.61	
France	61.37	91.39	76.38	
Greece	77.39	77.39	77.39	YES
Mexico	80.41	80.41	80.41	
Denmark	67.48	99.64	83.56	
Turkey	72.97	117.97	95.47	
Italy	79.08	117.82	98.45	
Belgium	108.36	108.36	108.36	
Japan (August 1995) (4)	109.57	109.57	109.57	
Germany	108.06	162.09	135.08	
Ireland	153.49	153.49	153.49	
Luxembourg	154.65	154.65	154.65	
Spain (5)	218.96	345.01	281.99	
OECD	67.35	83.94	75.65	
Infrastructure Competition	33.97	38.66	36.32	
No Infrastructure Competition	83.05	105.25	94.15	

Source : OECD

1. Includes 20 or 30 calls of one hour duration ad connection (or set up charge) spread over 36 months.
2. Netspace price for non-commercial users in November 1995.
3. Acay price in November 1995 and in August 1995.
4. InfoWeb price for November 1995 and Tokyo Internet for August 1995.
5. Abaforum price for November 1995 and EUnet price ofr August 1995.
6. Excludes all PTO charges for dial-up access. In other words the prices shown are just those of the IAPs. Shaded countries allow infrastruture competition.
7. OECD average excludes Australian an Spanish data for November 1995.

2. Lessons from the application of game theory

Theoretical work on the joint determination of network capacity and access prices has not been carried out until recently. In a paper in the process of publication, Urbano and others (1996) have set up a game theoretical model where a firm enters a network industry where the incumbent can choose the access price for the services provided to the new entrant, the capacity of the network and the price of a final service downstream supplied in competition with the new entrant. The incumbent network monopolists acts as a leader, accommodating for the entry of the new competitor in order to maximise his own profits if it cannot avoid entry. For simplicity, it is assumed that the network owner and the entrant produce just one single final service.

The outcome of this setting is not a trivial question. Given that the monopolist has two choice variables, a priori, it is not evident whether he will raise the access price or limit the capacity available to the entrant or both. Furthermore, the question becomes more interesting if we consider a key element underlined in the OECD study: the relative efficiency of the incumbent and the entrant.

The model assumes that, considering the prospects of entry, the incumbent network monopolist chooses a capacity level for himself and for the entrant, and an access price for the services delivered to the entrant for the use of the network. When fixing the optimum values for those variables, the monopolist takes into account the impact of that decision on his profits in the market for the intermediate service and in the market for the final service supplied in competition with the entrant. The resolution of the model shows a variety of possible outcomes,[30] with a quite unsatisfactory industry performance in most cases.

a) The case of the relatively efficient network monopolist

If the network monopolist is efficient or does not have a strong marginal cost disadvantage as compared with the entrant, he will choose an access price not too high in order to implement a "judo solution". In a "judo" equilibrium, the incumbent sets a large capacity and the entrant a small capacity. This solution captures the image of a small firm using its rival's large size to its own advantage, and relates directly to the Gelman and Salop (1986) model of "judo economics". Their model deals with the incentive of a cost-disadvantaged entrant to keep its scale of operation small, when the cost-advantaged incumbent is assumed to have enough capacity to serve the entire market. The entrant first decides upon a scale of operation, and a price to charge. The incumbent then follows with its choice of price. Thus the entrant is a price leader. Gelman and Salop show that it is optimal to choose a capacity-

---

30 As a matter of fact, there are different possible equilibria in this model. However, we will concentrate here just on those strategies that are dominant for the monopolist, which are those that it will actually implement depending of its relative efficiency with respect to the entrant. For a detailed explanation see Urbano et al. (1996).

price pair which will deter the incumbent from undercutting or matching prices and which gives the entrant positive profits.

In terms of the model by Urbano and others, this type of solution implies a high capacity for the incumbent monopolist and a much smaller capacity for the entrant. Neither firm will operate close to full capacity and prices for the final service will be quite high because the incumbent behaves "almost" as a monopolist in the residual demand left by the entrant, which, given their relative dimensions, is quite big. Nevertheless, the price of the incumbent will be higher than or equal to the price of the entrant.

The model predicts that in this case, the monopolist may cross-subsidise charging an internal price for the usage of capacity below marginal cost to foster the provision of final services. Thus, there is the risk of discriminatory behaviour and cross-subsidisation between the provision of access to the network and the provision of final services by the monopolist.

b) The case of the relatively inefficient network monopolist.

In this situation, the "judo" solution may not be the profit maximising strategy for the incumbent monopolist. If the marginal cost of supplying the final service is quite high for the incumbent network monopolist, its choice of capacity will fall relative to the capacity choice for the entrant. This implies a smaller residual demand and much lower profits. In that case, the profit maximising strategy is to choose a very high access price and to reduce industry capacity considerably, i.e. to reduce its optimal choice of capacity for himself and for the entrant. This solution allows the monopolist to remain as provider of final services despite entry and competition in that market. However, this will be a relatively passive type of competition and prices will remain relatively high. With this strategy, the monopolist remains active in the final service market, even if it is a highly inefficient firm. In that case, its capacity and output will be quite small, but the entrant will not be able to price him out of the market.

In this case however, there is no risk of cross-subsidisation between the provision of final services and the provision of access to the network.

Thus, economic analysis shows that when the strategy space of the incumbent monopolist includes both access prices and capacity choices, the performance of an unregulated monopolist will not be optimal. There are several theoretically possible outcomes in this setting. However, none of them is satisfactory from the point of view of competition in the final service market nor in terms of the development of the network. In the case of an efficient monopolist, the capacity choice gives a relatively large network size, but the impact of entry is quite limited as prices for the final services remain high. In fact, these high prices will act as a limit to the expansion of the service. On the other hand, if the incumbent is quite cost disadvantaged, it will restrain the growth of the network and competition will not be very active either. More importantly, the access price will be quite high and this will discourage entry and the development of markets for new services in the Information Society.

These results have been obtained in a highly stylised model and presents the very first analytical results about this problem. Much more research is necessary in this area to confirm or qualify these results in a more realistic model incorporating a really dynamic decision making framework. However, this game theoretical setting enables one to draw some interesting insights about the choices open to the incumbent monopolists who can decide on both access price and network capacity.

3. The case for "natural monopolies": arguments in favour and against the liberalisation of telecommunications infrastructures

The empirical evidence reviewed above, the recent learning from economic analysis and to a very large extent policy developments, have opened the debate in favour and against the liberalisation of telecommunications infrastructure. This debate has already produced several interesting papers arguing in favour and against the economic rationale for the liberalisation of telecommunications infrastructures.

J.M. Harper, a former manager and member of the BT Board has published several works arguing in favour of a monopolistic status for telecommunications infrastructures.[31] He claims that infrastructure competition works against consumers. Based on the UK experience, he argues that the telecommunications sector has been the subject of so many technological and organisational changes that it is difficult to isolate the real impact of the liberalisation of services and infrastructure.

As regards competition in local telecommunications, he claims that there are economic and technical reasons against the liberalisation of infrastructure. Despite the large investments carried out by entrants in the UK cable television market, nowadays, only a small fraction of the UK population has access to alternative infrastructure different from BT's. Moreover, the development of public broadband requires very substantial investments. Replication of networks and the difficulty to predict demand and the returns from investment that infrastructure competition entails will probably delay development of broadband networks.

Underlying these economic arguments there is a central proposition: the necessary investments to update the network and to develop the sector are very costly and a monopoly in infrastructures will help to raise profit expectations to carry out investments at a socially desirable rate[32].

---

[31] See for instance Harper (1990), (1994) and (1995).

[32] Similar arguments have been put forward by other authors in the context of other public utilities. See for instance M. Boiteux (1996) for the case of electricity in France.

From a technical point of view, Harper argues that the liberalisation of infrastructures poses problems in terms of the interconnection of the networks and the quality of the service. He argues that the new technologies permit to benefit from greater economies of scale than the old ones, hence reinforcing the case for a natural monopoly in the provision of infrastructure.

According to Harper, the optimum market structure for the sector would be one where:

- a series of competing unregulated companies of roughly similar size retail the inland services, no one of which operates in more than one city or region;
- the inland network including distribution plant is run by a separate single regulated operator whose role is to provide network facilities on a fair basis to the retailers;
- the retail role of this network operator is confined to international services both at home and overseas.

On the opposite side of the spectrum we find authors like Adam D. Thierer who maintain that there is not such a thing as a natural monopoly, at least in telecommunications. Thierer gives a historical explanation of how AT&T reached the "status of a natural monopoly". When the original Bell patent expired in 1894 and until 1913, there was a rapid increase in the number of telecommunications operators in different parts of the USA. Quoting figures from Brock (1981), Thierer reports that the number of competitors grew to over 3.000 and by 1907, the non-Bell firms were operating 51% of the telephone business in local markets. This had a very significant impact on prices and output. Between 1880 and 1920, the number of average daily calls per 1.000 population multiplied by 100 and the number of telephones per 1.000 people grew from 1.1 to 123.9 during the same period. At that time, nobody claimed that telecommunications had a natural monopoly character.

World War I and the nationalisation of telecommunications gave AT&T an opportunity to consolidate its monopolistic position. The introduction of rate regulation and geographically-averaged rates are presented by Thierer as key elements to disincentive and later eliminate any form of local telephone competition. The creation of the Federal Communications Commission and the passage of the Communications Act in 1934 worked in the same direction by requiring "to make available, so far as possible, to all people of the US a rapid, efficient Nation-wide and world-wide wire and radio telecommunication service with adequate facilities at reasonable charges."

This historical account seems to contradict the economic argument for natural monopolies. Despite the initial advantage enjoyed by AT&T in terms of scale of operations, the years that followed the expiring date of the Bell patent showed active entry by small operators in many states and cities. Presumably, the potential scale economies would have allowed AT&T to get rid of entrants. However, the number of entrants continued growing between 1894 and

1913. According to Thierer, the consolidation of the monopolistic position of AT&T seems to have been more the consequence of political and regulatory developments than the result of the working of economies of scale.

Conclusions

In this paper we have tried to raise a question mark about the economic case for the consideration of telecommunications infrastructure as a natural monopoly. The early economic papers putting forward ideas for the deregulation of utilities like Demsetz (1968) did not question the natural monopoly status of the networks.

We have shown several historical, empirical and theoretical arguments raising some doubts about the economic rationality of keeping competition away from telecommunications infrastructure. In practice, public authorities are introducing infrastructure competition to different degrees in an increasing number of countries.

However, it is far too early to draw conclusions based on sound economic reasons. Evidence seems to indicate that we are working in a world of "second best solutions" and it is quite difficult to carry out clear-cut comparisons in terms of social welfare in that context. The duplication of networks does have an impact in terms of social costs. It implies the extra allocation of resources from other sectors. But infrastructure competition seems to have beneficial effects in terms of competition and individual market performance. Therefore, there is a clear trade-off in terms of costs and performance for the economy as a whole, with a net effect very difficult to evaluate.

After the liberalisation wave that the sector experienced in the last two decades, there are an increasing number of voices calling for a reconsideration of liberalisation in certain areas. The need to invest to develop the Information Society is put forward by some as an argument in favour of maintaining a network monopoly. Some people tend to identify the existence of a trade-off between competition and the rate of advent of the Information Society. According to them, it is necessary to waive the application of competition rules to this sector because otherwise it would not be attractive to invest in the building of telecom infrastructure. In our opinion, this approach is flawed for the following reasons:

- The first reason is that the maximum possible rate of investment and growth of the infrastructure is not necessarily the social optimum. The opportunity cost of investment funds in that or in any other activity can only be rightly established if there are no distortions of competition. Thus, introducing distortions of competition in the telecommunications sector can lead to a faster growth of the sector but at an excessively high social cost.

- Secondly, competition can actually help to foster investment in the sector. Lower and undistorted equipment prices are indispensable for the development of infrastructure. This applies not only to equipment and capital goods, but also to services. Low prices for leased lines and lower tariffs for intermediate services can lower costs of final services and hence spur demand.

- Finally, the accumulation of profits in the hands of network owners is not a sufficient condition to have high rates of investment in infrastructure. Large profits can lead to slack payments, wasteful spending and inefficient performance unless the discipline of competition can help keep the firms lean and efficient.

Nevertheless, the evidence coming out from the current debate on the pros and cons of the liberalisation of telecommunications infrastructure seems to suggest that this is not a "all-or-nothing" question. There is a growing consensus that the different components of the telecommunications network have different degrees of the "natural monopoly condition". The segment connecting each consumer to the network accounts for approximately 70% of the cost of the network and has a very low frequency of usage on average. Long distance connections present large economies of scale. But the distinction between these two generic partes of the networks is changing constantly. In the near feature, the boundary of the high-tech network will move much closer to the final customer than today. Technology is modifying cost conditions in the local loop and this will also change the "optimum" size of local networks.

In this changing environment, it is hard to look for definitive answers to the issues that we have examined above. Past certainties are constantly being challenged and the natural monopoly condition of telecommunications infrastructures cannot be an exception.

References

Arora, A. And Gambardella, A.
The changing technology of technological change - general and abstract knowledge and the division of innovative labour, Research Policy, vol.23-5(1995)

Arrow, K.
The limits of organization, Norton(1974)

Allen, T.J. and M.S. Scott Morton (eds.)
Information Technology and the Corporation of the 90s. Oxford University Press, Oxford, 1994

Antonelli, C
New Information Technology and Industrial Change. Kluwer Academic Publishers, Boston, 1988
The Economics of Localized Technological Change and Industrial Dynamics. Kluwer Academic Publishers, Boston, 1995a

Besen, S. and Farrel, J.
Choosing how to compete: strategies and tactics in standardisation Journal of Economic Perspectives vol 8 n.2 (1994)

Brynjolfsson, E. and Hitt, L.
Information Technology as a Factor of Production: The Role of Differences among Firms. Economics of Innovation and New Technology 1995 (3)

Brock, G.W.
The U.S. Telecommunication Policy Process. Harvard University Press, Cambridge, 1994
The Telecommunications Industry: the dynamics of market structure, Cambridge, Harvard U.P. (1981)

Baumol, W.J. and G. Sidak
Towards competition in local telephony, Cambridge, MIT Press. (1994)

Coopers and Lybrand
The impact of the liberalisation of alternative Terrestrial Infrastructure for Non-reserved Services, Study for DG XIII of the European Commission. 1994

Capello, R
Regional economic analysis of telecommunications network externalities, Elsevier Science Publisher, Amsterdam(1994)

Cronin, F. et al
Telecommunication technology, sectoral prices and international competitiveness (1992), Telecommunications and Policy, vol 12.

Cronin, F.J, Colleran E.K., Herbert, P.L. and Lewitzky, S.
Telecomunication and growth Telecomunication Policy, vol 9. (1993)

Carpentier Michel, Farnoux-Toporkoff Sylviane, Garric Christian
Telecommunications in Transition. Wiley, 1992

Dasgupta, P. and David P.A.
Towards a new economics of science, Research Policy, vol.23-5 (1995)

David, P.A. and Foray, D.
Accessing and expanding the science and technology knowledge-base, STI Review, n°16 (1995)

David,P. and Blum, J.
The economics of gateway technologies and network evolution: lessons from electricity supply history, CEPR, 117, Stanford University, 1987

Demsetz, H.
Why regulate utilities?, Journal of Law and Economics, vol.11 , April, pp. 55-65. (1968)

European Commission
Commission Directive ***"Competition in the markets for telecommunications services"*** 90/388/90 of 28.6.1990

European Commission
Green Paper on ***"The Liberalisation of Telecommunications Infrastructure and Cable Television Networks."*** Parts I and II, Com (94) 440 final and COM (94) 682 final of 25.10.1994 and 25.1.1995. Brussels

Eliasson, G.
The Knowledge-based information economy, Almquist & Wiksell International, Stockholm(1990)

Foray, D. and Lundvall, B.A.
From the economics of knowledge to the learning economy, in Foray et Lundvall (eds), Employment and growth in the knowledge-based economy, OECD(1996)

Freeman, C. and L. Soete,
Technological Change and Fyull Employment, Blackwell, Oxford, 1987

Gelman J.R. and Salop S.C.
Judo Economics: Capacity Competition and coupon competition, Bell Journal of Economics, vol. 14, (1983)

Griliches Z.
Issues in Assessing the Contribution of Research and Development to Productivity Growth.
Bell Journal of Economics, 1979 (10)
Comments on Measurement Issues in Relating IT Expenditures to Productivity Growth.
Economics of Innovation and New Technology 1995 (3)

Harper J.M.,
The case against alternative infrastructures, (1994) Telecommunications policy.

Hulten, C.R.
Growth Accounting with Intermediate Inputs. Review of Economic Studies 1978 (45)

Hausman J.
Valuation of New Goods Under Perfect and Imperfect Competition MIT Working Paper June 1994 forthcoming in R. Gordon and T. Bresnahan eds.

Hausman J. and W. Newey
Non-parametric Estimation Of Exact Consumer Surplus and Deadweight Loss Econometrica 1995.

Hicks J.R.
The Valuation of the Social Income Economic Journal 1940.

Hudson Heather
Universal Service in the Information Age Telecommunications Policy 1994 18 (8)

ISTAT
Tavola economica intersettoriale 1985 a prezzi di mercato. Roma 1988(a) and following years.

Katz M and Shapiro C.
Product Introduction with network externality The journal of Industrial Economics vol XL n.1(1992)

Kellerman J.
Telecommunications and Geography Belhaven Press London(1993)

Lundvall B.A. and Johnson, B.
The learning economy, Journal of Industry Studies, vol.1(2) (1994)

Lucas R.
On the mechanisms of Economic Development, Journal of Macroeconomics, June, 22.1(1988)

Lafont J.J. and J. Tirole
Creating Competition through Interconnection: Theory and Practice, Toulouse, mimeo. (1995)

Matutes C. and Regibeau, P.
Standardisation across markets and entry, Journal of Industrial Economics, vol. 37(1988)

Melvin J.R.
Intermediate Goods and Technological Change. Review of Economic Studies 1969 (36)

Norton S.
Transaction costs, telecommunications and the microeconomic of macroeconomic growth, Economic development and cultural change, vol 30,n.3(1992)

OECD, DSTI/ICCP/TISP
Information Infrastructure Convergence and Pricing: the Internet, January, Paris. (1996)

OECD-ICCP
Special Session on Information Infrastructures "Towards Realisation of the Information Society", ICCP 3-4 April 1995, OCDE/GD(96)28

OECD
Technology, productivity and job creation: Analytical report, DSTI 95(4) (1996),

Paltridge Sam
Telecommunications ,infrastructure - The Benefits of Competition, OECD-ICCP N°35, Paris 1995

Pack, H.
Endogenous Growth Theory: intellectual appeal and empirical shortcomings, Journal of Economic Literature, Vol.8, n.1, Winter, (1994)

Romer P.
Increasing returns and long run growth, Journal of Political Economy, vol.94. (1986)

Senker J.
Tacit knowledge and models of innovation, Industrial and Corporate Change, 4(2) (1995)

Stiglitz J.E.
Economic Organisation, Information, and Development, In Chenery-Snirvassan, The handbook of Development Economics, vol.1, Amstrdam, North-Holland, (1988)

Thierer Adam D.
Unnatural monopoly: Critical moments in the development of the Bell System monopoly, **Cato Journal**, vol. 14 n°. 2 Fall, (1994)

Terleckyj N.E.
Effects of R&D on the Productivity Growth of Industries: an Exploratory Study, National Planning Association, Washington, D.C, 1974

Vartia Y
Efficient Methods of Measuring Welfare Change and Compensated Income in terms of Ordinary Demand Functions, Econometrica, 51, 1984

Xavier Patrick
Universal Service Obligations in a Competitive Telecommunications Environment, OECD-ICCP N°38, Paris 1995

Ypsilante Dimitri
Regulatory Requirements for Information Infrastructure, paper presented at the KISDI-OECD Joint Conference on Information Infrastructure: The Vision for the New World Order, Seoul, Korea, April 26-28 1995

How much will it cost ?
Pricing, Costing, Investment

CHAPTER 2

In order to design a regulatory framework within which an efficient market environment can emerge, agreement needs to be reached on access pricing methods, which up until now have been based on rather minimal and simplified concepts such as cost-orientation. Given the wide variety of final services expected to develop in the information society, one may wonder whether simplified access pricing rules are able to accommodate the wide diversity of network services that may be associated with the wide range of final products. Against this background, **Yves Smeers** seeks to answer the following questions: Will access be offered with the necessary diversity and with adequate pricing? Can the cost orientation constraint provide sufficient guidelines for a monopoly and its regulator to create the necessary variety of network services and to price them adequately? Smeers provides a brief overview of the different access rules, with each rule presented as composed of a cost component and a mark-up. He then argues that it may in principle be necessary to go beyond cost accounting in order to arrive at economically meaningful cost concepts and proposes a methodology which may help to overcome some of the deficiencies of the pure cost accounting approach and deal with the diversity of network services and final products. He proposes to differentiate access in terms of equipment and functions and to distinguish products according to priority and reliability of network services.

Cristina Murroni discusses the main issues surrounding the definition of the universal service obligation (USO) in a competitive environment based on the results of her research in the UK. She identifies the USO as an umbrella term comprising a number of different essential elements including: extensive geographical coverage; averaged residential tariffs; public telephones; and, targeted subsidies (e.g. for low income users, special users, free emergency calls). On the basis of empirical research, Ms. Murroni begins by identifying those individuals and groups who would most benefit from a USO and examines a number of important socio-economic questions raised by its provision, including: democracy; network externalities (social benefit to the customer not recognised in private context); and the two-way links that exist between network development and GDP. She then focuses on the costing of USO and how this will vary according to different tariff structures employed for different users and different locations, as well as the difficulties in defining "affordable" prices. She concludes that only *targeted schemes* can maximise access for particular groups, particularly the low income or needy (e.g. reduce connection charges, improve user control, revise disconnection policies) and that USOs should be unbundled (i.e. different policy targets for each obligation, different tools, different measurements).

Tadashi Kuriyama presents his analysis of four scenarios for infrastructure investment requirements in Japan: mobile communications, the Internet, the common Public Telephone, and Video communications (video phone, video conferencing, video-on-demand). He observes that the telecommunication market in Japan is being driven by high demand for the Internet, high demand for mobile communications, and effective use of the existing narrow-band Integrated Services Digital Network (ISDN). Demand for broadband ISDN is still quite flat and a number of ambitious investment plans for fibre to the home (FTTH) and universal optical fibre coverage have been announced in anticipation of rapid demand for optical communication in the future. However, these estimations have since been revised in the light of high growth in demand for the Internet and mobile communications Kuriyama concludes that, due to the introduction of new technologies, costs for telecommunications infrastructure are decreasing, and that computer-based communications are set to overtake telecommunications services, which are burdened by personnel costs (and regulation). He predicts that the Internet boom will die down within the next 5 years and that Internet users will switch to using high-speed optical fibre networks. He forecasts that if a 6% upgrading policy is adopted, penetration of the new telephone system (based on optical fibre networks) would be 60% by 2010. He estimates that 100% coverage by 2010 would cost around 10 trillion yen.

David Luck discusses the results of research aimed at developing likely evolution scenarios for broadband residential networks in Australia over the coming decade. The emphasis is on the demand conditions, with the technology assumptions being used primarily to inform estimates of the prices of alternative services. The research involves analysing household spending patterns and developing a spreadsheet based model to examine the economic viability of providing different services, including distributive services (pay TV), centralised interactive services (pay TV on demand), and generalised interactive services, on a range of delivery platforms over the coming decade. Luck draws a number of conclusions on the likely policy issues for government in particular in relation to competition and equity. He identifies a number of areas of possible concern including the problem of conditional access systems in a multi-service/multi-carrier environment, and the pricing of new services. Luck also raises the question of equal access to new services, particularly for those living in rural and remote areas. It has been estimated that the cost to the Australian government of subsidising access to a cable network for rural and remote communities could amount to over $AUS 1 billion per year. This compares with the current USO cost estimate for standard telephony of between $AUS 100 million and $AUS 200 million per year.

Sharon Gillett compares cable vs. ISDN as infrastructures for delivering faster Internet access to residential users. Based on case studies of two early U.S. deployments, the paper develops a capital cost model for each technology. Results from the models show the superior economics of the cable approach. For example, 4 Mbps Internet access over cable can provide the same average bandwidth and thirty-two times the peak bandwidth of ISDN access for 40% less capital cost per subscriber. The economy of the shared-bandwidth approach is even more evident when comparing the cost per subscriber for each bit per second of peak bandwidth: $0.30 for the 4 Mbps cable service vs. close to $16 for ISDN. In addtion, cable-based access can support full-time Internet connections. Despite cable's advantages, ISDN-based access is more widespread. The paper describes barriers to deployment of cable-based Internet access. It finds that the closed market structure for cable subscriber equipment has not been as effective as the open market for ISDN equipment at fostering the development of needed technology. Furthermore, monopoly control of residential communications infrastructure limits business opportunities for Internet service providers. The paper concludes with policy recommendations intended to reduce these barriers and foster more widespread and affordable high-speed residential Internet access.

Dale Stahl provides a critical survey of a number of proposals for pricing Internet transport services. As a benchmark for comparing these proposals, he begins with the theoretical ideal of optimal dynamic priority pricing. His simulation modeling suggests that this approach may indeed be practical. Stepped-pricing is introduced as a simplified approximation to dynamic optimal pricing that might be much easier to implement in the near term. By making users face the approximate social cost of usage, it would provide much better incentives for efficient resource allocation than any other scheme such as flat-rate pricing. The two serious shortcomings of flat-rate pricing are its inability to discourage demand during times of congestion and to redirect demand away from congested servers. Stahl also finds that smart-market proposals have serious flaws both theoretical and practical. The goal of public policy should be to promote the full realisation of the potential benefits of the network for society as a whole. Where the entire network is owned and operated by a government entity, that entity could (and should) directly impose the best approximation to socially optimal pricing as is feasible. In countries with privatised networks, economists and network experts know very little about how the private market will preform, but it is unlikely that socially optimal pricing will prevail. Stahl concludes that to prevent a tragedy of the commons, a well-designed effective public policy such as regulation and/or taxation will be required.

Access Rules and Product Diversity in Network Access

Yves Smeers

Professor at the Faculty of Applied Sciences of the Catholic University of Louvain, Belgium

Access to the network is a key element of competition in industries such as telecommunications, electricity, natural gas and rail transport. Networks, or parts of them are commonly considered as natural monopolies and hence regulated. Regulation is rarely if ever perfect and economic theory does not provide a unique recommendation as to how to design it. This may have consequences on the liberalisation process; first, in the presence of several contending theories, agreement may only be achieved on some rather minimal concept such as "cost orientation". Second, because cost may itself receive different interpretation, divergence can develop as to which cost notion to exactly apply.

Assuming that access pricing is indeed important for the efficiency of the final product market in the telecommunications industry (and in other network industries for that matter), a natural question is then whether departing from the more sophisticated access pricing methods, and/or from the more economically meaningful cost notions may be detrimental to the overall efficiency of the market. In particular, given the wide variety of final services that is expected to develop in the information society, one may wonder whether simplified access pricing rules are able to accommodate the wide diversity of network services that may be associated with the variety of final products. In other words, will access be offered with the necessary diversity and with adequate pricing? Can the cost orientation constraint provide sufficient guidelines for a monopoly and its regulator to create the necessary variety of network services and to price them adequately? These questions shape the structure of this paper.

The second section provides a brief overview of the different access rules. Each rule is presented as composed of a cost component and a mark-up. The difficulties of appraising these two components are discussed in section 3. It is pointed out that it may in principle be necessary to go beyond cost accounting in order to arrive at economically meaningful cost concepts. In particular, it is argued that engineering models may overcome some of the deficiencies of the pure cost accounting approach. Additional difficulties may arise to deal with the diversity of network services that may have to accompany the diversity of final products. These are introduced in two steps. In section 4, one first distinguishes differentiation of access in terms of equipment and functions. It is then argued that the notions recalled in section 2 and 3 can be extended to this differentiation of network services. A methodology is proposed for doing so. A second type of product differentiation is introduced in section 5. It deals with priority and reliability of network services. This new extension further complicates the problems of access pricing and ways to tackle this issue are examined. These different aspects are put in perspective in the conclusion of the paper.

1 Access pricing: an overview

Access pricing has been extensively examined in the open literature (e.g. Cave (1994) or Laffont and Tirole (1994) and in various studies undertaken by the Commission (e.g. WIK/EAC (1994)). As a background to this paper we shall categorise these pricing schemes as follows :

1.1. The reference: marginal cost pricing

Marginal-cost prices (MC) constitute the benchmark for all public utility tariffs. Although this pricing methodology is welfare maximising and solely based on costs, it is widely accepted that it cannot be used by a network operator (TO). Indeed, because of economies of scale and scope, marginal-cost prices fail to cover total network costs. This drawback is further enhanced when universal service or public service constraints are imposed on the TO.

Marginal costs can become impossible to measure when, as often in networks, equipment capacities are indivisible. Marginal costs can then be substituted by incremental costs (IC). Short run incremental costs (SIC) only account for the variable costs of the service. Long run incremental costs (LIC) take account of the investments necessary for supplying some services but do not necessarily encompass all the costs of the TO. For the sake of simplification, we shall consider in the following that short run marginal (SMC) and incremental costs are equivalent. In the same way, we suppose that long run marginal (LMC) and incremental costs are identical notions.

1.2. The alternatives

One can define a pricing rule as the sum of a marginal or incremental cost and a mark-up. What is included in the mark-up depends on the underlying economic theory. Three rules are commonly mentioned in order to determine access prices capable of meeting the TO's budget constraint (including the cost of universal service obligations).

Fully distributed cost (FDC) pricing allocates the access deficit following an arbitrary accounting rule. According to Arthur Andersen (1994) this approach is favoured by National Regulation Authorities (NRA) and TO who also seem to have little knowledge of their marginal cost. It is thus unlikely that FDC will reflect an adequate price signal.

Ramsey prices select the mark-up so as to cover the access deficit while minimising the distortion of economic efficiency. Ramsey pricing allows for cross subsidisation but constraints can be introduced in order to avoid them (Spulber (1989)).

Price caps are based on the idea that the firm should be allowed to maximise its profit under the constraint that some prices or some weighted combinations of prices remain within certain limits. Ramsey and price cap are equivalent under certain conditions (Amstrong et al (1994)) although their economic interpretation is quite different. They are also computationally related.

Efficient component pricing rule (ECPR) (see Baumol and Sidak (1994)) sets the mark-up to the marginal loss or, similarly, to the opportunity cost incurred by the TO in providing access to its network.

2. Implementation

Whatever the pricing rule, cost concepts are involved - in principle, marginal cost, - in practice, incremental cost. The mark-up also requires information on demand.

2.1. Costs calculation

All pricing rules mentioned in section 2 involve a cost concept. The Commission recommends that adequate accounting mechanisms be investigated but accepts the recourse to many cost notions (EC(1995a)). Following OFTEL (1995) we distinguish two costing methodologies namely the "top down" and "bottom up".

A "top down" methodology

Cost Accounting underlies FDC. The methodological drawbacks of the approach are well known: arbitrary cost allocations convey poor economic signals that may hamper efficiency. The larger the proportion of costs allocated on an arbitrary basis, the less adequate the signals, except if the allocation rules are rooted in Activity Based Costing (ABC). The idea of ABC is to deepen the understanding of the causal relations between activities and costs. Activity Based Costing allows one to transform some allocated costs into attributable costs, hence reducing the need to resort to arbitrary allocations. Needless to say this does not apply to the costs of universal and public service obligations which are by nature not attributable to the activities that cause them.

Even a perfect Activity Based Costing, that is to say, one where all costs can be transformed into Embedded Direct Costs (EDC) would not suffice to construct the adequate price signals. The reason is a behavioural one: marginal and/or incremental costs which constitute the cost component of economically justified prices assume that the cost function results from an optimisation process. This is justified in a competitive world but not in one where network services are provided by natural monopolies. In other words, the necessary efficient behaviour is not implicit in Activity Based Costing and there is no reason to believe that it is adopted by the TO. Some further step is thus warranted in order to arrive at the adequate price signals.

A "bottom up" methodology

The "bottom up" approach is based on engineering models and assumes that one optimises with respect to relevant parameters: demand, material costs, service quality. This provides the optimisation framework necessary in order to derive marginal and/or incremental costs.

The optimisation of the network traditionally consists of two sub-models namely the optimisation of the interconnection network (e.g. Gavish-Neuman (1989), Gavish-Altinkemer (1990) or Altinkemer-Yu (1992)) and the optimisation of the local loop (e.g. Gavish (1982)). This differentiation is rooted in the structure of the networks. It can be set in relation to access to the local loop on the one hand and to the interconnection network on the other. More generally, one should consider that engineering optimisation models should be called upon to determine the marginal or incremental costs of any part of the activity which retains a character of natural monopoly or which is not subject to competition. As shown in Gable and Kennet (1994) these models can even be invoked in order to explore the character of natural monopoly of the activity.

2.2. Mark-up calculation

The computation of the mark-up to be added to costs requires information on demand. This is generally considered to be a very difficult task, (e.g. WIK/EAC(1994)) especially in the telecommunication networks where the demand for the new products of the information society is not known. In contrast, others (e.g. Laffont and Tirole (1994)) have argued that firms know something about demand when they introduce new products and price new and old products. Implementing the more complex rules may thus not be such a hopeless venture. We shall not discuss the matter here but simply assume that some firms or regulators may wish to go beyond the pure cost oriented approach and deal with the mark-up problem through a formal procedure. The following can then be stated.

A "top down" methodology

Suppose an accounting description of the TO that consists of an EDC model of the TO and the residual unattributed costs (including the costs of the universal and public service obligations). It is possible to use the available demand information in order to expand these models in order to construct an implementation of the Ramsey/price cap or of the ECPR.

This will provide at least some assessment of the mark-up associated with a given pricing rule.

A "bottom up" methodology

The same can be said for the bottom up approach to the extent that engineering models of the TO can be expanded to encompass the available demand information necessary to derive Ramsey/price cap or ECPR prices and be complemented by a budget constraint.

3. Introduction Differentiation : Set of Network Services

3.1. Structuring Access Rules

Network services differ by the access rules that govern them and hence do not constitute an homogenous product. There may thus be a set of different network services supplied by a single infrastructure and the system that controls this infrastructure (see Deutsche Bundespost Telekom (1994) for an example of this diversity of services).

It is well known that the introduction of a range of products, together with their pricing, can be subject to monopolistic behaviour. One can thus claim that the access rules that define the range of network services offered on the market should also be regulated. We look at this problem through the notion of product differentiation and suppose that the TO and the NRA decide on a set of network services to offer.

Suppose first that the differentiation referred to in the above example can be entirely specified in terms of access to certain facilities and/or services. The problem can then be structured as follows. It is generally admitted that network services should be unbundled in order to remove market power from the TO. This implies defining a set of elementary network services that can be obtained separately from the TO. By analogy with the treatment of product differentiation in production theory we formalise this decomposition through the notion of a "bill of services". Each network service is decomposed into elementary services. Each elementary service requires the use of some function of the network infrastructure and managing system. We suppose that these can be defined on the basis of components of the intelligent network (IN).

This approach, which has been extensively developed in production management, involves developing a nomenclature of services and resources. This fits very well with Activity Base Costing. Indeed, in this formalism, the costing of a service can easily be obtained from the cost of each of its components through the bill of services. The costing of an elementary service results from the use of all capacities necessary for producing that elementary service. Finally, capacities, whether of the infrastructure or software type, should be defined by referring to the OSI framework for standardisation purposes. Attempting to construct such a network service decomposition therefore appears to be the first step of a cost analysis of these services and a natural way to undertake an ABC.

3.2. Adapting access pricing

The introduction of product variety as presented here can be readily incorporated in the different access pricing rules, at least in principle.

Adapting cost calculation

The introduction of product variety in the sense defined above should improve the accounting approach by transforming it from the FDC to the EDC. It complicates the engineering model approach but also improves its realism.

***The "top down" costing*:** as indicated above, the decomposition of a network service into elementary services and the measurement of the utilisation of the infrastructure and control facilities by these services constitute an implementation of the Activity Based Costing. This decomposition also defines the irreducible access deficit that will need to be allocated through a mark-up. The limitations of the approach are the lack of optimisation behaviour necessary to define marginal and/or incremental costs and the lack of mechanism to price the use of facilities at their capacity limits.

***The "bottom up" approach*:** in principle, the decomposition of network services and their utilisation of infrastructure and control capacities can be imbedded in the engineering optimisation models mentioned above. However the task may turn out to be extremely complex in practice.

Adapting the mark-up

Because we are now dealing with differentiated products, the possibilities of substitution between them need to be taken into account, whether one is dealing with a Ramsey/price cap or an ECPR. It can be expected that this information will indeed be very difficult to find.

4. Introduction Differentiation: Product Variants

4.1. Structuring Access Rules

Network services are not only described by their structure and their use of infrastructure and functional facilities. They also have a dimension of quality that can be defined by priorities and/or reliability. We refer to it as defining product variants. The question is then how much should one price a higher reliability or a higher priority. This relates to the congestion of the network and is thus of a rather different nature than the variety of services discussed in the preceding section. The problem can be described as follows. It is possible to account for reliability and priorities by introducing criteria that imposes certain quality constraints of this type on the services (see Mc Lean and Sharkey (1994a) for an example of this type of representation). The verification that these criteria are met can only be done by simulating the queues in different places of the network. This in turn involves a modelling of the routing operation and of the queue management policies at the different facilities. These operations may change with the technology but their nature will not: what is needed is a representation of queues in a network and a verification that the management of these queues at the existing facilities will allow one to meet the reliability and priority criteria.

4.2. Adapting access pricing

As before we successively consider the possibilities of adapting the computation of the costs and mark-up.

Adapting cost calculation

The "top down" approach: congestion phenomena are externalities and hence not really amenable to accounting measurements. In contrast, the bottom up approach can still be envisaged.

The "bottom up" approach: there exist engineering models that explicitly consider different differentiation of network services (e.g. Neuman (1992). The extent to which they can be developed so as to provide a sufficient representation of marginal or incremental cost of products of different reliability and priority levels is not clear.

Adapting the mark-up

There does not seem to be any hope to expand the accounting approach to deal with mark-up of the Ramsey/price cap or ECPR type for product variants. In contrast engineering models that encompass a representation of the queue management of the network can in principle be extended to account for demand information and are thus amenable to Ramsey/price cap and ECPR. Obtaining the relevant information may be quite a venture.

Conclusion

Competition should have a much more dramatic role in telecommunications than in other network industries. It is indeed the development of a whole range of new products and not only price reduction that should result from allowing new operators to access network facilities. Given this importance, it is embarrassing to note how little we know on the real operations of access and in particular on the importance of adopting sophisticated access pricing rules or rough approximation thereof. Given the importance attributed to the information society, waiting for the market to show us the result of a possibly inadequate regulatory or legal decision may not be a wise attitude.

There are some reasons to be doubtful as to the final outcome. The more economically justified rules seem to be out of favour because of their complexity. In cost orientated pricing, the least economically justified method, namely FDC, is reported to be the dominant approach. If FDC or somewhat more sophisticated cost oriented rules prevail, it seems useful to explore the extent to which they can depart from more economically justified approaches. In other words, do we get something significantly different by being more sophisticated? The objectives of this paper are to sketch some benchmark that the FDC rules could be submitted to. More appropriate cost causal accounting analysis constitutes an improvement. One should know whether the results are significantly different. Even this more sophisticated approach does not meet all desired properties. The construction of engineering based approaches for computing marginal and/or incremental costs is an alternative approach. It is probably foolish to try to impose these methods to all TO, but it could be useful to check in a few cases the extent to which they may differ from FDC oriented prices. Why not also try to assess the access deficit and hence the possible importance of the mark-up? Finally the benchmark could also be conducted in more complex situations where a set of network services exist and can differ by reliability and priority characteristics.

Universal Service in Liberalised Telecommunications Markets

Cristina Murroni

Research Fellow at the Institute of Public Policy Research, London

Telephones play an increasingly important role in our lives. Back in 1972, only 42% of British households had a telephone. In 1996, with penetration rates over 90%, we are likely to use telephones for booking and purchasing goods and services, finding out about the weather or sport results, and talking to distant colleagues and friends. Fax and modems allow us to share data and images along the same telephone wires. The advent of wireless telephony has shown mobile users - currently around 5 million in the UK - the importance of being within reach at any time they choose to do so. To most of us, life without telephones is inconceivable.

However, for many people in the UK, the telephone is still an unaffordable luxury. Telephone penetration rates are significantly lower in the poorer socio-economic groups. Over a quarter of households headed by an unskilled manual worker do not have a phone, compared to 2% in the professional group. At the bottom end of the market, as much as forty percent of households who earn between £50 and £100 a week do not have a telephone. The lack of telephone services is today explained by poverty more than any other factor.

It is widely accepted that all should have access to telephony, and that operators should be charged with a universal service obligation. But what does universal service mean?

1. Definition of Universal Service Obligation

The concept of Universal Service Obligation is dynamic: it has changed over time, and will continue to do so. In Europe the public policy goals of telecommunications were seldom formally defined and specified. The main concern was that of ensuring widespread national network coverage, and ensuring that citizen who lived in distant and rural areas were not disadvantaged and left at the margin of society. This committed the operator to *pass* all homes in the country rather than to *connect* any given percentage of households. Following liberalisation of telecoms markets, and the transition from public to commercial provision, universal obligations were clearly formulated and included in operators' licences. In the United States the Communications Act of 1934 set the public policy aim of providing all American people with telecommunications at an affordable price, thereby establishing an active approach to the concept of USO from the onset.

In the UK Oftel recently defined USO as "*the requirement to provide consumers with direct access to a switched telephone network, and the ability to make and receive voice calls, at a reasonable price*". The specific requirements imposed on BT are:

- "to meet all reasonable demand for basic telephone service, including rural areas"
- implementation of a residential light user scheme
- provision of special telephony services to the hearing impaired
- free emergency calls
- free directory services for the blind and disabled, and
- provision of public phones

We refer to USO to encompass a number of different policy issues, which are often related. Today's policies are aimed at ensuring that neither income, nor disabilities nor location prevent citizen from accessing the telephone network.

A central point to all definitions is the recognition that "some" telecommunications services would not be offered by the PTO without a specific obligation, because they are unprofitable. There will always be customers whose costs are above average, or whose spending on telecommunications is too low to make their connection to the network profitable. The definition of USO provides a line below which the operator would find it uneconomic to serve the customer. General regulation rules determine the costs of provision and the potential revenues that operators can extract from users, so the issue of USO cannot be viewed independently from the general regulatory regime. However, several variables in the definition of USO will affect the point at which the line is drawn. For example, the definition of the services included in the obligation makes a crucial difference. If USO is imposed for the simplest possible service, like receive-only voice telephony, relatively few users will be considered uneconomic to connect, once the revenues they generate (increased traffic in their direction) are taken into account. The more basic the service, the smaller the number of customers who would not be connected without a USO.

Also, identical services can appear more or less profitable depending on how their costs are measured and/or their revenues projected. What types of costs are taken into account?

What time frame is assumed? The assumptions made will influence the definition and degree of onerousness of USO.

Why are we worried about USO?

In the early days of competition in telecommunications, new entrants concentrated in the business and trunk segment, where tariffs and potential revenues are higher. The local loop, the wiring that links users in a given area to a local switch, remained an expensive and unprofitable business. Conventional wisdom about the economics of the local loop has changed in the 90s. The increased importance of delivering entertainment to the homes have sparked commercial interest in owning access to the mass home market. Technological changes have began to bring down the costs of a local network. Cable companies and mobile operators have started to nibble at the "natural monopoly" in the local loop in the UK. Convergence of other service industries into telecoms and increasingly slim margins on the trunk business promise to bring more competition in the local loop.

But the local loop remains a part of the network where competition is slow to develop, where regulation is necessary and where universal service questions are most pressing. Regulation can greatly influence the extent to which effective competition spreads to the local loop. USOs are an important part of the regulatory framework: a monopolistic provider can fund USO services from a single undifferentiated stream of revenues with no need for a clear identification of the costs. In a liberalised market, the costs of providing each type of service and social obligation need to be spelled out so that the costs of meeting social obligations are identified accurately and fairly shared between operators. A competitive environment requires a clear statement of the policy goals, so that each single task is specified, its cost defined and the costs allocated fairly and efficiently. In the short and medium term it is possible to charge only the incumbent firm with USO as a means to promote entry of competitors. But, in the long term this arrangement may unfairly burden the incumbent firm charged with USO, as competition naturally results in new entrants concentrating on the most profitable segments of the market.

Unless the principles of universal service are clear, a tension can arise between the commercial interest of new entrants, who will favour prime locations and customers, and the public interest, which points towards widespread availability. Regulation must ensure that affordable access is available to all who request it and that the means by which universal service is achieved are reviewed.

2 Different policy dimensions of USO

USO is a response to needs of economic and social nature. There are therefore a number of different dimensions to it, each a solution to a single policy concern. USO is used to maximise network extension, capture network externalities and to fulfil social goals.

The policy of ensuring extensive, or **"universal", geographical coverage** is designed for the promotion of a ubiquitous roll out of the network, which would not occur at the same rate or to the same extent with a free market. In a mature market, where network coverage has reached the majority of households, this requirement imposes a small burden on the industry. The bulk of investment has been sunk and additional connections add relatively little to the common costs. Conversely, in markets where network development is far from completion, this requirement can be very costly. Widespread access to basic voice telephony also satisfies the objective of security, in that it enables access to emergency services and to incoming calls, including the possibility of receiving warnings of anticipated potential harm. This policy aim should be monitored with given target penetration rates, which may be set on a regional as well as national basis, to ensure that regional differences are smoothed out. In Great Britain, the national penetration rate hides important regional differences: the percentage of untelephoned households in the North is over twice as high as in the South East

Offering residential services at **geographically averaged prices** responds to the policy aim of promoting fairness and reduce unjustified inequality which arise from location and distance from the centre. This policy is increasingly called into question, as prices closely related to costs are the basis for effective competition. Service providers charged with geographical averaging are exposed to cherry-picking by competitors who are not so obligated. Furthermore, regional disparities in the prices of other utilities have shown that geographically specific pricing is feasible. Abandonment of this policy would constitute a movement away from the goal of promoting social justice, and is likely to lead to the same (sparsely populated) areas being penalised, with all utilities relatively more expensive. Tariffs should stay uniform throughout the each operator's licensed area, but not necessarily across different classes of customers.

Installing and maintaining **payphones** in most public locations offers an important, although arguably inferior, substitute for universal residential provision. A portion of the total traffic generated by public phones is originated by people who do not own a telephone. Cave however points out that while those who substitute callboxes for home phones are mostly in low income groups, payphones are increasingly being designed exclusively for credit card holders. Additionally, the price of calls originated from public phones is significantly higher than the standard tariff applied to residential lines. The number of coin operated public phones may become a more appropriate measure of this social obligation in the future, and the evolution of payphone call charges ought to be monitored. Mercury's withdrawal from the payphone market in late 1994 suggests that payphone provision should remain part of USO.

Offering **targeted subsidies** to particular customers is designed to fulfil the prime social objectives of reducing inequality, promoting democracy and increasing opportunities. These subsidies are usually aimed at low-income groups (e.g. Lifeline in the US or the Light User Scheme in the UK), the elderly and the disabled. There are four million deaf people in the UK today, and ten million are hearing impaired. This group of users is bound to increase in size as the population ages. The design of targeted subsidies becomes of paramount importance to ensure that social equity is not neglected when the industry is forced to improve efficiency. Penetration rates among target groups of users should be the focus for monitoring progress in this policy area.

Calculating the costs of USO

We believe that supervision of USOs should be a leading task of the regulator. The regulator should provide a definition of the different USOs and specify the quality standards that are expected in telecoms service at any level. Without a clear definition of quality, affordable universal service can be an academic concept. As liberalisation promotes entry of more efficient firms, which should therefore be able to achieve USOs at lower costs than the incumbent, it is sensible to award USO on the grounds of efficiency rather than tradition. The different goals of USOs should be allocated with the firm who is best able to match their estimated costs - at specified levels of quality - or even undercut them. USOs should be measurable, their achievement and costs periodically monitored and put out to tender. This will enable a clear and dynamic vision of the impact of competition upon industry costs, as well as a firmer standing point for future discussions about extending USOs to more advanced services.

A major step towards efficient managing of USOs is calculating its costs. Once the actual expenses required to achieve USOs are established, it is possible to devise the best way to provide them. Differences in costing methodologies can yield significant variations in the estimates. Differences arise from the selection of different hypothesis about what drives the costs of service provision and about people's behaviour, for example about the way users who drop off the network will substitute for the telephone line they no longer have. Policy criteria - and realistic data availability - guide the choice of methodology. The main variations in costs concern:

- ***the time horizon chosen*** - long term vs. short term costs. Universal service is concerned with the long term gains of an integrated society, hence the time frame employed should be the long run.
- ***the viewpoint employed*** - users who would join the network with USO vs. users who would drop off without it. One assumption is that "uneconomic customers" would never be connected by an efficient operator in a free market environment, and hence the cost of serving them amounts to the cost of connection, maintenance and operation of their lines. Fully Distributed Costs (FDC), which include costs directly caused by the relevant service and a share of the common costs attributed to it, are an example of this type of costing. Alternatively, one can look at the sums saved if unprofitable customers were disconnected, and calculate the so called Avoidable Costs.
- ***the way common or joint inputs are attributed to a given service*** - are common costs to be included or would they be there irrespective of USO customers?

- ***the way revenue flows are attributed*** - cost estimates must be related to the revenues raised by the customer targeted by USOs. Revenues are given by the actual bill paid by the customer, the incoming calls, and the impact of the positive externality generated by the customers upon all remaining ones on the network. There are many ways to estimate the size of these three components. Also, any customer who is no longer on the network may use other lines (work, friends or relatives) and this substitution effect must be taken into account. To obtain a fair estimate of the earnings side, then, total revenues (outgoing and incoming calls) must be corrected by replaced calls - again both outgoing and incoming. The net revenue thus obtained is called Avoided Revenue.

Cave suggests a costing methodology that compares avoidable costs with avoided revenue to obtain net USO costs. The rationale for adopting avoided costs rather than FDCs is given by the fact that the UK (and European) telephone network is already rolled out, and most common costs are already met before the relatively small number of unprofitable customers is connected. A network which is still in a stage of development is characterised by much higher costs (economies of scale may not be fully exploited and common costs are shared among a smaller number of customers) and therefore increasing the number of customers would require costly investment in the network without a proportional increase in revenues. Costs are likely to change in time as network roll out takes place, and universal service becomes less expensive and easier to achieve.

Providing service to the needy

Any scheme aiming at maximising access among those who cannot afford it, must analyse the specific needs of these users. Targeted subsidies are more efficient than generalised cross subsidies, but may fail to provide an effective solution if they are not designed appropriately. In the USA, Cain and Macdonald showed that when the focus is on the 'borderline' class of customers who might drop off the network, many of the normal assumptions on demand for access to the telephone network no longer hold.

In the UK, a study by the Policy Studies Institute (1995) challenged the common view that households without telephones were never connected to the public network. In fact, nearly half the 'untelephoned' did have a telephone before, and they have either been disconnected (17% of those who no longer own a telephone) or have decided to do without telephone services. Disconnection policy, and the way users who have difficulty in paying the bills are handled by the PTO charged with USO, should be evaluated as an important part of the obligation.

Difficulty in managing telephone bills is the most frequently mentioned reason for not having a telephone; it was also the most common reason for giving it up, if there used to be a telephone. A well designed scheme for maximising access among the needy should focus on **spending ability** rather than usage patterns of the target group. People who find it difficult to stay on the telephone network need a system to help them control the costs of telephone (for example call barring), and limit the extent to which a change of situation (i.e. becoming unemployed) or an unprecedented high bill (the children calling premium services) may lead to disconnection.

During the transition to a multi-operator market, there may be grounds to require the industry to set up an information line, via the regulator or the consumer association, to advertise particular schemes or tariffs aimed at low telephone spenders. Increased awareness of the existing range of services and tariffs can only benefit competition, by improving consumer response to the competitive interplay of telephone companies, in a service area where consumer inertia can be a significant barrier to entry.

3 USO for broadband services?

Universal service is a dynamic concept, and the composition and extent of the USO will therefore always be a matter of judgement. We have referred above to voice telephony. However, other services will, in time, become part of the USO basket. As the use of advanced telecommunications becomes an increasingly important part of everyday life, more and more people are able to access such services. Democracy and equity demand that no citizen is unduly penalised through exclusion from such services. But USO for broadband services <u>now</u> is a very expensive commitment and a poor answer to the rise of an information rich-information poor divide in society. Public-funded projects to develop socially useful applications and IT education address this problem more effectively than universal availability of advanced transmission technology.

A first-step selection mechanism can help identify services that should be candidate for USO and simplify consulting processes in the future. The provision of new services should be left to the industry, in the first instance. Market forces will indicate the direction where technology is leading and where people are willing to spend their money. Only when particular services are widespread and commonly used, their availability becomes an issue on democracy and equity grounds. The extent to which services are taken up by unsubsidised subscribers offers a useful indicator, or 'trigger', of when such services should become candidates for the USO, while active programmes of public investment and education can stimulate early take up. We propose that when particular services satisfy the following three criteria:

- are accessible to 70% of subscribers and at least 50% of eligible users have taken them up,
- are characterised by network externalities, and
- are not substitutable with alternative services of comparable qualities,

such services should be considered for inclusion in the USO of telecommunication service providers.

In recent developments, OFTEL has implicitly adopted a similar stance, by proposing that basic voice telephony should be interpreted today as "*...individual access to the telecommunications network via switches capable of providing voice telephony, with free services of itemised billing and selective call barring, and some supplementary services available (such as call diversion and call waiting).*"[33]. The digital services mentioned are now available to the majority of UK population and are adopted by most customers who live in areas served by digital switches. There is no valid substitute to the ability of managing costs provided by itemised bills and call barring. The real object of USO, is hence the underlying service of basic telephony via digital switches. It is this basic service that allow full use of telephony services, and permit better management of people's time (through widespread bill paying facilities via touch-tone phones, for example) and money (the services mentioned above), while satisfying all three criteria proposed.

[33] OFTEL 1995, p.2

Recent Information Society Investment Estimations in Japan

Tadashi Kuriyama

Professor of Economic Statistics at Tohoku University, Faculty of Economics, in Sendai Japan.

In Japan, the information-communications industry is expected to play an important role. Developing an interactive/broadband information-communications network is a project requiring much time and money. In this paper, we build an econometric model to explain demands and supplies for interactive/broadband telecommunication services, and estimate the amounts of investment required to construct the infrastructure and evaluate practicable private investment and indispensable public financial aids.

1. Development of Investment Estimation

The amount of investment costs to construct B-ISDN in Japan were estimated as being from 33 to 90 trillion yen before 1993 *(tables: 4, 5, 7, 8, 10)*. After 1993, estimates are from 2 to 53 trillion yen *(tables: 3, 12)*. MPT (the Ministry of Posts and Telecommunications)(1993) advocates a 33 trillion yen plan (21 million Single Star SS systems and 54 million Passing Double Star PDS systems plan). It estimated 123 trillion yen telecommunication related markets and the creation of 2.4 million jobs. We analyze the 33 trillion yen plan. In 1994, Internet and mobile communication demand began to rise. MPT(1995) forecasted 32 million cellular and 38 million Personal Handy Phone PHP subscribers.

2. Model Outline

In our model, with a given demand, investment which satisfies demand is estimated. Using the learning curve function of the price of facilities and equipment , the effect of mass production is considered . Demand for mobile communications (cellular, pocket pagers and

PHP), Internet, conventional telephony, and interactive/Broadband ISDN are estimated. We consider only three kinds of B-ISDN demands (Video Conference VC, Visual Phone VP and Video-On-Demand VOD) and the switch from old media demand (conference with more than 30 minutes traveling, face-to-face meeting or interview with more than 30 minutes traveling and rental video). The switch of media from conventional to new can be realized if the cost of the new media is lower than that of the old. A comparison of costs includes direct costs to use, the information transmission efficiency of the media, and the loss of the opportunity cost due to traveling.

Four cases are compared to help understand the effect of the policy which promotes the installation of optical fibers in telephone system facilities. Case 1 concerns installing conventional metal wire line when updating common public telephones. Case 2 concerns installing optical fibers in the neighborhood of the resident when updating (6% updating rate). Case 3 concerns the increase in video conference, visual telephone and VOD with an increasing consciousness of quality time by people. Case 4 concerns the MPT's Policy to construct telecommunication infrastructure before 2010. It corresponds to a 20% updating rate.

3. Methods of Forecast

Demands for telecommunication services are estimated as follows. (1) Macro Indexes such as population, working age population and number of household are estimated from the Ministry of Welfare's "Estimates of the future population, 1991". (2) Demand for mobile communication and Internet users are estimated with the help of logistic regression models. Their saturation levels are 106 and 30 million. (3) The number of business and residential telephone subscribers are assumed to be proportional to the working age population and the number of households respectively. (4) Shifts to B-ISDN are calculated under the same annual growth rate (3.1%) for wage , income and GNP and the two times of present telephone service charge for B-ISDN. (5) The required facility investment are calculated from the product of the unit cost of the facility investment per subscriber and the number of new and updating subscribers. In the public telephone system, three patterns are considered when updating the line; using the conventional metal line with 250 thousand yen per subscribers, installing fiber optics 'PDS' system(363 thousand yen) in the neighborhood of the resident and installing B-ISDN(the SS system with 702 thousand yen). (6) The parameters for calculating telecommunication service revenue are estimated from present average values. Gross revenue is composed of the sign-up fee, the basic charge and time charges. Consumption of services and the price of service charge rate are assumed to be constant over time.

4. Results of Analysis

The tables below summarize the results of our analysis. (1) In 2010, Japan will have 678 trillion yen GNP, 126.3 million population, 55.8 million households, 50 million residential subscriber and 15.9 million business subscribers. (2) Future investment will be made in response to the Internet and mobile communications for which demand is rapidly increasing. The demand for the Internet will come to an end in a relatively short period, but one for mobile communications will continuously increase for a relatively longer period. Most investment will be for mobile communications. The two demands can produce surplus funds which may be appropriated for a telephone system replaced by an optical communication system. (3) Investment for B-ISDN will accelerate from about 2000. (4) If a wire line is renewed by optical cable, the investment will be less after 2010 , compared to the case of replacing with a wire line. (5) Infrastructure building for optical communication will penetrate about 60% with 6% updating policy. (6) The value of time will increase for people with large commuting time, and the time-saving limits on mobile communication and popularity of handling the Internet will lead demand toward B-ISDN. Consequently, from about 2005, demand will largely shift to B-ISDN. (7) But the building of infrastructure to cope with Japanese economic and social difficulties will not be in time for 2010. The infrastructure accelerating policy will begin after present Internet and mobile communication booms. Its financial cost will be from 10 to 30 trillion yen depending on policies.

Table 1 GNP, Population and Subscribers (trillion yen and million)

	GNP	*Population*	*Household*	*Pop Work*	*Subscriber*	*Sub h*	*Sub b*
1996	442.6	125.1	45.3	86.9	58.0	40.8	17.2
2000	500.1	125.9	48.4	86.2	60.4	43.4	17.0
2005	582.6	126.6	52.2	84.2	63.4	46.8	16.6
2010	678.6	126.3	55.8	80.9	66.1	50.1	16.0

Table 2: Mobile Communication

	Subscribers million	*unit cost (cellular) thousand yen*	*Investment billion yen*	*capital stock billion yen*	*revenue billion yen*
1996	18	416	31	1,795	2,155
2000	34	276	1,494	7,022	5,659
2005	60	192	960	8,358	7,969
2010	83	158	686	8,329	9,072
total 1969/2005			11,729		55,823

Table 3: Internet

	Subscribers million	*Unit cost thousand yen*	*Investment billion yen*	*Capital stock billion yen*	*Revenue billion yen*
1996	3	120	37	98	2,256
2000	22	38	120	475	6,117
2005	30	30	59	693	6,708
2010	30	28	37	722	6,656
Total 1996/2010			1,109		87,553

Table 4: Video Conference, Visual Phone and VOD (thousand)

	Video Conf.	*Video Conf.*	*Visual Phone*	*Visual Phone*	*VOD*	*VOD*	*SS %*	*SS %*	*PDS %*	*PDS %*	*PDS %*
	case 1,2	case 3,4	case 1,2	case 3,4	case 1,2	case 3,4	case 1,2	case 3,4	case 2	case 3	case 4
1996	17	17	3	3	41	41	.1	.1	6	6	6
2000	36	36	8	8	141	141	.3	.3	26	26	40
2005	1,740	2,046	26	47	3,091	5,542	8	12	43	33	67
2010	4,570	4,903	79	777	5,688	13,002	16	27	53	31	66

Table 5: Unit cost of SS-system and PDS-system (thousand yen)

	case-1,2	*case-3*	*case-4*	*case-1,2*	*case-3*	*case-4*
1996	2,654	2,654	2,654	470	470	470
2000	2,150	2,150	2,150	310	310	273
2005	850	749	749	263	285	231
2010	649	561	561	244	285	230

Table 6: Average investment expenditure per year (billion yen)

	Case-1	*Case-2*	*Case-3*	*Case-4*
1996/2000	1,183	1,475	1,467	3,217
2001/2005	1,862	1,721	1,448	2,137
2006/2010	1,833	1,907	1,486	1,806
Total 1996/2010	24,396	25,521	22,007	35,798

Table 7: Capital stock (billion yen)

	Case-1	*Case-2*	*Case-3*	*Case-4*
2000	15,837	17,121	17,079	17,082
2005	20,459	20,516	19,649	18,861
2010	23,695	23,730	22,258	21,822
2025	28,573	27,976	30,624	32,971

Table 8: Average annual total revenue (billion yen)

	Case-1,2	*Case-1,2 inc.Internet*	*Case-3*	*Case-3 inc.Internet*
1996/2000	3,961	9,837	3,960	9,837
2001/2005	4,725	12,312	4,911	12,684
2006/2010	6,927	17,013	7,402	17,963
Total 1996/2010	78,074	195,816	81,377	202,422

Broadband to the home: evolution scenarios for Australia

David. P. Luck

Research Manager, Federal Bureau of Transport and Communications Economics, Canberra, Australia

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

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

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

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

1. The network evolution approach

The approach essentially involved developing a structured framework for comparing the costs of technologically feasible future networks with the revenues they might reasonably be expected to earn.

A model linking net present values (NPV at a 15 per cent discount rate) of revenues and costs was used to identify likely evolutionary pathways for residential networks. Because it utilises a high level approach, the model precludes examination of specific business ventures. Nevertheless, the model was used to provide insights into the following sorts of questions:

- What factors will most strongly influence the timing and extent of cable network roll-out from urban areas to rural and remote regions?
- What kinds of networked services are likely to become available to different parts of Australia over the next decade?
- Can two broadband network roll-outs be commercially justified in some regions?

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

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

Four technology platforms were considered, namely:

- direct broadcast satellite, DBS;
- multipoint distribution system, MDS;
- hybrid optic fibre coaxial cable, HFC; and
- asymmetric digital subscriber line, ADSL.

2. Revenue estimates

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

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

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

Demand scenario *($ AUS)*	*Inner urban*	*Outer urban*	*Provincial cities*	*Rural*	*Remote*
1. Pay TV	50	51	35	32	32
2. Interactive home recreation	66	74	62	61	59
3. Interactive home transactions	18	22	16	16	15
4. Communicative home video	65	73	62	62	61

Source BTCE (1994).

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

Costs for the other three platform networks would be less than those for HFC but nevertheless would also be substantial. This diffusion curve is fundamental to the modelling process, since the mathematical function that generates this curve is linked to both cost and revenue variables, hence changes in both supply and demand over time, and in different market areas, can be simulated. The cost and revenue streams for a particular demand scenario are themselves functions of many input variables. Costs are a function of:

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

Revenues are a function of:

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

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

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

3. Cost estimates

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

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

- $25 billion for the initial distributive network;

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

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

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

4. Model results

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

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

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

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

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

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

5. Telephony revenue and network evolution

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

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

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

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

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

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

Conclusions

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

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

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

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

A key concern to the Government could be possible threats to competitive access to the new networks by service and content providers. With the development of interactive services, there is likely to be a large number of service and content providers seeking access to the networks, and this is likely to require sophisticated access and pricing (interconnect) rules. One particular area of possible concern regarding access is the possibility of tying up access through proprietary encryption interfaces, or conditional access systems, in the customer set-top unit.

Pricing of the new services could also become a major concern to the Government. While it is likely that economies of scope will arise between telephony and video and other services which will legitimately enable a reduction in prices, nevertheless the possibility of cross subsidies between services, and predatory pricing of particular services, should not be ignored. In the short term, while the networks are being rolled out, telephony services might be used to subsidise the new services. But once the networks are established, the reverse might occur and cross subsidising of telephony services might be used to stave off competition from potential wireless telephony providers as this technology develops. Prospects of the latter will increase with digitisation of video and other services. Video, data, sound and voice will be largely indistinguishable on the new digital networks and it will become difficult or impossible to maintain the current pricing structure for these services on an integrated network.

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

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

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

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

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

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

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

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

Connecting Homes to the Internet: An Engineering Cost Model of Cable vs. ISDN [34]

Sharon Eisner Gillett

Principal of Victory Research, USA

The Internet is a network of networks that interconnects computers around the world, supporting both business and residential users. In 1994, a multimedia Internet application known as the World Wide Web became popular. The higher bandwidth needs of this application have highlighted the limited Internet access capabilities available to residential users. Even at 28.8 Kilobits per second (Kbps)—the fastest residential access commonly available at the time of this writing—the transfer of graphical images can be frustratingly slow.

Providing faster residential Internet connections through cable and ISDN networks involves technology, economic and policy issues. Based on case studies of early U.S. commercial deployments of each technology, this paper demonstrates that the shared-bandwidth architecture of cable networks enables them to provide more cost-effective and full-featured Internet access than the dedicated-bandwidth architecture of ISDN.[35] The paper briefly describes the technologies involved and discusses the capital cost models used to compare

[34] This research was supported by ARPA's "Interface Technologies for Networked Computing" project, number N00174-93-C-0036; Siemens Corporation; and ARPA's "Design and Development of Distributed Video Systems" project, number#F30602-92-C-0019.

[35] The cable case study is based on PSICable, an Internet access service jointly developed by Continental Cablevision and Performance Systems International (PSI) for deployment over FTTN-upgraded cable plant in Cambridge, Massachusetts. The ISDN case study is based on Internet access service sold by Internex Information Services, Inc. in the "Silicon Valley" area south of San Francisco, California, based on ISDN telephone circuits available from Pacific Bell. Both services were introduced in the spring of 1994.

cost-effectiveness.[36] Results are then presented quantifying cable's ability to provide the same average bandwidth and higher peak bandwidth at lower cost than ISDN.

Despite this result, the realization of cable-based Internet access has been limited compared to ISDN. The paper concludes with a discussion of the barriers to cable-based Internet access, and recommends policies to encourage the cable alternative.

The capital cost models are based on the engineering cost model methodology described by Reed.[37] They consist of a series of spreadsheet-style equations expressing the relationships between the different technological components required to deliver Internet access over existing cable and ISDN infrastructure.[38] By attaching cost data to each component, the total capital cost of each type of access can be compared. Since the equations are parameterized by variables such as residential housing density and the average bandwidth needs of customers, sensitivity of the results to variations in the input parameter values can also be tested.

The works by Reed and others (referenced above) focus on the question of integration: if cable or telephone companies were to construct a single "Integrated Broadband Network" in the future, would it provide economies of scope or scale? This paper addresses a related but different question: do the architectural differences between existing cable and telephone networks make either one a more cost-effective Internet access medium today?[39] The costs of infrastructure that already exists are not included in the analysis; capital investments are included only if they are specifically needed to support the Internet access application.[40]

1. Market demand

Demand for residential Internet access is assumed to come only from homes that already have computers. In the U.S., the fraction of computer-owning households is estimated at about 1/3.[41] Thus a service penetration level of 100% means that 1/3 of all households in the community have chosen to subscribe to the service.

---

36 Operating costs and pricing isseus are outside the scope of this paper but remain useful areas for further research. [Bailey and McKnight, 1995] reviews the opening literature on Internet pricing.

37 See [Reed, 1992], pp. 8-9, and [Reed, 1993], p. 1. See also [Johnson and Reed, 1990] and [Sirbu, Reed et al., 1989].

38 The models were developed using the program Demos ("DEcision MOdeling Software") from Lumina Decision Systems, Inc., Los Altos, CA. Demos provides an object-oriented graphical user interface to spreadsheet-style data manipulation.

39 In so doing it continues the exploration of architectural differences in [Gillett, Lampson et al., 1994] and [Tennenhouse, Lampson et al., 1995], but with a narrower focus on cable and ISDN as the infrastructures, and Internet access as the application.

40 In the sense that it isolates the incremental investments needed to support Internet access, this paper also builds on the work described in [Mitchell, 1990] for telephony.

41 See [Pearl, 1994] and [Ziegler, 1995].

2. Traffic model

Since cable LAN bandwidth is shared among users, the statistical properties of user traffic will determine how many users can successfully share each LAN. Clearly, the more subscribers can share a LAN, the lower each subscriber's cost. Unlike a cable LAN shared by a group of subscribers, ISDN connections consist of point-to-point circuits terminating in multiplexers located at the Internet Point of Presence.

Given that the intent of the model is to compare cable vs. ISDN, the analysis begins with the assumption that the average bandwidth seen over the cable plant must be equivalent to ISDN's (approximatly 120 Kbps). This level of average bandwidth must be available to all active users during periods of peak usage. The model investigates values of 10, 20 and 30% of users active during the peak usage period.

3. Results

Figure 1 compares the cost per subscriber to provide the 500 Kbps and 4 Mbps cable services and the 128 Kbps ISDN service, as a function of the penetration level[42]

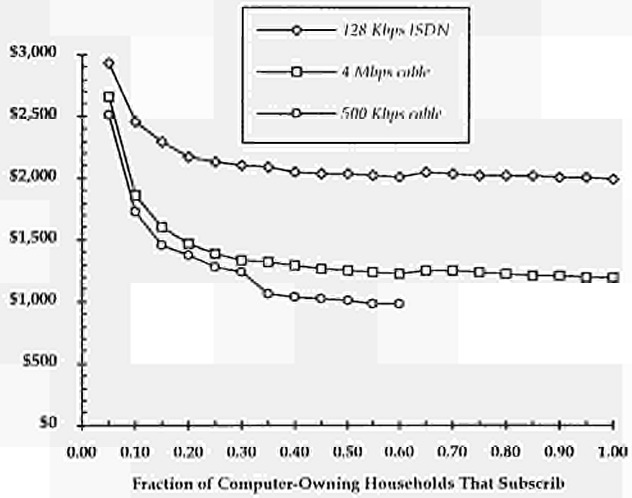


Figure 1: Average cost with original parameter settings[43]

[42] Note that the vertical axis represents average cost for any given penetration level; the curves do not represent trajectories, i.e. the marginal cost to move from one penetration level to another. Each penetration level represents the same number of subscribers across all 3 services. Given the assumption of 1500 homes per neighborhood cell, six cells (i.e. 9000 homes), and one-third of homes with PCs, each 5% increment in penetration represents an additional 150 subscribers.

The greater economy of both cable services relative to ISDN is immediately evident in Figure 1. Beyond initial penetration levels, the 500 Kbps cable service can provide the same average bandwidth and four times the peak bandwidth of the ISDN service for about half the cost per subscriber. Further, for only slightly more than the 500 Kbps cost (but still about 40% less than the ISDN cost), the 4 Mbps cable service can provide thirty-two times the peak bandwidth of ISDN, again for the same average bandwidth.

Normalizing the cost per subscriber by the level of peak bandwidth provided by each technology, as illustrated in Figure 2, shows cable to be even more of a bargain. From this perspective, each Kbps of peak bandwidth provided by the 500 Kbps or 4 Mbps cable service costs one-eighth or one-fiftieth as much, respectively, as each peak Kbps provided by ISDN.

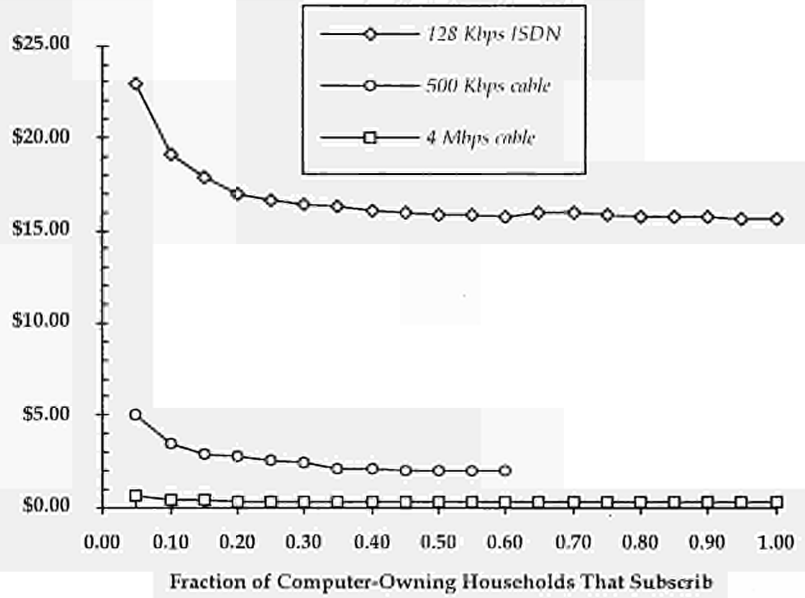


Figure 2: Average cost per Kbps of peak bandwidth

Figures 1 and 2 demonstrate the central hypothesis of this paper: the shared cable architecture can provide the same average bandwidth and higher peak bandwidths much more economically than the dedicated ISDN architecture.

---

[43] These parameter settings are: an urban residential density of 1500 homes per neighborhood cell; an intermediate community size of 6 cells; 20% of subscribers actively using the service at periods of peak usage; a minimum of 120 Kbps of average bandwidth per active user during the peak usage period; 100% efficient cable LAN. [Gillett, 1995] discusses these parameters in more detail.; surprisingly, changes in these parameter values were found to have not much effect on average cost (see pp. 136-147 for the details of the sensitivity analysis).

A potential problem with cable is also evident in Figures 1 and 2, however. Because of the small number (4) of upstream channels available, the 500 Kbps cable service is limited to serving only 60% of potential subscribers under the original parameter assumptions for traffic flow (i.e. 120 Kbps of average bandwidth and 20% of subscribers active). As Table 1 shows, this limit is quite sensitive to the traffic model, for both the 500 Kbps and 4 Mbps cable services. Table 1 also shows that whatever the actual traffic turns out to be, the 4 Mbps service is a better bet for avoiding penetration limits.[44]

Table 1: Cable penetration limits

		Penetration limit (%)	
Percent active (%)	**Average band-width (Kbps)**	**500 Kbps**	**4 Mbps**
30	120	40	85
20	120	60	unlimited
10	120	unlimited	unlimited
20	60	unlimited	unlimited
20	30	unlimited	unlimited

A significant portion of the cost shown in Figure 1 is contributed by the equipment purchased for each subscriber.[45] This result suggests that expected reductions in subscriber equipment costs over time should have a significant effect on the total cost to provide residential Internet access. Thus improvements in subscriber equipment are a key area on which to concentrate R&D energy.

This result also shows that the telephone industry's current approach of letting subscribers buy their own equipment reduces capital risk significantly for the Internet and/or infrastructure provider. This point is reinforced by Figure3, which illustrates how low average cost falls without subscriber equipment.

[44] Improvements in digital technology have already increased the LAN bandwidth achievable over the 6 MHz TV channel spectrum, to 10 or even 30 Mbps. Such increases lift penetration limits, by allowing the same number of channels to serve more customers. ISDN's penetration limits are more subtle; ISDN was originally conceived as a replacement for analog service, but in practice most subscribers purchase it as an additional service. If enough residences do this, new pairs will have to be installed in the local telephone distribution plant.

[45]See [Gillett, 1995] , pp. 119-128.

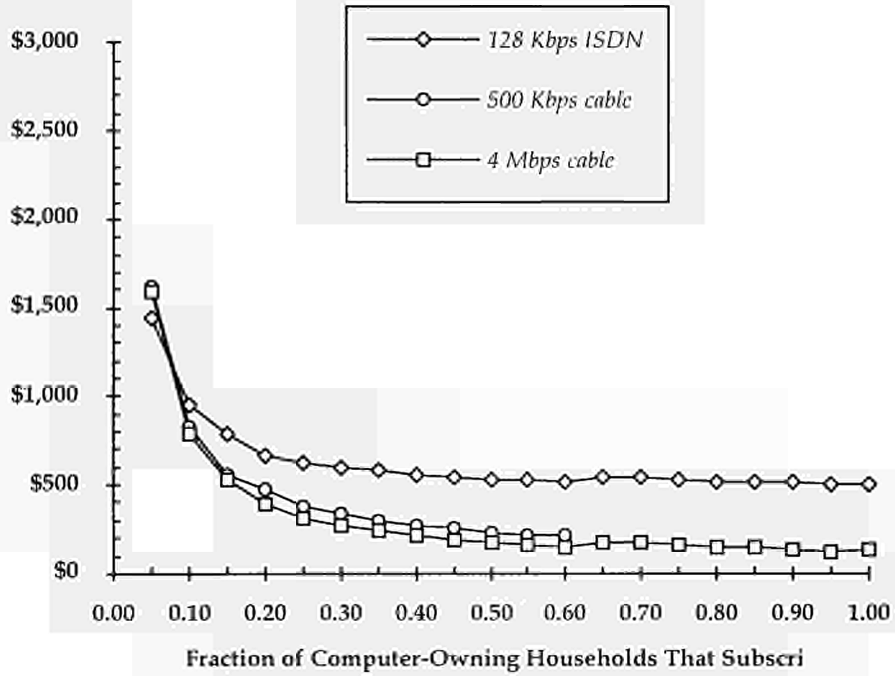


Figure 3: Average cost without subscriber equipment

Figure 3 suggests that the financial entry barrier is actually quite low when subscriber costs are either excluded (for example, subscribers purchase their own equipment) or deferred (for example, operators purchase equipment for subscribers on a "Just In Time" basis).

Figure 3 also shows that the difference between the average costs of the cable and ISDN technologies is not purely a matter of differing subscriber equipment costs. As subscribers are added, ISDN requires additional boxes and circuits to multiplex additional point-to-point connections. Cable's shared-bandwidth approach , in contrast, incurs much less overhead to add more subscribers.

Conclusions

In summary, cable-based Internet access has the following quantitative advantages over ISDN-based access:

- **The shared cable architecture can provide the same average bandwidth and higher peak bandwidths much more economically than the dedicated ISDN architecture.** As Table 2 shows, 500 Kbps Internet access over cable can provide the same average bandwidth and four times the peak bandwidth of ISDN access for less than half the cost per subscriber. Even more impressive, 4 Mbps cable access provides the same average bandwidth and 32 times the peak bandwidth of ISDN for 40% less cost per subscriber. The economy of the cable-based approach is most evident when comparing the per-subscriber cost per bit of peak bandwidth: $0.30 for the 4 Mbps and $2 for the 500 Kbps cable services—versus close to $16 for ISDN. However, the potential penetration of cable-based access is constrained in many cases (especially for the 500 Kbps service) by limited upstream channel bandwidth. While the penetration limits are quite sensitive to several of the input parameter assumptions, the cost per subscriber is surprisingly less so.

- **Because more of the cost of the cable approach is contributed by subscriber equipment, more investment can be deferred until demand materializes.** This property minimizes the chicken-and-egg problem that is so characteristic of local access infrastructure deployments. It is also encouraging because subscriber equipment costs are based on digital technology and can be expected to decline.

Table 2: Summary comparison of cable vs. ISDN Internet services

	Cable	*ISDN*
Economics		
Average cost per average Kbps	500 Kbps: $8.20 / 4 Mbps: $10.03	128 Kbps: $16.70
Average cost per peak Kbps	500 Kbps: $2.00 / 4 Mbps: $0.30	128 Kbps: $15.65
Bandwidth	Peak of 500 Kbps or 4 Mbps	Peak of 128 Kbps
Connectivity	Full-time	Part-time
Penetration scalability	Penetration limits, especially for 500 Kbps service	Limited free wire pairs and switch capacity for additional ISDN service
Commercial availability	Cambridge, MA	Several regions in U.S., Europe

Cable also has the following qualitative advantage over ISDN:

- **Cable's dynamic sharing of bandwidth readily enables full-time Internet connections, while ISDN access is limited in practice to a dial-up model of only part-time access.** Applications built for the Internet's peer-to-peer architecture work more naturally over a full-time Internet connection. For example, a subscriber with only part-time access would have difficulty hosting his or her own page on the World Wide Web.

Despite cable's advantages, Internet over ISDN is currently much more widely available in the U.S. than Internet over cable. The following technology, business and policy barriers hinder the deployment of cable-based Internet access:

- **Cable modem technology is immature.** Few (if any) products are currently available that combine all the features needed to make large-scale deployment feasible, including a price aimed at residential customers, and reliable operation with automatic monitoring and maintenance capabilities. Achieving reliable two-way data transmission can be a significant technical challenge, given that the primary focus of most cable plant engineering is on downstream TV transmission.[46]

- **The market for cable-based data networking equipment (including cable modems) is less developed than the ISDN equipment market.** In contrast to telephone equipment which is generally bought by individuals, cable equipment is purchased in large batches by cable operators. This pattern has contributed to a much more narrow array of price points and feature sets available in cable data networking equipment. In addition, most business customers cannot use cable-based data networking and therefore cannot help bootstrap equipment sales for the residential market.

- **Cable operators are not common carriers.** Through discriminatory pricing, cable operators exert tight control over what content is transmitted through their channels. If a monopoly cable operator does not believe that selling Internet access is the most profitable use of a channel, there is little opportunity for an entrepreneurial Internet service provider to prove that operator wrong.[47]

The following policy changes are therefore recommended to help reduce these barriers:

---

[46] Further research is warranted on this issue. For example, what is involved in making the cable plant more reliable for data and how much would it cost? Can subscriber equipment economically compensate for plant impairments? What kinds of monitoring and test capabilities are most useful?

[47] Telephone companies were hardly the first to use their networks to offer Internet access. Only now, as the economic value of commercial Internet access has grown increasingly obvious, have telephone companies begun to enter this business in competition with the Internet service providers who have been using the telephone networks all along. Presumably, cable operators will catch the same spirit despite their traditional focus on only the video entertainment business.

- **Encourage open markets for subscriber equipment.** Subscribers purchasing their own cable interface equipment can lower the cable operator's financial risk in offering Internet access. This business model has proved viable for ISDN-based Internet access, purchased by many telecommuters (for whom the cost of equipment is generally borne by employers) and small home-based businesses. It would also help foster technological development of data-over-cable equipment, including cable modems.

- **Encourage greater access to cable channels by non-video information providers unaffiliated with cable operators.** As Pool and Johnson have argued, application of common carrier status to the already-developed cable industry is an impractical goal.[48] U.S. federal cable law does, however, provide two alternative forms of independent access to channels: "commercial use" and "public, educational, or governmental use," or so-called PEG access.[49] Where these alternative forms of access are available, their use for residential Internet service should be allowed. In some cases, achieving this policy can be a simple matter of interpretation. For example, the use of PEG channels for Internet access is appropriate given the Internet's use for public internetworking as well as access to government information repositories and educational institutions, including K-12 schools.[50]

If followed, these policy recommendations will help to make cable-based Internet access a more widely available option. That in turn will help make fast, full-time access more available and affordable to all residential users of the Internet.

---

[48] See [Pool, 1983] , pp. 155-88, and [Johnson, 1994] , pp. 60-63. Opposition comes both from the courts and the cable industry.

[49] PEG and commercial access are described in 47 USC §531 and §532, respectively. Both of these forms of access are limited to small numbers of channels and may not be available in all areas, since they are subject to state and local pre-emption.

[50] The current rules governing PEG and commercial use access are relatively new, since The Cable Television Consumer Protection and Competition Act of 1992 changed the relevant law. The FCC could strengthen the commercial leased access provisions by, for example, requiring public disclosure of price schedules and non-discriminatory pricing of commercial leased channel access. Such a re-interpretation is especially important for data services, since they are unfamiliar to most cable operators and therefore unlikely to be implemented if left entirely to the cable operator's judgment.

A Critical Survey of Internet Pricing Proposals

Dale O. Stahl

Department of Economics, University of Texas, USA

The number of people who have acquired Internet connectivity is doubling every year. Further, the bandwidth requirements of future multimedia applications such as video conferencing and movies-on-demand are orders of magnitude greater than current uses (which are predominantly text-based). While bandwidth capacity is increasing dramatically (from 56 Kbps a decade ago to 45 Mbps currently and 1 Gbps in the near future), it is doubtful that capacity growth can keep up with demand growth, and in any event serious bottlenecks will remain at the connection pipelines to the backbone. Hence, key resources are and will remain scarce for the foreseeable future. How should these scarce resources be allocated?

Economics, being the study of resource allocation problems, can provide answers, and the standard economic answer is to create markets and let prices allocate the scarce resources. However, the economic answer for the Internet is a bit more complicated. **First,** since most of the costs are sunk into infrastructure, the marginal cost of Internet data *transport* are essentially zero, so if Internet resources were private goods prices should be zero. Note we have separated the process of data transport from the process of producing the information *content* of the packet being transported, and we are focusing in this paper on the former. **Second**, Internet resources are public goods and consequently congestion is a potential negative externality. Marginal-cost pricing of public goods can lead to a "tragedy of the commons" in which the common resource is overutilized, causing avoidable losses for the whole society. When negative externalities are real possibilities, prices should exceed the marginal cost of production by the marginal social cost of the congestion, in which case a consumer uses the resource if and only if their private benefit from use exceeds the social cost of that usage. This is the theoretical economic argument underpinning virtually all proposals for usagebased pricing of Internet resources. Differences in how to implement this theoretical ideal separate the different proposals.

2. Ideal Economic Pricing Proposals

2.1 Dynamic Optimal Pricing

The economic foundations for optimal congestion pricing are deeply routed, going back at least to Pigou (1928) and Vickrey (1969). This economic theory was first applied to computing environments by Naor (1969) and Mendelson (1985). Stahl and Whinston (1991, 1992) and Gupta, Stahl and Whinston [GSW] (1995a) extended these single-server models to network computing environments and investigated its practicality using simulation. Subsequently GSW (1995b-d) applied their network models to the Internet. Recently, Mendelson and Whang (1994) have also developed a very similar network model of optimal congestion pricing.

At the center of the GSW approach is a general mathematical representation of a computing network, a model of price and time sensitive user demand for services, and a stochastic model of traffic flows and buffers. It is shown that a socially optimal allocation of scarce network resources can be achieved by imposing *optimal priority pricing* at each site of potential congestion. The optimal prices depend on the traffic flow at the site, the size of the packets, the priority class, and the social cost of time. The latter can be econometrically estimated from the sensitivity of traffic to actual price and throughput time fluctuations at the site. A practical decentralized method of determining optimal prices in real time is proposed. A simulation model is constructed that demonstrates the feasibility of this proposal.

In GSW (1995b-d), the simulation model is calibrated to represent the Internet and to compare the historical free-access policy with the theoretical optimal pricing. This calibrated simulation suggests that without effective management of the Internet (as provided by efficient pricing), congestion and misallocation of resources could cost the economy hundreds of billions of dollars of lost benefits per year. This same simulation also demonstrates that the potential social gains of optimal pricing, if sought solely from capacity expansion could have a capital investment cost exceeding the social gains. Thus, we argue that congestion is a very real concern and not just a theoretical finepoint.

In the GSW vision a typical user deciding whether and when to access an Internet service would be presented with a menu of options including the monetary cost and (when relevant) expected throughput time for each option. The options would specify a priority class, and could also include a security/anonymity level, minimum guaranteed qualities, and contingency options such as "submit the service request when the cost falls below $b". The user would then select the most preferred option. A personalized smart agent could automate the user's decision process based on previously specified user preferences. Frequently updated price and time information would come from the user's access provider. Smart agent software could serve this function also, gathering information from posted prices of transport providers and network congestion status reports.

The user would not receive a bill from each node and link of the network, but would rather receive one bill from his access provider for the posted price of that access provider for the service requested.[51] In turn, the access provider would receive a bill from the transport providers to which it is connected based on posted prices and actual usage. Each network transport provider need keep accounts only for the adjacent providers to which it is connected, not the individual users. In the vertical direction, each telecommunication carrier (such as AT&T, MCI, Sprint) need keep accounts only for the networks (such as PSI, AlterNet, ANS, etc.) to which it provides IP transport. This disaggregated pricing and billing approach mirrors the wholesale pricing practices in most industries. Ultimately it is the responsibility of the access providers to charge the user and to cover its costs vis-a-vis the transport providers.

Capital investment decisions can be greatly improved by the imposition of optimal priority pricing. First, as demonstrated in GSW (1995d), imposition of priority pricing alone may generate more benefits at much less cost than capacity expansion. Second, without priority pricing since the physical resource allocation is inefficient, the observed congestion can be a bad signal about which parts of the infrastructure should be expanded first. By imposing optimal pricing first, the distribution of network traffic can change significantly revealing a different ranking of the bottlenecks. Thus, with optimal pricing, capital investment can be focused on projects that will produce the greatest benefits.

While the general model deals with potential congestion anywhere in a computing network, in practice the most likely sites of congestion are the 56 or less Kbps pipelines to information content providers, their local area networks and servers. Thus, in the near term while we still have excess capacity on the backbone, optimal congestion pricing will be most effective for these bottlenecks. However, as data-intensive real-time video uses grow, congestion could very likely become a serious problem on the backbone as well, in which case optimal priority pricing will become a valuable tool for resource allocation throughout the Internet.

2.2 Stepped-Pricing by Facility

Optimal dynamic pricing specifies prices at each facility and for each moment in time, priority class, and job size. Potential administrative complexities of this ideal make it worthwhile considering simple approximations to the ideal.

Congestion can be measured in terms of expected delays, or the percentage of bandwidth capacity utiltization. The optimal prices are a smoothly increasing function of bandwidth capacity utilitization. One approach would be to approximate this smooth function by a step function: i.e. a partition of bandwidth capacity utilization into exhaustive categories (such as 0-50%, 5075%, 75-100%), and a price for each category. We will call this "stepped pricing".

Every such categorical scheme would have an "uncongested" category, and one or more congested categories. In the uncongested category, the price would be set equal to zero,

---

[51] Recall that we are dealing with network transport services only. The user might well receive bills for the content of the data transported from many independent content providers.

since the marginal social costs are essentially zero. In the congested categories, the price would be an average of the optimal dynamic prices for the range of congestion in that category. In a two-category scheme, there would be just one non-zero price at each facility.

The best way to specify congestion categories and prices could be investigated theoretically and via simulation modelling. What would be the best way to improve the efficiency over that of a simple two-category steppedpricing scheme? Would societal benefits be increased more by going to a three-category scheme, or by introducing a two-priority system?

Edell, McKeown and Varaiya (1994) present a specific system for metering traffic and billing users within TCP protocols. A test of this system based on the BayBridge gateway demonstrates that the system is practical. TCP traffic data from the University of California at Berkeley reveal that timeof-day usage pricing could decrease peak loads due to the shift of email and bulletin-board traffic to off-peak times. More importantly, if prices were to vary dynamically in response to congestion, the efficiency of the network could be increased dramatically. Thus, a fairly good approximation to dynamic optimal pricing may be practical.

2.3 Static Priority Pricing

Cocchi, Shenker, Estrin and Zhang CSEZ (1993) pose the general problem of designing a service discipline and a pricing scheme that maximizes timeaveraged user benefits. A *service discipline* is a mechanism implemented by the network operators to assign jobs to specific service classes (such as best-effort, virtual connection, guaranteed minimum delay, etc.), and a *pricing scheme* associates a price (by bandwidth usage) to each service class [see also Shenker, 1995]. CSEZ specifically investigate a standard twopriority service discipline. Theoretically, there is an optimal allocation of user demands to each priority, and there are prices for each priority such that each user facing those prices will voluntarily select the socially optimal priority. Using a simulation model, CSEZ demonstrate that optimal priority prices can be found that significantly increase the benefits over single priority discipline and the corresponding usage pricing.[52]

CSEZ do not present a computational algorithm for these prices, so we cannot assess the practical feasibility of that crucial task. From the mathematical model, it appears that a central authority would need vasts amounts of proprietary information from the users about the value of each class of service, but the users have incentives to misreport that information.

---

[52] CSEZ require the revenue collected under the two alternative to be the same. Since access charges can be adjusted to make up differences in usage-based revenues, this restriction is not necessary. If the optimal single-priority pricing scheme raises more (less) revenues than the system needs to cover fixed costs, then why should the two-priority scheme be constrained to generate the same surplus (deficit) of revenues? The preferred economic analysis would impose no revenue restrictions and would solve any resulting surplus/deficit problems separately. Any revenue restriction will muddy the comparison of the benefits of two-priorities versus one-priority, and will cause the prices to differ from the socially optimal level. Further, unlike GSW, CSEZ model the user demands as inelastic with respect to cost; Shenker (1995) acknowledges the importance of elastic demand.

These priority prices are "static" in the sense that they do not vary with the dynamic state of the network. There will be times when the network is badly congested and high priority users will be paying too little. Moreover, in contrast with optimal dynamic pricing by facility, the CSEZ scheme **effectively** has a high priority choicer paying a premium at every facility even if only some or none are congested.

3. The Smart-Market Approach to Congestion Pricing

Parallel to the research described above, MacKie-Mason and Varian (1995) have proposed a different approach to implementing optimal congestion pricing. Rather than using econometric methods to estimate the social cost of congestion, they propose a mechanism in which the users have incentives to state their true willingnesses to pay for faster service. This can be accomplished by an incentive-compatible auction (*or smart market*).

Suppose there are a fixed number of jobs that users want processed in a given time interval and everyone would like their job done sooner than later. In what order should the jobs be done? Let each person submit a monetary bid for the right to have their job processed. Submitted bids are ordered from the largest to the smallest, and the jobs are processed in this order. The price paid by every processed job is the bid of the first job not processed during the alloted time interval. If all jobs are processed, the price is zero. It is optimal for every user to bid the true value of the job no matter what the other users do. To see this, note that bidding more will increase your chances of having your job processed only in those cases where the price you pay turns out to be greater than the true value of your job, and bidding less will only decrease your chances of having your job processed without affecting the price you pay.

MacKie-Mason and Varian propose that the Internet operators run smart markets for packets at every potential site of congestion. Each user includes a bid in the header of every packet. The network gateways carry out the sorting at frequent periodic intervals. Under this scheme, every packet would suffer a one period delay while packets are being queued and bids sorted, before proceeding to the normal routing and transmission function. Besides this deadweight loss of time, there are other theoretical and practical problems with this approach.

The efficiency properties of the smart market pertain to a static situation in which (1) all potential users are present at the auction, and (2) the value of the job is not contingent on any other market. Both of these assumptions are violated in a dynamic stochastic network. **First**, observe that to work in real time, bidding must be confined to fixed intervals of time; hence, jobs that arrive later, even nanoseconds later, have no influence on the current price. In contrast, the fully optimal congestion prices depend on the extra delay imposed on all future arrivals. This "generational" bias will cause inefficiencies in resource allocation just as citizens in a republic may squander natural resources because the unborn cannot vote. **Second**, the value of having a packet transmitted is contingent on having other related packets transmitted along diverse paths in the network. No matter how a user allocates bids among the thousands of packets that comprise a single Internet transaction, ex post regret will be rampant. Sometimes almost all packets will get through without incurring any significant charge but the last crucial few will get dropped, so the user will wish the bid had been concentrated on the packets that encountered congestion. Other times a few crucial packets will get dropped first (but after all others have begun their journey), and the user will have wasted bids on the later, now worthless, packets. Of course, we could imagine an elaborate accounting system to ameliorate these probems, or we could imagine a dynamic bidding process in which each packet could communicate with the others so as to coordinate their bids as every packet proceeds through the network. Both of these fixes are clearly impractical.

4. Connection-Only and Flat-Rate Pricing

By far the predominant forms of pricing currently in practice are combinations of connection-only and flat-rate pricing. The connection-only fee is usually based on the bandwidth of the user's connection for a contracted period of time, with discounted rates for longer term contracts. Recently, some frame relay networks offer a Committed Information Rate (CIR) on top of a low maximum bandwidth connection fee. Users who stay within the CIR are guaranteed uninterrupted transport service, but if they exceed the CIR, they receive best-effort service only.

In addition to these fixed connection fees, many providers charge a variable fee based on active connection time (e.g. AOL and Prodigy). Since there is a positive correlation between connection time and bytes transmitted, one could view connection time fees as an indirect measure of bandwidth usage. However, it is important to recognize that connection time is not an accurate measure of bandwidth usage, and it obviously does not discriminate between a real-time video session and an email session. Hence it does not confront the user with the correct social cost of his specific usage.

Flat-rate pricing consists of a fee for bandwidth usage that does not vary with the level of bandwidth usage nor the current state of congestion. Compuserve offers flat-rate pricing, and New Zealand and Chile have experimented with flat-rate pricing for their international link.

Since flat-rate pricing is a usage-based scheme, it can potentially improve the efficiency of the resource allocation over that which would prevail under non-usage based schemes. The model of GSW could be modified to solve for the best flat-rate prices by imposing this as a feasibility constraint on the optimization problem. Alternatively, the GSW simulation model could be calibrated to represent the time-averaged stochastic flows (over say a month or a year) and then take the time-averaged optimal congestion tolls as an approximation to the optimal flat-rate prices. GSW (1995c) did this time-averaging of the dynamic prices at each server in the network, then imposed these prices. They found that per-packet prices for each server did indeed improve the efficiency of the network, but not nearly to the extent achieved by dynamic optimal pricing.

Part of the reason for the disappointing performance of per-packet pricing by server was the lack of a component that depends of the size of the "job". Optimal pricing imposes much higher prices for large jobs than for small jobs since large jobs would impose disproportionately longer delays for the users whose jobs arrive after large jobs. Optimal non-linear pricing causes a reallocation away from the large jobs towards the small jobs. However, within the backbone where packet sizes are standardized (especially ATM), shouldn't optimal pricing be a single per-packet fee? The answer is that the fee should be based on the number of contiguous packets at the bottlenecks, which in the GSW simulation was at the LAN servers.

If Internet traffic were fairly uniform - characterized by an average flow with a relatively small variance and standard sized non-contiguous packet streams - then a well-coordinated layered regional system of flat-rate pricing might achieve much of the maximum attainable efficiency. However, Internet traffic is anything but uniform. It is characterized by frequent irregular bursts of contiguous packets, and the variance in flow tends to increase more than proportional to the average flow. In such an environment, there are huge potential efficiency gains from better resource allocation during and between bursty periods. These gains can only be realized by dynamic optimal pricing.

Wang, Peha and Sirbu (1995) propose a two-part pricing scheme that consists of a flat-rate for usage up to a guaranteed bandwidth and an surcharge for best-effort service beyond the guaranteed bandwidth. They solve for profit-maximizing prices rather than socially optimal prices. While they suggest an algorithm for computing their solution (a network-wide fixed-point), whether it will work in practice is unclear. Using net user benefits as the objective rather than profits, one could solve for socially optimal two-part prices. However, since the price paid for bandwidth usage is independent of the state of congestion in the network, this scheme will not provide the necessary incentives for efficient usage.

5. Voluntary User Declarations

A classification of services and assignment of priorities to those classes has been proposed whereby individual users are asked to voluntarily choose the appropriate classification. This choice would be recorded in the Type of Service field of the IP header, but prices would not depend on the choice. The effectiveness of this scheme would depend on each user selecting the correct category, even though they have clear incentives to always choose the class associated with the highest priority. Recognizing this incentive compatibility problem, it is suggested that occassional inspection of the packet streams and TOS field coupled with penalties for false classification could be used to enforce compliance. However, it is not clear how such an inspection/enforcement system would be implemented nor how effective it would be. Others [e.g. Kelly (1995)] have proposed that optimal prices could be posted but not charged, and that these "virtual" prices could act as guidelines that induce users to modify their demands voluntarily to bring about an efficient allocation of network resources.

We believe it is extremely naive to assume that individual users will act in the best interest of the whole system when that conflicts with their private interests. Tragedies of the commons are very real phenomena, and the Internet could become another tragedy.

6. Public Policy Users

The ownership structure of the network determines the kinds of public policies that are pertinent in the obvious sense that with public ownership pricing policies could be imposed directly, while with private ownership regulatory policies are needed to influence pricing. In either case, we highly recommend simulation studies of alternative public policies before implementation.

The simulation model of GSW is a first step towards developing an adequate model of the Internet for policy research. That model captures the network hardware and basic services, but must be extended to include ownership status, proprietary information services and for-profit service providers, and information brokers. With each of these levels, a pricing structure must be specified that could include bandwidth fees for servers and brokers, access fees and secure access code/protocols for user classes, and usage fees based on workload and priority class. These intertwined pricing structures must be coupled with an accounting/collection system that is cost-effective.

Pricing and performance (delay) data must be available to users. In a non-cooperative private market, entrepreneurs are likely to collect this data and make it available (for a fee). The presense of pricing structures will create significant incentives for the development of software (such as smart agents) to use this information to minimize the acquisition costs of services for individual users. Competitive pressures will force brokers to provide effective decision support services.

The frequency and timing of price changes will be important, but we have little a priori grounds for predicting these characteristics. For instance, will a leader emerge that sets prices first, with other (smaller) players following? Will players post prices simultaneously or sequentially (what order) as in Maskin and Tirole (1988)? Alternative regimes will need to be studied to determine the effectiveness of specific polices as a function of the price/timing regime.

Game theory, on the one hand, appears to be ideally suited to studying this market game. Unfortunately, classic game theory has virtually no predictive power in this complex dynamic environment. As illustrated in the previous section, even an extremely simplified competitive network model may have no pure-strategy non-cooperative equilibrium. On the other hand, permitting intertemporal strategies unleaches the "Folk Theorms" of game theory which say that virtually any behavior is possible.[53] A more promising approach is evolutionary game theory,[54] in which players are endowed with computable decision processes ranging from simple rules to sophisticated strategic thinking and who learn from experience.

What will players assume about user expectations of waiting times? Will the player's models of users incorporate user forecasting based on published reports, past observations and expectations, and current posted prices? Will players assume that other players will continue their past pricing unchanged, or will they attempt to anticipate how the other players will react to recent experience, observed prices, and network status? What time horizon will players use in forecasting and choosing their strategies? How quickly will players adjust their prices (or how long is a "period")? These are but a few of the crucial issues that must be addressed in building a model for public policy analysis.

The economic stakes are sufficiently high so undoubtedly considerable private research will be devoted to devising profitable strategies for the real game. We are interested in anticipating how the real players might behave, and what public policies should be adopted to protect the common resource aspect of the Internet. A central research agenda item would be to determine what (if any) dynamically stable strategies arise. Simulation is the only practical way to pursue this question.

During such simulation runs, profits, delay costs, net benefits and efficiency losses can be measured. Alternative public policies concerning price regulation, taxation, vertical and horizontal mergers can be incorporated into the model and simulation runs can be used to determine the impacts. Does the policy tend to stabilize or destabilize the system? Who are the winners and who are the losers? Are capital investment incentives distorted or corrected?

Conclusions

We have provided a critical survey of a number of proposals for pricing Internet transport services. As a benchmark for comparing these proposals, we began with the optimal dynamic priority pricing proposal of GSW, since it comes closest to the theoretical ideal. GSW have used simulation modeling to argue that their approach is practical, so why should

---

53 Friedman, 1971; Fudenberg and Maskin, 1986; Abreu, 1988; and Dutta, 1991.

54 For example, see van Damme, 1991; Mailath, 1992; and Stahl, 1993.

that not be everyone's first choice? Putting aside the regretably many criticisms due to misunderstandings of the GSW proposal, legitmate questions can be raised about the administrative costs of implementing their scheme and the lack of smart agent software to perform the vital functions.[55] Without the latter, users may strongly object to the uncertainty and fluctuations of dynamic prices. Stepped-pricing by facility was introduced in this paper as a simplified approximation to dynamic optimal pricing that might be much easier to implement in the near term. By making users face the approximate social cost of usage, it would provide much better incentives for efficient resource allocation than any other scheme such as flat-rate pricing. The two serious shortcomings of flat-rate pricing are its inability to (1) discourage demand during times of congestion, and (2) redirect demand away from congested servers.

Smart markets, which are efficient mechanisms for resource allocation in static environments, lose their efficiency properties in stochastic dynamic environments. Furthermore, in a network, a user's value associated with one packet depends on what is happening to all other packets of the user throughout the network, and there appears to be no practical way to adapt smart markets to such a network environment in real time.

The goal of public policy should be to promote the full realization of the potential benefits of the network for the society as a whole. In a country where the entire network is owned and operated by a government entity, that entity could (and should) directly impose the best approximation to socially optimal pricing as is feasible. In countries with privatized networks, we know very little about how the private market will preform, but it is unlikely that socially optimal pricing will prevail. To prevent a tragedy of the commons, a well-designed effective public policy (such as regulation and/or taxation) will be required. However, we strongly recommend simulation studies of alternative public policies before their implementation.

---

55 We have a current project to develop prototypes of these smart agents.

References

Abreu, D.
Towards a Theory of Discounted Repeated Games Econometrica, 56, (1988)

Altinkemer, K. and Z. Yu
Topological Design of wide Area Communication Networks, Annals of Operations Research 36, (1992)

Amstrong M., Cowan S., J. Vickers
Regulatory Reform-Economic Analysis and British Experience, The MIT Press. (1994)

Arthur Andersen
A Study on cost allocation and the general accounting principles to be used in the establishment of interconnect charges in the context of telephone liberalisation in the European Community, Study prepared for the Commission of the European Communities, DG XIII. (1994)

Bailey, J. P. and L. W. McKnight
Interet Economics: What Happens When Constituencies Collide. INET'95, Honolulu, HI, Internet Society. (1995)

Bonatti, M., F. Casali, and G. Popple (eds.)
Integrated Broadband Communications: Views from RACE-Network and Engineering Aspects, North-Holland. (1991)

Calabrese Andrew and Donald Jung
Broadband telecommunications in Rural America: Emerging Infrastructures for Residential Service Telecommunications Policy, Vol.16, No.3 (April 1992), (1992)

Cave, M.
Special Issue : Symposium on Access Pricing, Utilities Policy, Martin Cave Ed., vol. 4(3), (1994)

Clark, D.
A Model for Cost Allocation and Pricing in the Internet, J. of Electronic Publishing, http://www.press.umich.edu:80/jep/ (1995)

Cocchi R., S. Shenker, D. Estrin, and L. Zhang
Pricing in Computer Networks: Motivation, Formulation, and Example, IEEE/ACM Transactions on Networking, 1(6), 614-627

Edell R., N. McKeown, and P. Varaiya
Billing Users and Pricing for TCP, Department of Electrical Engineering and Computer Sciences, University of California at Berkeley, (1994)

European Commission
"Communication on Universal Service for Telecommunications in the Perspective of a Fully Liberalised Environment", COM(96) 73, 13 March 1996

Friedman, J.
A Non-cooperative Equilibrium for Supergames, Review of Economic Studies, 38, 1-12. (1971)

Fudenberg D. and E. Maskin
The Folk Theorem in Repeated Games with Discounting or with Incomplete Information, Econometrica, 54, (1986)

Gable D. D.M. Kennet
Economies of Scope in the Local Telephone Exchange Market, Journal of Regulatory Economics, Vol. 6 (4), (1994)

Gavish, B.
Topological Design of centralised Computer Networks-Formulations and Algorithms, Networks 12, (1982)

Gavish, B.and I. Neuman
A system for routing and capacity assignment in computer networks, IEEE Trans. Comm. 37, (1989)

Gavish, B. and K. Altinkemer
Backbone Network Design Tools with Economic Trade-offs, ORSA Journal on Computing 2, (1990)

Gillett, S. E.
Connecting Homes to the Internet: An Engineering Cost Model of Cable vs. ISDN. Massachusetts Institute of Technology. Masters' Thesis LCS Technical Report 654; http://www.rns.lcs.mit.edu/ publications/mitlcstr654.html. (1995)

Gillett S. E., B. Lampson and D. Tennenhouse
Putting Telecommunications on the Technology Curve: Architecture and Economics.
MIT Laboratory for Computer Science. Research Seminar Series MIT/LCS/RSS-23. (1994)

Gupta, Stahl and Whinston
A Priority Pricing Approach to Manage Multi-Service Class Networks in Real Time, J. of Electronic Publishing, http://www.press.umich.edu:80/jep/. (1995c)

Johnson, L. L.
Toward Competition in Cable Television. Cambridge, MA, The MIT Press. (1994)

Johnson, L. L. and D. P. Reed
Residential Broadband Services by Telephone Companies? Technology, Economics, and Public Policy. Rand. R-3906-MF/RL. (1990)

Kelly, F.
Charging and Accounting for Bursty Connections, J. of Electronic Publishing, http://www.press.umich.edu:80/jep/ (1995)

Kobayashi, M.
Conditions of B-ISDN and Multi Media Business, JSICR Annual Report, (1994)

Kuriyama, T., H. Oniki and S. Kawamura
Demand and Supply Analysis of Broadband ISDN, Telecommunications Advancement Foundation Research Report no.9.(1995)

Mc Lean, R.P. and W.W. Sharkey
An approach to Pricing of Broadband Telecommunication Services, Telecommunication System, 2, (1994a)

MacKie-Mason, J., and H. Varian
Pricing the Internet, in B. Kahin and J. Keller (eds.), Public Access to the Internet, Prentice-Hall. (1995)

Mailath, G.
Introduction: Symposium on Evolutionary Game Theory, J. of Econ. Theory, 57, (1992)

Maskin, E. and J. Tirole
A Theory of Dynamic Oligopolgy, II: Price Competition, Kinked Demand Curves, and Edgeworth Cycles, Econometrica, 56, (1988

Mendelson, H.
Pricing Computer Services: Queuing Effects, Communications of ACM, 28, 312-321. (1985)

Mendelson, H. and S. Whang
Pricing for Communication Network Service, Stanford University. (1994)

Neuman, I.
A System for Priority Routing and Capacity assignment in packet networks, Annals of Operations research 36. (1992)

Naor, P.
On the Regulation of Queue Size by Levying Tolls, Econometrica, 37, (1969)

OFTEL
Effective Competition: Framework for Action-A Statement of the future of interconnection, competition and related issues. (1995)

Oi W.
A Disneyland Dilemma: Two-Part Tariffs for a Mickey Mouse Monopoly, Quarterly J. of Econ., 85, (1971)

Oniki H., M. Kawamura, and M. Noguchi
A Study of the Supply of Telecommunications Services in Japan:1996-2025 - Economic Foundation of BISDN Construction, Institute for Posts and Telecommunications Policy(IPTP) Review,No.4,(1993)

Pigou, A. ,
A Study in Public Finance, Macmillan: London. (1928)

Policy Studies Institute [PSI]
Barriers to Telephone Universal Service.
PSI. London. (1995)

Reed David P
Residential Fiber Optic Networks: An Engineering and Economic Analysis. Artech House, Inc. (1992)

Scotchmer
Two-tier Pricing of Shared Facilities in a Free-Entry Equilibrium, Rand J. of Econ., 16, (1985b)

Shenker, S.
Service Models and Pricing Policies for an Integrated Services Internet, in B. Kahin and J. Keller (eds.), Public Access to the Internet, Prentice-Hall. (1995)

Spulber, D.F.
Regulation and Markets, The MIT Press. (1989)

Stahl, D.
Evolution of Smartn Players, Games and Economic Behavior, 5, (1993)

The Ministry of Posts and Telecommunications(MPT)
Report of Study about Future Vision of Optical Communications . (1988)

The Ministry of Posts and Telecommunications
Report of Study about Broadband ISDN. (1992)

The Ministry of Posts and Telecommunications
Report of Study about Multimedia mobile Communications. (1995)

The Telecommunications Council
Reform for the Intelligent Society of the 21 Century. (1994)

Van Damme, E.
Evolutionary Game Theory, chp 9 in Stability and Perfection of Nash Equilibria, Springer-Verlag. (1991),

Vickrey, W
Congestion Theory and Transport Investment, Amer. Econ. Review Proceedings, 59,(1969)

Wang Q., J. Peha, and M. Sirbu ,
The Design of an Optimal Pricing Scheme for ATM Integrated-Services Networks, J. of Electronic Publishing, http://www.press.umich.edu:80/jep/(1995)

Working with New Technologies and Services in the Organisation of Tomorrow

CHAPTER 3

Changes in the structures and processes within and between organisations, and the advent of new forms of business entity, are altering the relationships between organisations. In this chapter, the various aspects of such organisational and inter-organisational impacts of the introduction of Information and Communication Technologies (ICTs) and the proliferation of electronic transactions are explored.

Alain Dumort examines whether ICTs can foster a new wave of products and services capable of sustaining lasting growth and job creation and under what social conditions. He begins by discussing the uncertainties surrounding the impact of information infrastructures on employment and the need to base analysis on long-term assessments. He refers in particular to the so-called '*network effect*' of ICTs,which can help diffuse productivity gains, improve firms' market reach and multiply benefits across the entire economy, including job creation in the longer term. However, despite the creation of jobs in the most dynamic and largely liberalised sectors of the telecommunications market (e.g. mobile communications and value-added services), there is no guarantee that the benefits of telecommunications liberalisation and increased competitiveness will compensate for the negative direct impacts of rationalisation and of labour productivity increases achieved mainly through the substitution of labour with capital in the former telecommunications monopolies. He argues that job creation across the economy is also dependent on BPR and on a significant overhaul of business strategies and socio-economic structures. He concludes that the first priority for governments must be to create a favourable legal, technical and financial environment including the adaptation of labour and social security legislation to allow greater flexibility, the promotion of adequate training and technological awareness for employees, and the launch of catalytic pilot experiments which can help boost the supply and demand for advanced communications services.

Using the results of an extensive OECD survey of firms of different sizes and from a range of industrial sectors, **Georges Ferné** discusses how organisations are achieving significant improvements in performance through ICT usage. The effects of economic recession, new forms of competition and changing patterns of demand mean that firms are increasingly turning to ICTs and flexible manufacturing systems as key enablers in the re-organisation and rationalisation of business and production processes to achieve ever higher levels of productivity, flexibility and customisation. Coordination of ICT adoption was recognised as a crucial factor in achieving effective integration of new technologies, but often encountered only limited success due to institutional rigidities. In the services sector, significant adjustments in administrative processes have been achieved through computerisation of marketing and management. In some cases (in particular banking and insurance) the high productivity gains achieved in these information-intensive sectors made it possible to retain the workforce at the cost of massive training and re-training efforts. In terms of effects on employment, despite evidence from the case studies which demonstrates that ICTs *per se* have not caused lay-offs when corporate policies promoted training and adaptation, there was widespread feeling that technological solutions provided a substitute to job creation and made it easier to reduce staff and liberate resources required for investments, though new employment has been generated in some cases by outsourcing. Those most affected by job reductions tend to be the administrative personnel and middle-management. The economic recession is considered the major factor in job suppressions, but ICT have made it possible not to create new jobs when expansion resumed. Ferné also notes that the the introduction of ICT applications by government agencies can have a knock-on effect on their private partners, generating informatisation throughout the economic and social fabric.

Yumio Imamura's research, based on a number of case studies, focuses on the Japanese experience of BPR which has required significant structural reform of the Japanese economy using ICT, dramatic changes in traditional Japanese corporate management systems, and deregulation measures. However, the employment effects of BPR in Japan have been less dramatic than elsewhere since Japanese management has been keen to maintain employment levels to achieve "common value" among employees through long-term contracts. BPR is implemented in order to reduce production costs by reducing time and materials and coping with changing market needs. Imamura reports how the *NKK Steel Corporation* envisages using the Internet for the purchase of raw materials enabling them to establish just-in-time systems for steel materials and to optimise the level of raw material inventory and stabilise the product supply. Imamura reports that *Yokogawa Electric* was able to reduce its stock term by three months to 16 days by re-engineering its information systems. They effectively introduced network-based computing to improve communications between sales, R&D and production and to establish a cost-efficient production management system. Imamura's case studies serve to demonstrate that whilst the positive impacts on employment are less evident, BPR using ICT has lead to clear improvements in productivity which can revitalise the economy, giving rise to growth and new business opportunities. He emphasises these benefits rather than exploring the impacts on employment which, as Ferné points out, may take considerably more time to be felt, especially in cases where ICT adoption has not been accompanied by appropriate BPR measures, or the latter have come up against institutional obstacles.

Ian Courtney illustrates how telecommunication technologies have drastically changed business practices in the banking sector in the UK. He discusses the changes in the retail banking sector in terms of re-structuring of the industry, changes in work patterns and skill requirements, and how banks have identified the use of the telephone and ICTs as a means to reduce costs whilst maintaining high levels of customer service. He describes how the re-structuring of retail banking in the UK following de-regulation of the financial services sector in 1986 gave rise, on the one hand, to diversification in the range of services offered by banks (e.g. insurance, mortgages, etc.) which was necessary to increase income levels and, on the other hand, a dramatic programme of cost reductions involving the re-organisation of the local banking network into satellite banking groups and the closure of local branches.

This clustering has enabled management and supervisory functions to cover a much wider customer catchment area. Another consequence has been the complete re-structuring of employment in the banking sector with a considerable drop in permanent staff (9% decline in full-time male employment between 1986 and 1993), a significant increase in part-time employment (12 000 increase in part-time employees between 1986 and 1993) and the introduction of 'flexible' contracts. Courtney illustrates how the use of ICTs as a medium for service provision has facilitated this process with reference to the *First Direct* bank case which involves intensive use of ICTs. In terms of recruitment requirements, he notes that emphasis is being placed on behavioural (personality) skills and the ability to be adaptable and flexible in response to changing working practices, rather than on specific banking skills.

Ranald Richardson examines the organisational and spatial changes in employment opportunities occurring in the office-based service sector as a result of developments in ICT. Using a number of case studies (*British Airways, Quarterdeck International,* and *Hoskyns Group plc*) he illustrates how telephony is being used today as an important strategic business tool, particularly in the area of customer services, which can be delivered more cost-effectively via the telephone. In the case of British Airways, distribution and mediation costs have been dramatically reduced as booking and enquiry operations are being brought in-house with a focus on direct (tele)sales. One of the most significant effects observed is the increase in the *locational flexibility* of firms. By allowing production to be separated from consumption, the use of ICTs has enabled many firms to seek out locations in regions where production costs, particularly labour costs, are low, and then 'export' services to more wealthy regions, creating employment and investment opportunities in peripheral regions with often high rates of unemployment. Richardson also shows how the introduction of teleservices is giving rise to horizontal and vertical integration processes as firms cut out intermediaries and place themselves 'closer to the customer'. However, the emergence of new specialist third party teleservice firms is leading to a counter-trend towards the blurring of sectoral boundaries as call centre workers handle customers from a range of different sectors. Richardson cites the increased routinisation and standardisation of front office and customer service functions as a key factor driving the introduction of teleservices, observing that these functions, which are now being supported by the telephone, are being concentrated into "call centres" located at one or a few sites rather than at multiple branch offices close to the customer as was the case in the past.

Electronic Data Interchange (EDI) using the existing network is already established today as the major vehicle for commercial transactions in some industry sectors. However, open networks such as the Internet are now becoming another space for commercial activity not only for business to business activities but also for direct transactions between businesses and consumers. Electronic transactions are beginning to have a significant impact on the structure of organisations and industry. The increasing demand for electronic transaction practices is also creating the momentum for the growth of the network infrastructure itself. **Laurent Gille** argues that the use of electronic transactions for commercial purposes will be the key drivers of demand for advanced communication networks. He compares the broadband requirements of transaction services with those of TV-like entertainment services. He argues that TV service requirements can be met by cable TV, hertzien, and satellite networks which are dramatically cheaper to use than the telephone network. From these observations Gille concludes that commercial electronic transactions, rather than home entertainment services, will drive demand for broadband networks. He observes that transaction-based (data exchange) services are on the increase due to an evolution in demand from products to integrated services or "packages", leading also to the development of intermediation and the emergence of new intermediaries in an increasingly globalized market. Integrated services are based on transaction process centres (TPCs) able to instantly process and transmit high volumes (capacity) of data in a variety of formats using intelligent network functions.

Maintaining growth and proliferation of electronic transactions is subject to the introduction of reliable and operational payment schemes on the open network, in particular the Internet. **Kenji Ito** carries out a review of the available technologies and systems such as 'DigiCash' and the 'e-cash' system (based on the settlement of accounts via the Internet), 'CyberCash', 'First Virtual', and 'Mondex' (smart card-based), as well as looking at various adaptations of existing financial systems such as telecom billing systems, encrypted credit cards, and credit card-based intermediary services. He considers some of the key requirements of such systems in terms of security, convenience, and cost, which differ according to the network environment - closed (e.g. American Online, etc.) or open (e.g. Internet). In the open network environment, the payment system should ensure security (e.g. through encryption) and provide individuals with IDs that make mutual confirmation of identification possible. On the other hand, on closed networks where individual users make a contract to use the network, payments are only made between a gateway service provider (i.e. network-operator), member consumers and member IPs.

It has been argued that, in the absence of major advances in the techniques available to secure networks, electronic commerce will fail to expand globally to encompass all sectors of the economy. **Robin Mansell** claims that the security of information systems is *the* organisational issue. In the future it is expected that a variety of means of encryption, authentication, public-key cryptography box and reliable certification procedures will offer real hope of extending private networks into the public domain. Ms. Mansell argues that this hope is unlikely to be fulfilled in the absence of widespread changes in institutional practice. Issues of security and privacy in advanced network environments are as such matters of management, social ethics and public policy as they are matters of technology. Many of the key problems and debates are concerned with the institutionalised means of establishing and maintaining trust relationships among those involved in information exchanges and electronic transactions. A wide range of social, economic and political issues surround encryption debates. She argues that the outcomes of these debates, and those in other countries, will shape the environment in which new legislative and regulatory conditions emerge. Ms. Mansell reviews developments in the use of a range of technical means of securing advanced information and communication networks and assesses their implications from the perspective of suppliers and users of applications. The paper is based on recent research which assesses the economic and social impact of moves to implement open generic network environments for business transactions and electronic commerce.

The institutional implications of the expansion of electronic commerce are also considered by **Takashi Uchida.** Faced with the fact that a key feature of electronic commerce is that it is not confined to national boundaries, his paper focuses on the provision of an international institutional environment for electronic transactions. His analysis is based on three types of electronic commerce which he identifies as: closed EDI or electronic transactions associated with closed networks between specific corporations (e.g. manufacturer and retailer); open EDI, whereby corporations can select transaction partners from a range of unspecified corporations within a network (e.g. worldwide raw material procurement in manufacturing); and consumer transactions occurring within a network (e.g. Internet-based and electronic mall-type consumer transactions). Among the issues identified by Uchida are the problems associated with authentication, the standardisation of communication and business protocols, and damage attribution. However, the borderless character of open network transactions means that measures to deal with such disputes adopted by individual countries are hardly appropriate. Uchida suggests that in addition to exchanging information on the content of laws in individual countries, a forum needs to be established in which to debate the unification of standards. Finally, Uchida discusses the issues raised by the arrival of completely new transactional techniques such as the electronic negotiable instrument (e.g. electronic bills of lading, which are already at the trial stage) and electronic money. Uchida argues in favour of the establishment of international fora in which to debate an appropriate response to these extremely complex issues.

Direct contacts between producers, consumers and users will become commonplace as the popularity of electronic commerce rises. However, **Jiro Kokuryo** challenges the popular notion that electronic commerce removes the need for "middlemen" and argues in favour of the 'business platform' model. In his paper, Kokuryo, presents his research into the role of intermediaries or platform businesses in electronic commerce in the context of open computer networks, such as the Internet. His theory is based on the observation that the increased opportunity for transactions between formerly unknown trading partners increases the need for intermediaries. He explains that intermediaries have an important role to play in matching buyers and sellers who do not know each other and therefore have no basis of trust. Kokuryo identifies a range of key functions for intermediaries in the electronic marketplace: (1) provision of a partner-search function; (2) creation of trust among trading partner; (3) evaluation of economic value; (4) provision of standardized interfaces; and (5) integration of functions. According to Kokuryo, these functions would be performed by "platform businesses". He notes that business platforms have a role to play in cases where firms need to make ad-hoc electronic transactions with a formerly unknown trade partner by creating a situation in which all trade partners have prior contractual relations with the platform business if not directly with eachother. A number of impacts of platform businesses and open computer networks were considered in the context of two Japanese case studies. One of the key impacts is that the creation of global relationships via computer networks and the rising cost of domestic procurement is prompting Japanese firms to review their traditional policy of maintaining exclusive networks of local vendors and distributors, known as *keiretsu* "closed network of firms".

Employment and Labour in the Information Society [56].

Alain Dumort[57]

Marielle Riché-Magnier

European Commission

1. The Principles of the Knowledge-based Economy

In the past, the development of water, transport and energy infrastructures deeply modified the patterns of socio-economic development and growth in Europe. The same is happening today with the deployment of information infrastructures (or information superhighways) which consist of advanced communication networks delivering at a high-speed new interactive multimedia services. This phenomenon will have far-reaching consequences as regards qualitative changes in the organisation of all human activities, whether in the professional, private or institutional sphere, thus leading to the emergence of a new model of socio-economic development referred to as the "**information society**".

From an economic standpoint, the development of information infrastructures is generating economies of scale and scope[58] which, through the elasticity of offer and demand[59], will progressively modify manufacturing processes, consumption patterns and the societal modalities of wealth redistribution. This spread-out effect across the entire economy is

[56] The opinions expressed in this article do not necessarily reflect the European Commission's official point of view

[57] With the assistance of Denis Baresch, E.C.-DG XIII

[58] Economics of scale are factors allowing for the reduction of production costs per unit in relation to market size; economics of scope are factors allowing for the diversification of production with no proportional increase of costs.

[59] Price-elasticity refers to the correlation between price and demand for a specific product; wage-elasticity refers to the correlation between households' income and their demand for a given product.

known as the principle of **economic externalities**. The resulting productivity gains are expected to stimulate investment and consumption.

This dynamic process is taking place against the background of **globalisation** and **liberalisation** of the world's economy which, from a European point of view, both increases competitive pressure from the outside and opens up new market opportunities abroad.

The overall assessment of this socio-economic revolution can only be done in the long-term and by taking fully into account the uncertainties entailed by economic forecasts. Hence, the full effect on growth and employment of the deployment of a new generation of infrastructures has to be measured over **at least a period of 15 years**[60].

While there is no doubt that information infrastructures will boost global wealth, their **impact on employment remains uncertain**. However, past experience shows that any important technological leap results in the destruction of redundant professions and tasks while at the same time prompting the appearance of new activities and jobs, both directly through the emergence of new products or services and indirectly through the dissemination of productivity gains throughout the economy.

The key question then is whether information and communications technologies (ICTs) can and will foster a new wave of products and services capable of sustaining lasting growth and job creation as was the case in the past for instance with TV sets or household appliances.

The massive computerisation and automation of businesses launched in the
restructuring impact leading to competitive gains mostly through the substitution of capital to human labour. But given their strong economic externalities, ICTs are likely to have a more positive macro-economic impact than stand-alone information technologies (ITs).

The so called "**network effect**" in particular differentiates ICTs from ITs. Indeed, the network effect of new on-line multimedia products and services allows to remove constraints of time and space both as regards market reach, the localisation of production and the dissemination of innovation, thus leading to a multiplying effect across the entire economy. For small and medium-sized enterprise (SMEs) for instance, which play a leading role in terms of wealth and job creation with over 65% of European employment, the network effect will enable them to expand beyond their traditional - usually local or regional - markets.

Yet there is no guarantee that the network effect combined with the positive indirect impact on employment of the liberalisation of telecommunications (through lower prices leading to higher consumption as well as the stimulation of innovation, investment and the emergence of new services) and the greater overall competitiveness triggered by the penetration of ICTs in all businesses will compensate both the negative direct impact of the rationalisation of

60 "Telecommunications and Growth": Cronin, Colleran, Herbert, Lewitski, Telecommunications Policy, December 1993.

former telecommunications monopolies and the increase of the productivity of labour in all sector of the economy achieved mainly through the substitution of human labour with capital.

The fundamental paradox today is that of an economy that creates more wealth than ever before but fosters record-high unemployment levels, thus questioning the capacity of our competition-oriented and technologically sophisticated production system to create a sufficient amount of stable jobs[61]. Furthermore, **the place and role of work itself are questioned**[62].

2. Work questioned, Employment pending

The evolution of tasks and qualifications increasingly puts less-qualified workers at a disadvantage and increases **"technological unemployment"**. At the same time, more productivity gains will be achieved through yet more cuts in the workforce. But mere re-engineering and outsourcing seldom pays off in the absence of a sound enterprise strategy which also includes a social dimension. Hence, businesses who only rely on job cuts to boost productivity often have difficulties to respond to fast-changing markets due to a **shortage and poor management of human resources**.

ICTs do indeed prompt the **adjustment of work organisations** towards greater flexibility and decentralisation as well as flatter hierarchies, thus **modifying the nature of work relations**. A striking example is teleworking, whether at home or in telecentres, which is likely to affect a worker's identification with his or her employer since work isn't related to a specific place (office or factory) anymore. Teleworking at home also blurs the strict separation line between work and private life, a trend which is further reinforced by the progressive decline of fixed working schedules.

ICTs are also likely to reinforce the trend which appeared in the 1970s towards **increased flexibility and precariousness**. Yet greater flexibility while avoiding precariousness can be achieved through the adaptation of the legal framework governing relations between employers and employees.

Automation of the most labour intensive and repetitive tasks could also contribute to the development of a **more qualifying and gratifying work environment**. This, however, requires that employees, in particular the less-qualified ones, are offered adequate training opportunities to adapt to the new work organisation and be able to perform new tasks.

---

61 "Work for All or Mass Unemployment" - Chris Freeman and Luc Soete, Pinter Publishers, 1994; "Technologie, Emploi et Productivité" - OECD/DSTI, 1994, 1995.

62 Numerous essays and conferences have addressed the issue, for instance: "Quel Avenir pour le Travail en Europe" - Carrefour de Luud, Octobre 1995, "L'Avenir du Travail" - Revue Esprit, August-September 1995; "Rethinking Work" - Eric Briton, Ecopla,, 1994.

So far, the structural adjustment which is taking place in the information-related sectors, i.e. telecommunications, computers, consumer electronics and content, has led to important job cuts. Public telecommunications operators for instance have axed 7.5% of their workforce between 1982 and 1992[63]. The liberalisation of the European telecommunications sector in 1998 is fostering yet another structural adjustment which is likely to have a further negative impact on the sector's employment.

There is also a **threat of job delocalisation**. While the transfer of manufacturing to economically less-advanced countries where the workforce is cheaper and social and environmental legislation less constraining is common knowledge, there is less focus on the delocalisation of services and non-material tasks. Yet this is routinely done by European or US firms for data acquisition, insurance services or airline booking in countries who have cheaper yet qualified workers such as India, the Philippines or the Caribbean.

But the risk of delocalisation should not be overestimated as **the cost of labour is not the determinant c iteria of competitiveness for a growing number of activities in the knowledge economy**. Indeed, cultural proximity between the employer, its increasingly qualified employees and the clients is essential for tailor-made products and services.

In the framework of an appropriate environment, in particular as regards the qualification of workers and the availability of public services as well as transport and communications infrastructures, **ICTs can also contribute to re-localise jobs in Europe**. That concerns both new services and traditional industries thanks to productivity gains and the network effect[64].

At the end of the day, **employment seems to be the fundamental stake of the global information society, both as regards the amount of created jobs and their "quality"**. This dimension can not be entirely left to the invisible hand of the market. Hence, political decision-makers cannot spare the quick launch of an in-depth prospective reflection on the future of work, especially as regards its content, duration, distribution, modalities and societal role[65].

---

63 The figure takes into account the jobs created in the area of new telecommunications services, for instance mobile telephony. OECD, December 1995.

64 The JOINT Study (see reference next page) mentions the example of TOP-COM, a French company specialised in the telemarketing of herbal and cosmetic products. This marketing method has multiplied the sale of products by a ratio of one to five compared with traditional mail orders. As a result, five new jobs created in relation to the "immaterial" generate one new job in manufacturing.

65 "Le Travail dans vingt ans" - Report of the Commission chaired by Jean Boissonnat and prepared by the French Commissariat Général du Plan, Documentation Française, 1995.

3. Towards New Jobs

Direct job creation in the short to medium-term is already taking place but probably at a slower pace than was initially expected. This results from the interdependence of the multimedia market with other markets.

As regards the interdependence with **publishing and audiovisual**, a study realised in 1994 by "Recruit Multimedia" in Britain stresses that 60% of firms in the content sector convert existing products to the multimedia format. This suggests that the multimedia sector may, at least in the short term, recruit people more by transfer than by actually creating new jobs.

In the **telecommunications** industry, the setting up, management and maintenance of networks requires highly-qualified workers. This concerns equipment manufacturing (switches and optical fibre), software production (conception, development and updating) and network engineering. In spite of expanding markets, equipment manufacturers suffer from growing competition, the resulting diminution of margins of profit, and a high substitution of labour with capital. As regards software, the rate of product replacement is high (one year in average) and the possibility of achieving productivity gains by substituting capital to labour more limited, a situation which is more favourable to employment.

New jobs are mostly being created in the **most dynamic segments of the telecommunications market** which have already been largely liberalised, in particular mobile telephony, satellite communications, value-added services for multinational corporations, etc. These jobs are a direct result of the emergence of new services and the intensification of competition.

Many jobs are also expected to be created in sectors whose fast growth is directly triggered by the **convergence of the information-related industries**. So far, this trends can mostly be witnessed in the USA with a rapidly emerging "copyright" industry (software, audiovisual, electronic publishing), which already constitutes a important pole of activity and job creation, and the production of digitised content.

In the medium term, the growing transmission capacity of communications networks is likely to boost activity and employment by opening up new ways of offering services with no geographical limits. Telematic networks could for instance offer European public services an opportunity to sell their know-how and expertise in other countries, for instance in Eastern and Central Europe[66].

Two recent French studies confirm the driving effect on the economy of the deployment of information infrastructures. The Théry Report[67] considers that the revenue of communications traffic will generate a threefold revenue in on-line services. As for the

---

66 "Job Opportunities in New Tele-Activities" (JOINT Study) - CESLA, 1996.(Report for the E.C. DG XIII)

67 "Les Autoroutes de l'Information" - Ministerial report of G. Théry, Documentation Française, 1994.

Breton Report[68], it emphasises that the amount of jobs created in France in connection to new on-line services could range from 170,000 to 370,000 at the horizon 2005. Yet some of these new jobs would in fact correspond to transfers.

The dissemination throughout the economy of high productivity gains fostered by ICTs will also **indirectly generate new jobs in all sectors of activity in the longer term**. The macro-economic effects of information infrastructures has been evaluated in some countries. The US Administration for instance estimates that the implementation of its National Information Infrastructure (NII) plans in the context of telecommunications liberalisation[69] will result in an additional 0.5% growth per year and the creation of over 3 million jobs by 2005. In Japan, the Ministry of Posts and Telecommunications claims that the use of broadband networks in all sectors of the economy will lead to the creation of about 2.4 million new jobs by 2010.

The forecasts of these government reports might prove a bit overblown as they are based on optimistic economic growth scenarios and may be mainly oriented towards sending a strong political message. However, the capacity of advanced communications services to create new activities and jobs was confirmed at European level by a report commissioned by the European Commission which comprises case studies in Austria, France, Germany and the UK[70]. It suggests that under certain conditions - proper re-engineering of business structure and overhaul of business strategy -, on-line services can foster the creation of jobs across the economy.

Even if the creation of new jobs is expected to progressively compensate the destruction of jobs in the medium to long-term, there remains the prospect of a job deficit in the short to medium-term. Furthermore, as a result of the redundancy of certain professions and tasks, most new information-related jobs will not be created where the old jobs have been destroyed, hence the crucial challenge of readapting laid-off workers.

This means that **the mutation of the productive system bears a socio-economic cost.** It will be up to **government to minimise this cost and render it socially bearable**. Steps must therefore be taken to facilitate the transition from the old employment system to the new one. But bandaging the wound with unemployment benefits is not enough. A priority must be to **speed up the transition from one system to the other so that we enter the job creating phase as quickly as possible**.

Furthermore, positive measures must be taken to stimulate the creation of jobs through sectorial support mechanisms and incentives. A wider offer of training schemes will also

---

68 "Les Téléservices en France: Quels Marchés pour les Autoroutes de l'Information" - Government report of Thierry Breton, Documentation Française, 1994.

69 The new US Telecommunications Act was adopted on February 8, 1996.

70 Report on "Employment Trends related to the Use of Advanced Technologies" - Tele Danmark, PREST, ITA, 1995, shows that the use of telematics has allowed to create jobs in some Danish economic sectors in recession, for instance textile, clothing, paper production and publishing.

play a crucial role in helping people adapt to the new jobs. So will support to alternative activities[71] such as community services as well as environment and public interest works.

4. Professional and Social Qualifications

A key trend in the European job market is **the growing level of required qualifications**. In addition, the vast majority of jobs in manufacturing and services now require basic computer skills while as much as one third of positions in manufacturing necessitate advanced computing knowledge.

Whatever the considered sector, the introduction of ICTs in the workplace will modify roles and competencies, thus leading to a reconfiguration of all activities, whether at the management, manufacturing or marketing level. The introduction of advanced services will require the combination of new skills and qualifications, including adaptability, polyvalence, critical thinking, communication, conceptualisation, technical and intellectual processing of information, autonomy and team work.

These skills form a core of **social qualifications** which will progressively gain momentum over **technical and specialised qualifications**, even though the latter will still remain a key factor of professional integration.

Training systems must take these new requirements into account by emphasising the human relation dimension, in particular by teaching collaborative work in groups or over the network, the capacity to analyse and understand user needs, and the development of critical thinking. Just as essential is the capacity to rapidly locate and exploit relevant information and the ability to acquire new skills and know-how on a life-long basis.

5. Removing Obstacles to the Take-off of the ICT Market

Past industrial mutations show that the economies who adapt the more readily to the new technology also enjoy the greatest benefits. Adaptation refers in particular to the quick deployment of the infrastructure underpinned by the new technology as well as the overhaul of the manufacturing process, consumption patterns and the modalities of wealth redistribution. This suggests that **boosting growth and employment will depend on**

---

[71] White Paper on "Growth, Competitiveness, Employment - The Challenges and Ways Forward into the 21st Century" - European Commission, 1993.

Europe's ability to carry out a continued adaptation of its socio-economic structures to the fast evolving technologies[72].

The take-off of the new ICT market in Europe will result from a collective effort focusing on key technical, legal and financial factors, as well as life-long training and the launch of experiments in real conditions.

The first priority is to create a favourable legal, technical and financial environment.

The creation by January 1, 1998 of a **new telecommunications environment** in the European Union will remove a key obstacle to the rapid deployment of advanced networks and services. Its first pillar will be the liberalisation of infrastructures and services which will trigger private sector investment in the deployment of infrastructure as well as competition amongst incumbent companies and newcomers which will foster a greater offer of services, lower prices and higher quality. Its second pillar will be the setting up of a regulatory framework introducing a sufficient level of market harmonisation, for instance as regards interoperability of services, interconnectivity of networks, licensing procedures and standards.

This new regulatory framework will also emphasise the **social dimension**, especially as regards access of all European citizens to the information superhighway through universal service and a balanced deployment of infrastructures throughout the Union's territory to promote socio-economic cohesion amongst all regions. Other important issues which will be addressed include the protection of personal data and privacy, system security and integrity, the protection of copyrights and intellectual property rights, and the adaptation of media ownership to convergence.

As regards **labour and social security legislation**, it will have to be adapted on the basis of a close concertation between employers and worker representatives to allow for greater work flexibility while avoiding discriminations in terms of income, social protection and precariousness.

A special emphasis must be placed on **improving innovation systems** as a nation's capacity to innovate as well as assimilate and exploit innovation largely determines its economic development and its ability to create jobs. The focus here must be on SMEs which, unlike big corporations, often lack awareness of the latest innovations, the ability to access it and exploit it as well as the capacity to themselves innovate.

The second priority is to promote adequate training and technological awareness of employees.

Europe suffers from a severe **shortage of certain categories of highly-qualified personnel**. An adequate number of ICT specialists must therefore quickly be trained.

---

72 "Employment, Unemployment" - OECD, 1994.

Unfortunately, while expertise exists, training is often too expensive. Economies of scale could be achieved at Community level by interconnecting companies and training organisations.

As regards **SMEs' access to teleservices and distance training**, it could be improved by the intervention of a new layer of "**intermediary professions**" capable of analysing their needs and orienting their demand towards an appropriate offer of services.

The promotion of **life-long training and the reconversion of workers** could help foster a positive attitude of workers towards technological progress and changes in the workplace, thus leading to a more qualifying and gratifying working environment, reducing technological unemployment and boosting competitiveness.

As broad consensus emerges across the industrialised world on the necessity to broaden access to life-long education and training for everybody, the Commission published in December 1995 a White Paper entitled "Teaching and learning - Towards the Cognitive Society" which proposes ways through which institutions involved into the provision of education and training in Europe could further this goal.

The third priority concerns the launch of pilot experiments.

A dynamic of offer and demand of advanced services must be triggered by the promotion of real-scale experiments. **Public authorities, whether at a local, national or Community level, must act as a catalyst by supporting the establishment of partnerships with industry and research centres**. This approach would also facilitate the participation of SMEs and less-favoured regions to national or cross-European projects.

Information Infrastructures and Employment Case Studies [73]

Georges Ferné

Information, Computer and Communications Policy Division, OECD

1. Business Strategy

All firms had suffered to a large extent from the contraction of business activities starting at the end of the last decade. Constraints were roughly the same for the public service, in this case a Customs Department, as a result of budget cuts.

Major restructuration efforts were thus undertaken everywhere to reverse a trend characterised by important drops in sales and a greater cost-awareness. The focus, in most cases, was on abandoning low profit activities, efforts to improve customer services, development of new products, penetration of new markets, and upgrading of the core production technologies. A major feature of the period was also rapid growth of investments and R&D. Sales picked up again around 1993, and market shares increased significantly.

Profound re-organisation was seen as a natural consequence of these strategic goals. Globalisation was a crucial consideration for all firms, usually implying decentralisation and creation of establishments in new locations, as well as rationalisation of operations world-wide and efforts to rationalise investment and marketing decisions. In one country whose

---

73 The case studies coverd three manufacturing companies (agricultural machinery, motor vehicles and chemicals), six service-oriented corporations (insurance, multimedia, finance) and a public service (customs). Most corporations were approached as groups with a global reach. The exceptions included the subsidiary of a producer of agricultural machinery, mostly active in sales and maintenance, as well as firms in one Member country where the first stages of informatisation are not yet completed .

networking infrastructure remains at a very early stage, and while the focus of industrial efforts was on developing the IT platforms required for data processing, international competitive pressures were especially effective in some services (for example multimedia or supply of IT management systems) to foster a search for higher levels of quality and effectiveness, often based on the development of networks involving suppliers as well as clients.

On the **manufacturing** side, however, these new trends have met many obstacles: lack of positive response, if not opposition, to technological change; strong traditions of autonomy in departments and units; vertical and hierarchical communications patterns that cannot be easily overcome to establish smooth flows of information between all levels and locations. One exception where major applications stemming from the new Information and Communications Technologies (ICT) were rapidly and effectively implemented turned out to be the chemical group - probably due to the fact that modern chemical industry is rooted in scientific concepts that provided a readily available general framework for effective data processing and simulation at all levels, based on combinatory chemical analysis.

The situation was very different for **private services**. Decreases in revenues also generated internal adjustments with downsizing and focusing on core business to cut expenses. But the mid-90s turned out to be a period of drastic change, with new competitors and new forms of competition at all levels and - most importantly - in new areas. In these information-intensive branches, the diffusion of ICT applications had a revolutionary impact on operations and products. This led to increasing diversification of activities and global extension of activities. The "in-house" culture turned out to be most receptive to technological change, in spite of its impact on the quantity and profiles of jobs. Differences could be found, however, reflecting the size of the firms: in smaller firms, the need to maximise returns on ICT investments prompted diversification and growth - thus generating the creation of new jobs.

There was another dimension in the case of **public services** such as Customs: The strategies for the development of new structures and the introduction of new technologies had to take account of possible impacts with traditional private partners and adjust to the pace of change acceptable by the majority. Also, strategic changes could only be implemented through policy changes that are necessarily slow.

2. Technology and Production

In large manufacturing groups, an over-riding goal was to re-organise production processes in order to achieve ever higher levels of productivity and flexibility. Central objectives assigned to these efforts included flexibility, greater proximity of operations to markets, better horizontal co-operation, integration of functions world-wide, extension and acceleration of market-oriented activities, and increased employee motivation.

The availability of ICT was usually seen as a necessary condition for success in these efforts and required harmonisation of technological choices at all stages, from production to sales, and including new modes of management ("just in time" inventories) as well as more clear-cut functional specialisation within the groups.

One of the developments that were to affect directly the core processes within industry stemmed from the **globalisation of markets** that challenged large firms as well as smaller ones that were under the growing pressure of foreign competition. It was thus generally recognised that new forms of competition combined with changing patterns of demand to require that products be increasingly niche-oriented. This prompted the adoption of flexible manufacturing systems, making possible more and more sophisticated forms of customisation and enrichment of the scope of products offered to customers Thus, it was no longer a question of simply improving production: success would also be determined by the logistics of delivery and distribution. Also, the attractiveness of ICT was all the greater in view of the fact that flexible technologies would help adjust to fluctuations in an increasingly unpredictable economic environment.

Co-ordination of ICT adoption was thus recognised in all these firms as a crucial factor in achieving effective integration of new technologies, but often encountered only limited success. In addition to the institutional rigidities noted above, the accumulated heritage of past investments turned out to be a source of sluggishness that delayed local decisions and affected local technological choices to prevent full harmonisation.Of all the manufacturing groups covered by the study, the chemical corporation was by far the most effective in overcoming these difficulties.

In Customs, the potential importance of ICT was fully recognised by the end of the 1980s, and steps were then taken to take advantage of these new tools to improve operations and reduce costs and constraints on partners. Objectives were gradually diversified, in line with the expanding opportunities to use common carriers networks for automation of operations. Strategic goals assigned to the informatisation drive included productivity and output gains, better client service, development of new capabilities for new tasks, greater effectiveness, and production of data for decision-making. This new view of ICT as a strategic resource for the improvement of the service became a compelling force for all partners who had to adapt, follow the new path thus designed for them, and bear the costs of these adjustments.

The same strategic considerations ranging from market segmentation to greater skill and economy in the management and exploitation of inventories - were also recognised by the private services. Specific features, however, were also at work: the strategic nature of ICT could be more readily recognised and accepted because data processing and information dissemination are in fact what the business is about in these groups. The "pursuit of efficiency" as the key to competitiveness is the ability to take advantage of ICT applications to achieve ever higher degrees of efficiency and design new products.

Here again, customising and targeting mixes of products to address the whole national market - or, in the case of the larger more internationalised groups, the global market, have become the rule. Past investments, however, turn out to be an asset rather than a handicap. A broad range of options in insurance, or large "information warehouses" in multimedia, represent crucial resources for future exploitation through new media, development and diversification. In such a challenging environment, restructuring and achieving a more co-ordinated use of resources is also much easier than in manufacturing.

On-going changes are thus very rapid and keep pace with technological changes, such as the growing availability of advanced networks that provide test beds for new products.

The limits to expansion in many business areas or new locations result from the regulatory environment - in particular high telecommunications tariffs - or the unavailability of the powerful tools required nationally and internationally, such as fully adequate networks or internationally accepted electronic commerce tools. It is hoped that these obstacles will be rapidly removed and in the meantime diversification and alliances with strategic partners are pursued systematically at national and international levels.

3. Employment Trends

In spite of the evidence, most manufacturing firms did not explicitly acknowledge that ICT - or new technologies in general - might be responsible to some extent for labour cuts, and mainly see the economic recession that began at the end of the previous decade as the single source of job destruction. This reluctance in recognising the impacts on employment that may have stemmed, at least partly, from the introduction of new technologies may be linked to the fact that the first stages of ICT integration are far from over. Explicit recognition of the resulting disruptions might have a powerful negative effect on industrial relations. This assessment might be reinforced by the fact that several firms declined to be surveyed, on the ground that "the subject is much too sensitive".

As noted above, it is undeniable that the chain of events that led to the current in-depth restructuration of the manufacturing sector stemmed from adverse economic circumstances. In some cases, firms recognise that the impacts of economic difficulties was all the greater because the previous neglect of ICT was a factor in the loss of competitiveness. Subsequently, however, the availability of ICT created an expectation of rationalisation and competitiveness which triggered the modernisation process. In addition, there was widespread feeling that technological solutions made it easier to reduce staff and liberate resources required for investments.

A number of consequences could be easily seen within the **manufacturing sector**. The number of employees fell sharply everywhere in just four years at the beginning of this decade, in percentages ranging from 20 to 50% in one case, with the largest cuts in office staff who were often the first to be exposed to the informatisation process. At the same time, all firms achieved high productivity gains that can often be linked to the output increases achieved through more efficient numerically controlled processes.

Concomitant changes have deeply affected the work-force. Greater effectiveness, for example, makes remaining staff available for new tasks. Significant changes in work organisation (linked to the introduction of flexible production as well as computer-aided management and sales, etc.) have also taken place. The elimination of low-profit or irrelevant activities has promoted outsourcing and new partnerships facilitated by electronic networks, and has led to the creation of new job opportunities outside the firms concerned. At the global scale, the combined forces of new marketing efforts, new partnerships and gains in overall efficiency have in fact safeguarded - if not increased - the overall volume of employment within the companies studied. In most cases, however, this is not the case within the OECD area.

All these developments obviously do not have ICT as a unique cause. It remains that these technologies - with their expanding data processing and networking capabilities - can be viewed as the enabling technology that made these initial steps possible. In most cases, however, the informatisation process is still very far from completed in the manufacturing sector.

On the **services side**, ICT applications have exercised even more profound impacts. This is the case, for example, with Customs, where productivity (in terms of number of transactions that were dealt with) increased 16% in the period 1991-1994 thus making it possible to cope with expanding activities: Electronic long-distance data-processing affected directly the movements of tangible goods and products, and fostered the expansion of international commerce. There has been a continuous effort to adjust processes towards an increasingly paperless environment. Job suppression started in the early 1990s. Some employees were-hired by new firms, but many private sector jobs and firms disappeared as a result of speedier ("just in time") processing of data. Overall, job losses are estimated to have outstripped job gains.

In **private services**, an era of rapid technological change began at the end of the last decade, with job descriptions adjusted rapidly - at times after a quarter century of inaction. Updating of tasks, elimination of duplication of efforts, suppression of intermediary steps, and decentralisation of decision-making became the new corporate "rules of the game" implemented with computerisation of marketing and management. In this sense, "tele-working" from the office (rather than necessarily from the home) has become a dynamic force in the re-organisation of business world-wide.

In some cases (in particular banking and insurance), however, the high productivity gains achieved in these information-intensive sectors made it possible to retain the work-force at the cost of massive training and re-training efforts. This reflected the view that "knowledge of the job is more important than technical skills". Yet there was a steady decline in the ratio of administrative personnel, with an expanding volume of business. This illustrates the erosion of the white collar population in many existing services - while some new employment were generated by outsourcing. New firms emerged to develop services and software, and older firms sought new roles in data processing and accounting. They thus replaced some of the middle men and intermediaries that were no longer needed within the firms.

Significant differences of outlook came to light, reflecting the different sizes of firms. In the larger groups, the prospective reduction of jobs (as a result of lay-offs or, in the longer-term, of stability of the volume of the work-force) may have been a strategic factor in favour of ICT investments. Smaller firms were below the threshold that would make such savings a significant consideration but, on the other hand, had to search for new outlets to maximise returns on investment. There was a definite tendency for smaller firms to be more innovative in their search for profitable ICT applications.

In the larger firms, ICT per se have thus not caused lay-offs when corporate policies promoted training and adaptation. They have, however, provided a substitute to job creation, facilitated organisational reforms and decentralisation. The recent recession (rather than ICT) may have been the major factor in job suppressions at the time, but ICT made it possible *not* to create new jobs when expansion resumed. The bank investigated, for example, had roughly the same number of employees as in the mid-1980s in spite of the spectacular expansion of its activities.

This was accompanied by a re-definition of sales activities and relations with clients, with more aggressive commercial behaviour encouraged. Salaries were also often affected when local regulations made it possible to implement new rating systems for job performance, rewards for merit, and various incentives.

4. Training and Skill Development

New problems have emerged in human resources management for both the manufacturing and the services sector. One overall concern, for example, is the lack of potential recruits with the profiles required for higher-level management responsibilities in the new global techno-economic environment.

Other difficulties result from the changing structure of the work-force in all sectors, which must be recognised to grasp the magnitude of the training challenges that many companies must address.

In manufacturing firms, a strong technical culture facilitated the introduction of new ICT applications to a certain extent. Greater effectiveness in the use of the new tools, however, is still hampered in many cases by traditions that focus on the processing of goods rather than of information. Co-ordination and re-organisation are difficult for these reasons. Also, many firms or units remain content to improve existing activities and pay little attention to the opportunities for creation of new products and services.

On the services side, on the other hand, it has become indispensable during the last decade to acquire a technical capability that was often lacking. This profound shift in the structure of human resources generated a dualism within the staff, with a technology-oriented "ICT community" and a marketing-oriented "ICT users community" that are not always fully integrated. As a result of this difficult interaction, technological choices do not always take fully into account the actual needs and abilities of management, production, marketing, etc. This generates waste, delays, and failure to anticipate the organisational implications of new applications.

In addition to the need to prepare staff for new tools, new tasks and greater flexibility, these general difficulties also require various forms of training. Sizeable efforts have been launched to develop and provide the relevant training programmes. The magnitude of the resources allocated to training in global groups is difficult to assess precisely, due to the profusion of local initiatives that are not controlled centrally. In some manufacturing and service firms, these resources are reported to be as high as 6% to 7% of total sales. There is a great deal of interest in harnessing the more recent technologies (such as virtual reality) to these training efforts and new service providers have emerged in these areas.

5. Labour Costs and Wage Determination

In some countries, collective bargaining and regulations have not allowed as much flexibility as desired by the firm in their wages policies. The crucial concern here is the need to account for the new flexibility, adaptability and productivity-oriented efforts required of the staff. Wherever adjustments could be made, salaries now include the basic pay, merit pay and incentive pay.

The possibility of implementing such schemes has become a crucial consideration in the decisions to locate or re-locate establishments in various countries. Tele-working also provides an easy way to circumnavigate local regulations and recruit personnel to work under competitive conditions.

6. ICT Introduction Strategies

All these findings underline the key importance of ICT in the structural adaptation of firms world-wide. The introduction of the technologies in question, however, has not always been recognised as a crucial strategic effort that calls for careful planning and decision-making.

In spite of verbal acknowledgement of the principle, there is little evidence in the groups studied - except in the chemical area -that such is actually the case. It has been difficult in these cases to identify clear group strategies for IT application. The basic rules applied are limited to encouraging technological choices that maximise independence from proprietary systems and promote ICT uses deemed to foster greater profitability. There is only very loose co-ordination, with lack of integration of the various information systems. Important applications being introduced in a more integrated way - frequently at the initiative of important clients or partners - extend to marketing and electronic commerce in order to automate transactions, but their structural implication have not usually been drawn.

Globalisation is in fact often viewed as a centrifugal force that makes co-ordinated approaches difficult. This is far from being the case in the chemical group and in services, where Information processing and on-line access and distribution are major strategic tools and fully recognised as such. A major policy decision has often been to carefully limit outsourcing in this area. The goals are to raise productivity and improve services, eliminate paper, and provide all staff with easy access to information.

These developments are direct consequences of advances in global telecommunications, which have progressively created a new environment with new opportunities, decrease of paper, etc. Operations did not change significantly in the 1980s, but the present decade witnesses momentous changes.

Impacts then went beyond management to affect delivery and nature of products on the basis of specifically tailored electronic platforms conceived to achieve global integration and more rational use of resources (including human resources). The location of administration and management became indifferent and could make possible a global re-allocation of strategic functions. Relations with the various partners such as banks, government agencies, suppliers and service providers, etc., became automatic while on-line services were increasingly available for clients.

Application of ICT prompted reviews of all practices and led to re-definition of policies and controls. The corporations rapidly gained in sophistication, gradually changing from passive buyers to active seekers of technological solutions with direct influence on developments by producers and suppliers. These new trends provided for the establishment of permanent relationships with all kinds of partners, with trust progressively built in to encourage new forms of more effective interaction, such as long-term procedural arrangements with customs or transporters, or the provision of access to inventories for suppliers. Global networks of co-operation thus emerged, with partnerships based on the use of common electronic platforms.

The initial investment required for the development and implementation of such networks may be very high, but operating costs are minimal. The closed networks of this type thus acquire a dynamism of their own. Once launched, they become very attractive for prospective partners, and each new member makes the network even more attractive. Such networks have already attained significant size at global scale, and become new economic actors to be taken into account.

7. Government Policies

When firms refer to government policies as a major factor in the current adjustment process, it is usually because legislation and regulations are felt to establish conditions that affect the competitiveness of business activities.

In addition to the domestic "rules of the game" relating to salaries, a broad range of regulations are at stake, ranging from working conditions to environmental protection and including taxation. The new global information infrastructure has significantly increased the scope of options available to corporations to take these constraints into account and circumnavigate them through re-location or tele-working. The latter is still exceptional, but clearly represents an important strategic option for the future.

One essential area in this respect relates to the telecommunications regime. The provision of global services will take it into account, and will favour national systems that allow maximum competition at all levels, in particular for the finance and multimedia industries.

Government policies may thus have non-deliberate negative effects on the diffusion of new technologies at national level. They may also, however, represent an important factor in the promotion of change.

The informatisation process of government agencies usually has an enormous impact and has influenced the private sector in many countries with respect to the choice of more open standards and technological solutions. Furthermore, in some cases, and very much like large firms, important government agencies can exercise enormous influence on their private partners. This was the case with Customs, and probably also applies to a number of other government activities as diverse as taxes, the judiciary institutions, land use registries and many regulatory bodies. The introduction of ICT applications in these spheres generates waves of informatisation throughout the economic and social fabric.

In one country where networking was still embryonic, government agencies were lagging far behind the leading edge of the private sector in terms of ICT platforms and networking. There is little doubt that efforts to develop ICT applications, in particular network-based applications, in government agencies would represent a strong incentive - perhaps a compelling one - for private firms to re-design their processes accordingly and thus become better prepared to face up to foreign competition and expand at international level.

8. The Future

The pressure towards adaptation of the core production and organisational processes in manufacturing is relentless and even bound to become greater when multimedia technologies open new opportunities for management and trade. Globalisation has already led to re-deployment of offices and plants, creation of subsidiaries, new products for new market segments, work around the clock, establishment of new partnerships, use of electronic commerce to reduce formalities and delays at all levels, creation of paperless environments, etc. ICT thus challenges established practices and lead to "re-architecting" of the operational process in industry, based on the mainframe computer as an operational tool, the PC to implement job-shop processing or customs solutions, the network for company-level rational use of resources.

A new phase has begun, calling for more systematic modernisation of top management in order to meet the challenge of combining this broad range of new technical capabilities with strategic direction.

The changes to come are expected to be at least as great as the recent ones with respect to all staff functions, including simplification of management, new types of marketing approaches and networks based on electronic relations with customers, new emphasis on individual performance, structural innovation and creativity, product quality. Coping with the human dimensions of these changes will prove essential for the competitiveness of the company as well as for the countries concerned.

It has been generally acknowledged in the firms visited that a stabilisation of employment in industry and services is unlikely in this light. Future job destruction would affect in particular sales jobs to be by-passed by new communication flows between customers and the company; and middle-management supervisory and administrative jobs currently representing the majority of employees in many corporations. It might well be that 30 to 40% of current white collar jobs will become redundant. One consequence of this new pattern of work allocation would affect current career profiles (the bottom-up career). Firms are already trying to cope with this problem, as in the case of the bank where new recruits at the most junior levels are now expecting to have post-secondary education degrees.

BPR and Information Technologies in Japan: A Case Study

Yumio Imamura

Managing Director Japan Users Association of Information Systems

1. Current Investment in IT and Key Issues

The Japanese economy peaked in 1990 and then rapidly fell into recession. Although it showed a sign of recovery in 1994, it took a downward turn again in early1995. All agree that in order to promote sound recovery, it is necessary not only to maintain the current exchange rate, but more importantly to promote deregulation and structural reform of the Japanese economy.

According to many economists, the necessary factors for structural reform are aggressive utilization of IT in industry and the growth of the IT market. The table below compares the relationship between GDP and IT investment in Japan and the US.

	Japan		*US*	
Fiscal Year	Real GDP Growth	% of IT investment in total equipments investment	Real GDP Growth	% of IT investment in total equipments investment
1985	5.0	12.5	3.2	15.5
1988	6.2	18.0	3.8	18.8
1990	4.8	17.2	1.3	19.9
1993	-0.2	18.0	2.2	24.8
1994	0.5	19.0	*3.4	26.1

(*Private IT investment is estimated -3.0% from the previous year in 1994 based on the JUAS survey. Source:Annual National Economic Data Table by Economic Planning Agency and Survey of Current Business by US DOC.)

In Japan, when the real GDP growth rate dramatically decreased from 4.8% in 1990 to -0.2% in 1993, the ratio of IT total investment to equipment investment increased only 4.6%. In comparison, in the US when the real GDP growth fell 66% from 1988 to 1990, IT investment ratio increased 28%. The report published by MITI (Ministry of International Trade and Industry) called "Program to Revitalize Industry Dynamism Utilizing Information Technology" pointed out that the electronics and IT industry lost the opportunity to expand the market because they did not make an effort to foster new technologies during the recession.

Application of new IT such as multimedia, Electronic Commerce, CALS, and high-speed digital communication lines are the critical factors that bring reengineering and structural reform to the industry

Economists point out that Japanese industry requires the following changes:

- Incentive-oriented employment system for capable employees
- Investors-oriented management
- Shift of manufacturing facility overseas
- Protection of citizen life and environment

In addition to the above reforms, they called for use of new IT such as Internet. These reforms require a drastic change in traditional Japanese corporate management systems and challenge for corporate managers. Deregulation also requires challenging efforts not only by bureaucrat but business managers.

Many managers realize from their experience that the current recession is rooted in structural factors. As a result, an increasing number of corporations initiated challenging projects to utilize IT for survival. However, many corporations have no experience in applying IT to BPR (Business Process Reengineering) although they have experienced in applying IT to traditional business process.

Japanese management has been hesitant to introduce American methods directly in BPR because it is the top priority for Japanese management to maintain employment for their workers.

2. BPR Maintaining Employment

Japanese management's effort to maintain employment reduces the effects of BPR. As seen in the table below, Japan's unemployment rate remained much lower than the US which was in a relatively healthier economic state.

Unemployment Rate					
	Japan	**USA**	**UK**	**Germany**	**France**
1986	2.8	7.0	11.0	7.7	10.4
1990	2.1	5.5	5.9	6.2	8.0
1993	2.5	6.8	10.2	8.8	11.7
1995	3.0				

(Source: Overseas Labor White Paper 1995)

It is doubtful that the low unemployment rates can be sustainable in the future,and there are management questions about the significance of BPR. In reality,it is said that many Japanese corporations retain more employees than they need ,and some corporations introduced early retirement incentive measures with increased retirement allowance.

When Japanese corporations implement BPR, they reduce the excessive labor by not filling the position held by retired employees or by reallocating employees in the newly created business.There are many cases that they evaluate excessive labor deductively by BPR and plan reallocation of that labor to new business development. Of course, BPR's objectives in Japan include not only reallocation of labor,but production cost reduction and coping with changing market needs.

3. Case Studies of BPR Utilizing IT

3.1 Yamaha's Entry into the Electronics Industry

Yamaha Corporation is well known as the world largest manufactures of music instrument including pianos and electronic organs. It also succeeded in leisure and sports industry such as motor boats, skies, rackets, and golf clubs. As seen in the table below, Yamaha has expanded the scope of its business by entering new markets and dividing the company into business units.

Sales Percentage of Yamaha Corporation

Year	*Music Inst.*	*Electronic Inst*	*Audio/ Furniture*	*Sports Devise*	*Electronics*	*Total mil$*
1980	59.5%	0	8.4	11.6	4.7	2,975
1985	45.8	11.7	10.9	13.9	6.9	3,574
1994	38.5	18.9	7.6	7.5	20.2	3,161

Yamaha Corporation also experienced the decrease in sales and profits due to recession since 1990. However, their electronic device business has grown and is expected to be close to 30% of all sales in 1995.

The share of a magnetic hard-disc head (announced 1989) increased to be the second largest in the world as use of multimedia technologies and PC expanded. Yamaha has promoted the R&D in new materials and gained high market shares in semiconductor lead frames, magnetic materials, and electrode materials.

The investmen in electronic device businetss in 1994 takes up 60% of $200-million investment that the company made for plants and equipment. Yamaha positions their electronic device business as the key for the strategically important multimedia business.

The number of employees has decreased from 11,000 in March 1993 to 9,000 in September 1995 by not hiring new employees due to profit decrease since 1994. However, the number of employees working in electronic device business increased from 780 in March 1991 to 1,600 in September 1995. Most of them were reallocated from the other business units.

3.2 Steel Industry Betting EDI

The Japan Economic Journal announced in February 1996 that NKK Corporation will use the Internet for purchasing raw). NKK will establish just-in-time systems for steel materials, aiming at optimizing the level of raw material inventory and stabilizing the product supply using the Internet to monitor the status of overseas mines and raw material shipping status (i.e. the location of tankers).

NKK will communicate via e-mail on the Internet with all business partners such as trading companies and shipping companies.Information collected in the purchasing department at NKK headquarters will be forwarded on the leased lines to steel plants. NKK imports 120 types of raw material including 30 million tons of iron ore and coal annually from abroad. The number of trips of tankers reaches 250 annually. In the past, NKK used fax for communicating with business partners on the raw material information,but it was difficult to consolidate the information; and, consequently, there had been mistakes in determining purchasing time.This new way of purchasing raw material via Internet will enable the most appropriate inventory level and reduce the number of employees in purchasing.

The Japanese steel industry is forced to achieve drastic cost reductions and improved productivity because they are facing fierce price competition from foreign competitors (mostly East Asian steel companies) in domestic and overseas markets today.

In order to improve their productivity, they are spending much efforts to define standards of business protocols needed for transactions, and they have been proceeding this standardization together with other steel companies in Japan,users, and distributors. Standadizing business process, Japanes steel companies are executing reengineering of their informatiom system, as follows.

- They have started implementing electronic commerce in order to share information with steel makers, resellers, distributors, and users. They think shareing information with associated companies is a key factor to improve productivities of their transaction and production and cut down the cost of the operation.
- They are implementing the system based on the concept of CALS to define standerds for information regarding plant equipments for their improving productivity and cost reduction of maintenance and purchasing.
- They are installing wide band networks and expanding service areas coverd by their networks.
- They are adapting object oriented technologies to develop business object so that they expect to shorten the time frame to develop application and cut down the cost of its development. Developing business objects is also expected to work well for standardizing business protocols.

3.3 Yokogawa's BPR by Sharing Corporate Information

Yokogawa Electric Co. has been a one of the world leaders in the manufacture of technologies for electronic measuring instruments and control equipment for chemical plants.

Yokogawa Electric has faced increased competition in the overseas market with the movement to build new plants overseas by Japanese petrochemical, steel and chemical industries as well as price competition with imported products in domestic markets due to the appreciation of the Japanese yen.

Yokogawa Electric has been employing IT to improve efficiency in various aspects of business,including cost-cutting from late 1980's. However, as seen in the table below,market changes progressed faster than its efforts, and its profit has fallen.

Since 1990,Yokogawa Electric has implemented BPR by applying information systems and succeeded in changing the corporate structure. As a result, its profit has increased since 1993.

($mill.)	*90*	*91*	*92*	*93*	*94*	*95*
Revenue	1,990	2,028	1,840	1,803	1,712	1,720
Sales-Profit	126	52	22	10	23	25

The objective of BPR for Yokogawa Electric was to increase its productivity. In order to realize this, Yokogawa Electric tried to reduce business processes (from processing orders to collecting payment) and to improve productivity among white-collar workers.

Plant instruments (measurement control equipment) and electric measuring instruments are usually made in small lots and in variety of types. Yokogawa Electric believed that it is necessary to accept customization requests of its products to gain customers' satisfaction. Since sales, R&D, and production departments did not share the information, sales people had to spend a substantial amount of time to coordinate R&D and production before closing a deal.

Yokogawa Electric focused on product standardization and reducing inefficiency in business transactions in order to cut costs. It reached the conclusion that it is necessary to improve communications between sales, R&D, and production and to establish a cost-efficient production management system. The top management decided to introduce IT aggressively to realize the objective. The budget for IT investment increased as indicated below.

IT investment vs. sales revenue at Yokogawa Electric

89	*90*	*91*	*92*	*93*	*94*	*95*
0.6%	**1.4%**	**1.4%**	**1.3%**	**1.2%**	**1.1%**	**1.0%**

Considering that the average IT investment ratio against sale revenue in Japanese manufactures is 0.6%, the ratio shows Yokogawa Electric's strong expectation in IT as it increased the ratio even when its business was not profitable.

Yokogawa Electric focused on network computing that enable use of information systematically across sale, R&D, and production. The restructure of the system aims the following business reengineering:

- Defining the market strategy and product strategy that meet dynamic changes in the market.
- Speeding up the process for new product development
- Reducing the business processes from order receipt to payment collection
- Improving design quality for plant engineering and reducing the time for design and development.

They introduced client/server systems across production, R&D, sale, and administration, which led to the creation of a corporate-wide business database and a management information database, and that they extended the network globally to have a common master file for its products around the world. In addition, they developed global EDI systems by adopting EDIFACT, which is the international standard for EDI protocols, and plan to evolve this system into global CALS.

By information sharing, production loads were leveled and the inventory-checking period was reduced from three months to 16 days. The implementation of BPR increased the productivity of white-collar workers. The excessive labor created by increased productivity was adjusted by not filling the positions held by retired employees or by reallocating employees in the newly created business in 1993 including the system integration business and information equipment business.

4. IT and Productivity Increase

One characteristic of Japanese management after World War II was the life-time employment system. Many managers emphasized the importance of having the common valueamong employees, which was achieved through long-term employment contracts. The current recession forced corporations to increase their productivity by improving and reforming their business processes, but the corporations who were not able to reallocate their excessive labor could not realize effects of the reform. Consequently,they introduced an incentive program for early retirement and an incentive-oriented salary scheme (reviewed annually) in order to increase productivity of individual employees instead of changing the system of inefficient life-time employment. The reallocated employees also had to confront the problem of low labor mobility derived from the current retirement system in Japan which provides disincentives for workers to leave their company, and therefore discourages most employees to change jobs.

According to the survey on salaried workers at large corporations conducted bya bank, 30% responded that they were willing to change jobs if they were satisfied with the benefits offered. This indicates the possibility that the labor market can bemore mobile, and the life-time employment system will be surely reevaluated. However,it is also true that the life-time employment system gave corporations a motive to maintain the employment during the recession. As previously explained,it is not acceptable in Japanese society for profitable companies to lay off their workers as done in the US. There is no one clear answer for which system is better. It depends onthe value perception of the society and people in that society.

It does not seem meaningful to discuss whether IT will create new jobs. However, there is no doubt that IT will create productivity improvement. The new business creation and productivity improvement through IT will revitalize the society and develop new perspectives. Whether or not management should link improving productivity to laying off their workers depends on the standpoint of each corporationand on the level of efforts made by employees. The government should only focus on proceeding with deregulation.

Re-Inventing an Industry: A Case Study in the Use of Advanced Networking Solutions from the UK Retail Banking Industry

Ian Courtney

Interconnect Communications, UK

This paper investigates the circumstances in which electronic information processing has been used by one firm to alter the shape of an industry.Traditionally a career in banking has been considered one of the most secure. However the first half of the 1990s has seen the service sector experience the same processess of labour shedding and restructuring experienced by the manufacturing sector in the first half of the 1980s.

A programme of pro-competitive financial services legislation has resulted in the introduction of new market entrants, particularly from mutual organisations which have historically served the lending market for house purchase. Faced by this prospect and handicapped by overcapacity, weak margins and uncompetitive cost structures, the banks were in a poor position to respond to the challenge posed by new rivals. A typical reaction was to re-organise local retail branch networks into "satellite banking groups" involving a restructuring of management and supervisory functions over a wider geographic area and customer base. However these changes have been accompanied by job losses, which according to the banking trade union amount to over 100,000 in the last 5 years.

As banking orthodoxies disappear a different and more complex form of inter-firm competition has emerged. In the new model success is frequently determined by the ability of firms to exploit economies of scope and meet highly discriminated consumer preferences. For the banks this has spelt a number of harsh lessons. Customer surveys indicated declining levels of satisfaction amongst account holders combined with increasing expectations of service.

The case study indicates how a new "green-field" site banking operation has moved to exploit sophisticated network and switching technologies and to carve out new channels for dealing with account holders from a single location. In the process the bank has modified the geography of banking provision while enhancing customer service and broadening the scope for "cross-selling" customised financial products. The features of First Direct's operation emphasise the value to the business of Information and Communication Technologies (ICT) and human assets.

The case study also provides some important lessons for government agencies involved in local employment promotion. Not only is the bank's experience being emulated by other banks, but it is also leading to new customer service jobs being created within industries as varied as computing, car repairs and airlines.

1. The Retail Banking Industry

At the start of the decade a Financial Times leader (Financial Times 16 November 1990) summarised the prospects facing the industry in stark terms:

"Virtually all the world's traditional industries....have gone through major re-structuring in the last two decades as changing markets have caught up with....outdated capacity....Today it is the banking industry which is suffering from the same problem".

Richardson (1993) has shown how legislative changes introduced by the Financial Services and Building Society Acts of 1986 "resulted in a rapid interpenetration of hitherto discrete markets within the financial services sector". One result was an intensification of competition between the "big four" high street banks (National Westminster,Barclays, Lloyds and Midland) and the building societies. Richardson (1993) has shown how the bank's operating efficiency suffered by comparison with the building societies. Cost/income ratios amongst the "big four" ranged between 60% and 70% in contrast to the Abbey National Building Society which had a ratio of 45% at the time it exchanged mutual status for banking status.

Typically the response of the banks consisted of two courses, one of these was to increase revenue by moving into non-traditional markets, such as mortgage lending. The other was to embark upon a dramatic programme of cost reductions. The most visible sign of this has been the restructuring of the banking network into centralised "satellite banking groups" accompanied by the closure of high street branches. In the case of the "big four" this amounted to a reduction of over 20% between 1986, when banking de-regulation was introduced, and 1993.

Other noticeable consequences have been changes in employment and operating practices. Table.1. shows how the "big four" reduced staff by 10% between 1986 and 1993.

Table 1: "Big Four" Banking Employment

	1986	*1990*	*1993*
National Westminster	75,100	85,900	72,200
Lloyds	49,400	58,600	44,900
Barclays	82,200	84,700	68,700
Midland	47,500	47,100	42,400
TOTAL	254,200	276,300	228,200

Source: British Bankers Association.

However these aggregate figures conceal a deeper trend, namely a shift to part-time employment, often at the expense of full-time male employees amongst management and supervisory grades within local branches. For instance data from the British Bankers Association reveal that for the industry at large (the "big four" plus the Bank of Scotland, The Royal Bank Of Scotland, Standard Chartered, TSB Group and since 1990 Abbey National) part-time employment grew by exactly one third between 1986 and 1993. Over the same period full-time male employment declined by a little over 9% from 121,800 to 110,400.

At the same time as staff redundancies and branch closures were being announced new management practices were being implemented. The industry was taking the opportunity to introduce a new younger management cadre who were judged to be amenable to changes in management culture and more adaptable to the new competitive conditions.

The dilemma for the banks was that there existed considerable customer resistance to these changes. Market Research (see for instance Henley Centre 1994) revealed that of all the main retail industries the banking sector faced the greatest demands for improvements in customer service and that advancements in customer service were valued as more important than lower prices. Conventional wisdom alleged that a main contributor to this state of affairs was the decline in the role of the mature branch manager figure and his (for it was normally a he) replacement by an immature and geographically distant new recruit located in a "satellite banking" site.

The reality was that much of this received wisdom was in fact myth. From their own reseach one bank established the following findings:

- Only one in four customers had ever met their branch manager;
- Only one in two customers knew the name of their branch manager,

The most important banking relationship was between the customer and the bank teller. Although this was of declining importance because very nearly half of all individual cash withdrawals were carried out via automated telling machines.

In the face of a continued erosion of their market share and a poor profits performance the industry faced a cross-roads. How was it to deliver efficiency improvements while avoiding repetitions of the charge that it was complacent about continued declines in public service.

2. Case Study of First Direct

First Direct is part of the Midland Bank one of the United Kingdom's "big four". When it was launched in 1989 it had two stated objectives:

- to arrest the decline in the Midland's market share and profitability;
- to support business banking , one of the Midland's core business activities.

First Direct provides the full range of services and products that are available at branch banks e.g savings and cheque accounts, credit cards, mortgages and insurance. What distinguishes it from traditional branch banking is that it offers services twenty four hours a day, seven days a week over the telephone.

The banking sector has been amongst the most avaricious consumers of ICT (previous studies of ICT applications in banking include Hepworth, Green and Gillespie 1987 and Morgan and Courtney 1994). Not all of this represented a wise investment. For instance Cole and Palmer (1991) have commented that "the industry has had a gigantic appetite for technology, which it has hardly digested, but the productivity of such investments is remarkably low; so low that it not have been tolerated in other more financially and managerially diciplined industries".

The distinctive aspect of First Direct is the way in which three key technologies have been integrated within the organisation to automate and systematise operations. This has been achieved by tracking information flows and processes in order to reduce costs and increase customer service. The three key technologies in question are:

- Automated Call Distribution;
- Computer Telephony Integration;
- Intelligent Networks.

The combination of these technologies have resulted in impressive productivity improvements. Staff can avoid spending the initial 15% to 20% of the call identifying the caller and can also achieve higher levels of courtesy. Other benefits include reduced call charges and reduced call queuing time.In addition customer information held on "host computers" enables First Direct to identify opportunities for cross-selling by using "data mining" techniques.

In many respects the defining feature of First Direct is in the field of recruitment policy. It has eschewed a policy of seeking employees with prior banking experience. It is perhaps highly significant that an idealised staff profile might include time previously spent with one of the United Kingdom's most successful retail groups, Marks and Spencer or employment as a nurse!

Commenting on the emphasis the Bank places on personality Kevin Newman, First Direct's Chief Executive stated "we recruit from behavioural skills rather than banking skills, because you can acquire banking skills through training" (Financial Times 19 August 1994).

It is no exaggeration to suggest First Direct has changed the landscape and geography of banking provision. All members of the "big four" and most financial services institutions employ similar technologies and customer service strategies. Direct customer communication via the telephone is becoming the financial services industry norm rather than than exception. It has contributed to a model of industry compettion where firms differentiate themselves on the basis of service as much as price. In the case study ICT has also enabled systematisation and automation to occur and alter the range and depth of banking tasks traditionally undertaken by labour.

Conclusions

It is apparent that ICT and in particular the roll out of the intelligent network infrastructure is contributing to a recasting of the geography not just of retail banking but also customer service and support functions more generally.

In the United Kingdom BT forecasts that freephone and local call rate traffic growth of over 25% per annum over the period between 1994 and 1997 will result in the generation of additional annual revenues of £1 billion. From this BT has estimated that over 150,000 jobs will be created in telemediated customer service and support activities by the end of the century.

Subject to the availability of connectivity to the intelligent network, the geographic location of customer service and support activities seems to be largely determined by the availability and cost of labour. This is a prospect that has not been lost on Government economic development institutions throughout Europe. Many of these are engaged in the promotion of the competitive labour cost attractions and potential of their particular locations for customer service occupations.

Prompted by new market conditions, brought about by regulatory changes in both the financial services and telecommunications industies, the firm in the case study has responded by building a corporate architecture around ICT. However within the setting of the Information Society the view of the United Kingdom's contemporary banking sector is of an industry where knowledge is vested in the hands of a small minority; namely intelligent network software designers.

Network Technologies, Organisational Change and the Location of Employment: The Case of Teleservices

Ranald Richardson

Research Associate at the Centre for Urban and Regional Development Studies, University of Newcastle on Tyne, UK

It has been clear for some time that firms across the globe are having to come to terms with an increasingly competitive business environment. The reasons behind this new environment are well documented and include, liberalisation and deregulation, the emergence of new players and markets, increasingly sophisticated customer demands, and rapid changes in technology.

In this new competitive climate firms have been forced to develop new goods and services. They have also been forced to evolve cost-effective, innovative methods of producing and delivering those goods and services. Information and communications technologies have come to play a key *strategic* role in this process and, therefore, in the battle for competitive advantage. In the 1970s and 1980s 'leading edge' firms used these technologies to strengthen *internal* communications and organisational structures or to develop partnerships with other firms, forming *networked* firms (Runge and Earl, 1988; Keen, 1988). In the 1990s firms are widening their focus, and are now using these technologies to develop new interfaces with the customer. Moreover, such behaviour is no longer limited to a small number of 'leading edge' exemplar firms in advanced 'information intensive' industries.

Ultimately, it will be the emergence of truly interactive and user-friendly multi-media technologies which will revolutionise the producer-customer interface. However, in the current competitive environment firms cannot afford to wait for such technologies. Instead they are exploiting developments in office and telephone network technologies to deliver customer services cost-effectively, via the telephone, and it is somewhat ironic that just as commentators are pronouncing the 'death of telephony' (Gilder, 1993) firms are increasingly turning to this medium as a business tool and introducing '*teleservices*' (Richardson, 1994a). There are a number of reasons for the current popularity of telephony as a customer service delivery mechanism:

- telephony itself has been transformed through information technology and the emergence of digital exchanges and 'intelligent networks' have radically transformed its functionality, reliability and performance;

- telephony costs have fallen rapidly and new *customer*-oriented services such as toll free, local call and premium services, have been introduced, utilising the intelligence in public networks; these new services encourage further use of the telephone;

- telephone penetration is high in the key markets of the advanced industrial economies, both within businesses and in the home, and potential customers do not need to invest in expensive hardware or software;

- most people are familiar with the telephone and have few problems using it – it may well be that consumers can adapt to new uses of this familiar technological artefact (e.g. touch-tone) more easily than to completely new technologies;

- complex and relatively rich information can be communicated over the telephone and clarification and recapping can take place in *real-time*, with follow-up instructions sent by fax or e-mail if necessary;

- on a similar point, many firms suggest that a far higher number of sales can be generated or sales opportunities converted by a well trained telephone agent than by existing interactive technologies (or by those on the horizon), the argument being that people still want an element of human contact.

This paper focuses on the organisational implications of the growth of teleservices. It is chiefly concerned with new possibilities for new spatial divisions of labour, both at the national and international level, resulting from the growth in teleservices. The paper also touches upon the impact of these new forms of organisation on the distribution of power within sectors.

1. Teleservice Growth and the Location of Employment

Teleservices do not represent a discrete new sector of employment. Rather the term describes a new way of delivering services to (business and consumer) customers. It is growing across a range of industries and a number of functions are becoming 'telemediated'. These include:

Sales	Banking
Marketing	Market Research
Technical Support	Reservations
Appointment Setting	Order Taking
Lead Generation	Membership Renewal
Customer Enquiries	Brochure Fulfilment

When face-to-face interaction is replaced by the telephone there is obviously less need for 'production' to be located physically proximate to the customer. So, for example, we see the removal of functions from branch networks – banks, insurance brokers, travel agencies. These tasks are then concentrated in one or a few sites where firms can achieve economies of scale in terms of capital expenditure and labour utilisation, can better control the labour process, and can ensure uniform quality of service. What is tending to happen in teleservices is the industrialisation of service activities, with the standardisation and routinisation of the labour process. We are seeing the emergence of 'customer service factories' – in industry parlance, the *call centre.*

Another result of firms being able to separate service production from service location is that the 'locational repertoire' of firms are expanded. Firms no longer have to locate production close to markets and can, therefore, search more widely for the most cost-effective production inputs, notably labour. Given appropriate digitised, 'intelligent' telecommunications networks, which can host non-distance tariffed services, such as toll free and local call rate dialling, firms have a wide range of locational options. The degree of locational mobility will vary from firm to firm depending on a number of factors, including; the type of labour required – certain skills may only be available in a limited number of labour markets; labour market regulation – regulation may mean that there is less differentiation in labour costs across space within particular national territories; the nature of the product – some products may require local knowledge which cannot be captured and transported; existing real estate portfolios may make it economically sensible to continue to locate at existing sites. Even allowing for these caveats, however, it is clear that a large number of firms are reorganising the production of their telephone operations, concentrating them into one or a few sites and then seeking out the most cost-effective locations from which to service customers by telephone. This is happening both within national territories and on an international basis (Richardson, 1994a and 1994b).

The growth of teleservices is also implicated in both horizontal and vertical integration within and across industrial sectors. Several trends can be identified. First, firms which have traditionally relied on intermediaries for sales or customer support (e.g., airlines, computer manufacturers) are now dealing directly with customers via the telephone. Data on customers is now seen as a strategic asset which can both be used for a firm's own planning and as a product with a re-sale value. The emergence of new cost-effective delivery channels such as teleservices allow these firms to cut out the intermediary and to capture more information on the customer. This has profound implications for power relations within individual sectors. Second, firms are moving into new sectors via teleservices, potentially undercutting existing players. This is clear, for example, in UK financial service markets. Third, third-party outsourcing specialists are emerging in teleservices, thus offering organisations the option to hitherto 'core' functions. This option has been exercised by several organisations in the UK including local and national government. This outsourcing process begins to blur sub-sectoral boundaries and again raises questions regarding sectoral power relations.

The paper now turns to look at short, firm-based, case studies which illustrate some of these points:

2. Case Studies

British Airways

The UK's major airline British Airways has always relied heavily on telecoms to allow potential customers to make enquiries or bookings. BA is now focusing closely on direct sales, however, in order to lower costs and to build direct customer relationships. BA is using new technologies to cut out the intermediary and bring operations 'in-house'. The company is then using its increasingly strong competitive advantage within the travel filière to place pressure on, for example, travel agents to reduce commission charged.

BA has also used new technologies to separate production from consumption. In the UK the company has regionalised its telesales operations, opening or expanding offices in several UK provincial cities, whilst down-sizing its London operation, despite the fact that over 85 per cent of its customers are based in the South-East of England. By regionalising its teleservice operation away from the tight labour markets of the South East BA has reduced costs. First, from lower labour turnover and thus lower training and recruitment costs, saving the company around £2 million per annum. Second, from lower wage and associated costs, typically £3,000 to £4,000 per annum, per worker. The labour force in the regions is also said to be well-motivated, and the market for highly skilled staff is less competitive Since 1989 the workforce at Heathrow has been reduced from 900 to less than 100, whereas in

Newcastle, in North-East England, the workforce has grown by around 600 in the same period.

BA uses local call rate services provided over BT's intelligent network. Callers pay only the local call rate regardless of where they are telephoning from. BA divides the country up into six sectors for these calls, and BT's intelligent network routes calls generated from within those sectors to a nominated call centre. If that centre is busy the call will flow to the next centre. Not all calls go to the nearest centre, for example, calls generated in the south of England, but outside the Greater London area, will go to Glasgow in the first instance. If for any reason the operation gets out of kilter, for example, a fire or a strike at any centre, BT can simply reconfigure the lines.

BA's telesales operation, although located at five sites, can be seen as a 'virtual single office'. Central control extends to the preparation of a 'national roster' - the number of staff required at any site at any time. Activity can be equalised across regions. For the customer the service is the same regardless of which centre he/she reaches.

For the UK's provincial cities the type of decentralisation of work from the 'core' south-east region illustrated by BA case clearly has implications for employment. Newcastle, for example, has seen the emergence of around a dozen call centres in the last five years with employment at around 1,500. Other provincial cities such as Leeds and Glasgow have shown even more rapid growth, each employing well over 2,000 in large call centres. Most of these call centres serve a national and, in some cases, an international market.

Quarterdeck International

The US firm Quarterdeck International designs and manufactures a range of software products for PCs, most significantly a memory management software package, and has production sites world-wide. Quarterdeck sells its products through a network of agents with principal offices in London, Dusseldorf, Paris and Barcelona – the agencies are located in accordance with the largest markets. The company operates in the mass-market end of software and looks to sell to large companies.

Quarterdeck set up a telemediated technical support operation for its products at Dun Laoghaire, near Dublin, in the early 1990s, the first such operation in Ireland. The centre offers telemediated technical support to clients throughout Europe. The Irish site also services offices on both seaboards of the US, outside their office hours.

Each of the company's product lines is allocated a telephone number. If a problem arises customers call their nearest agent - for example, a German, Scandinavian or Eastern European customer will call Dusseldorf. These calls, however, are not answered at these centres, but are 'gathered' by the software in the private exchange and passed, via leased lines, to Dun Laoghaire The firm's network hosts voice, fax, a bulletin board, and a call-back fax, where customers can ring up and request a fax back (i.e. customer is paying for fax transmission). Twelve multi-lingual technical support personnel deal with the calls. Each member of staff speaks four or five languages. The technical support staff are knowledgeable about the firm's products and have access to several databases including the firm's own database in US and in Ireland.

As in the BA case this example illustrates how functions which have traditionally been carried out face-to-face are being performed at a distance over the telephone. It also represents a firm taking an aspect of production in-house. This trend has been common in the past few years in the computer industry. Quarterdeck is a relatively small firm and retains sales agents throughout Europe. For other larger firms such as Gateway and Dell, however, the importance of intermediaries is declining, as direct sales capture a larger share of the market. This case study also illustrates the potential for firms to sell products and offer customer services *across international boundaries*. The ability to separate production from consumption through ICTs allowed the company to take advantage of low production costs, but still penetrate wealthy core markets. Quarterdeck chose Ireland primarily because of its inexpensive, but well educated, graduate population. Other important factors were government financial incentives and high quality, competitively priced, telecommunications. Other teleservice firms have also been attracted by these factors. By Spring 1996 there were around 35 teleservice firms, operating on an international basis from Ireland. Most of these were US firms attacking European markets. About half were in the computer sector.

Conclusions

Network technologies and other ICTs have been used as a *strategic* resource by major firms in organising their internal operations for some time. It appears that such companies are now beginning to use these technologies to develop 'teleservices' to replace or complement face-to-face interaction with customers. This paper has illustrated that these developments are leading to changes in the way in which production is organised. Firms are concentrating telephone functions at one or a few sites rather than at multiple branch offices close to the customer. Once production is separated from consumption firms are better able to take advantage of a wider range of locational options. The empirical evidence presented in this paper suggests that many firms are seeking out new locations in regions where production costs, and particularly labour costs are low, and then 'exporting' services to more wealthy regions.

Teleservice firms have a number of locational requirements. First, the necessary telecommunications infrastructure must be in place. For some firms this may only mean timely access to leased lines at a competitive rate. Other firms may, however, require more. Links to an intelligent network hosting services such as toll free, local rate and premium dialling may also be important as they help to generate calls from across a national territory, or across national boundaries. Second, a well qualified, reasonable cost, workforce. Generally speaking teleservice firms will want to cherry-pick from a large pool of labour. Firms generally tend not to be too concerned about formal qualifications. On the whole these are not highly skilled jobs as the knowledge tends to be embedded in the technology. What is required, however, is the ability to interact with the customer, whether in order to sell product or assist with a problem. Third, firms will often expect a range of financial or other incentives of the kind usually associated with manufacturing employment.

It is clear from the case studies reported in this paper that opportunities exist for less favoured cities as a result of the rise of teleservices. Call centre work is not homogeneous, however, and different firms will require different skills, depending on the nature of the product and the markets served. It is likely that the more complex the tasks and the higher the skill requirements the closer to core regions firms will locate. As Ireland shows, however, there may be opportunities for non-core regions to attract higher order functions requiring technical and linguistic skills. Nevertheless, less favoured areas should consider carefully the nature of the tasks being relocated before offering generous packages. On the one hand low skill tasks will be the first to be overtaken by new technologies or by competition from lower cost sites. On the other they may represent useful experience in using new technologies on which a region can build and a cost-effective way of upgrading skills which might not be available from other local sources.

The Exchange Process in Question [74]

Laurent Gille

Sirius, France

1. Information and Transaction

The market represents an extremely complex mechanism. Economists have frequently insisted on the role that information plays in the functioning of markets. But the market is not a simple meeting place where supply and demand encounter the exchange of information: the market is also a production site, production of advanced and complex commercial functions that enable transactions between economic agents. These commercial functions are continually enhanced due to two important phenomena that characterize today the articulation of supply and demand:

- products are no longer sold, but serviced
- products are more and more the result of assembly rationales rather than transformation rationales.

Products, whether they be goods or services, are less and less delivered and more and more serviced. The difference is not just one of form, but corresponds to a profound evolution of demand. The transaction that formalized the transfer of property, the sale of goods or the provision of a service, was often limited to a simple sale. Whereas, examining current markets reveals that transactions today involve not only a sale, but also the provision of numerous services that accompany that sale. The guarantees given more or less traditionally on the functioning of goods have thus been complemented by insurance and assistance services, which make it possible to sell not only the merchandise, but also a guarantee for its

---

74 This paper was originally written for the 1995 report of the IDATE Foundation and is reproduced here with IDATE's kind permission

use. Forms of payment have been extended to include all kinds of credit, of exchange, of ownership modalities. The availability of merchandise or services has been largely extended, to all hours of the day or night, permanently and at any location. Products must be provided rapidly (the notion of urgency) and everywhere (the notion of space-time coverage).

This evolution is particularly evident in information products and services: the myriad forms of financing, insurance, assistance, logistics, etc. make it possible to associate goods and services in multiple, different packages to form more and more customized products. Each product put on the market today is more and more a combination of diverse components (goods and services). Supply thus consists, not only of refining these combinations, but of enriching the associated products in order to increasingly globalize the need that is addressed. Industry, whether material or immaterial, is no longer required to transform, but to integrate.

This globalization of demand is manifested in numerous sectors and is the object of a more and more integrated offer: the tourism sector, in advance as concerns these globalization phenomena due to the considerable increase of tour operators, must confront this growing globalization by means of an ever-greater customization of its offer. The services provided at a certain place, a certain time, within a certain context, are potentially adaptable to the circumstance (a vegetarian meal on an airline flight, multiple options within an organized tour, etc.). In the real estate sector, innovative maintenance offers demonstrate the integration of increasingly varied repair functions; operators now offer a complete household maintenance or improvement service, for whatever kind of artisan might be needed. This type of evolution is also beginning to appear in the domains of training, health, family management, etc.

Markets are being segmented, just as are production activities. The acquisition of goods or services requires an information process, the acquisition of information on available offers, a process of comparison, of assessment with respect to the purchaser's needs. Traditionally, the organization of markets, the market hall, the shopping street facilitated this selection process for the consumer. Within that form of organization, it was, in the end, the distributor that represented the suppliers. From now on, faced with an ever more diversified offer, which complexifies the possibilities of comparison and selection on the part of the consumer, and faced with the consumer's increasing demand for globalization, the latter tends to delegate the choice, the selection of the product, to an intermediary whom he mandates for that purpose. This process of dividing markets is accompanied as well by an evolution of the consumer, who, formerly customer, is becoming user: it is no longer enough to transmit to him the ownership of a product, one must also guarantee its use and the adequation to his needs. In place of the initial market, several markets have been substituted: one market between the users and the new intermediaries, one or more markets between these intermediaries and the producers. The integration of services thus multiplies the number of markets, due to the range of combinations introduced by the integration mechanisms.

The rationales themselves at work on these markets are evolving: the traditional commercial relationship (which presupposes an evaluation of price vs quality) is giving way to a relationship characterized more by confidence in a representative (which presupposes an evaluation of use vs understanding of needs); these representatives will thus try to obtain a quality label for their interventions and thus new evaluation mechanisms appear. Today, the role of financial managers presupposes relationships largely based on confidence; this situation is being generalized to insurance, for example, where it is more and more difficult for a company or an individual to decipher an insurance contract. New intermediaries are appearing, known as risk managers, who are the intermediaries between the insured and the insurance companies, who do not act as distributors of those companies' products, but who intervene under mandate of their clients (and are thus remunerated by the latter).

Markets thus call for a twofold evolution:

- globalize the service and at the same time customize it
- go from an ownership rationale to a user rationale where it is a matter of accompanying and assisting the customer throughout the life of the product,
- go from a commercial relationship to a richer type of relationship where confidence is of importance: the complexity of the gift, for a long time studied by anthropologists , is resurfacing under modern commercial forms.

This is what we have called **"servicing the product"**.

Thus, the production system is less and less required to distribute products, but must address more and more generic consumer functions: moving from place to place, communicating, housing, health care, child raising, entertainment, etc. without these functions being exclusive. On the contrary, they are destined to overlap, interpenetrate, or complete one another, according to the situation, perception, habits and taste of the consumer.

In addition, the enrichment of the intermediary operations leads to a more and more meshed production system: each producer that integrates a commercial function must integrate products coming from other partners and must, himself, sell his products to other producers that integrate often similar components in a different way. A chain rationale which corresponded to production mechanisms consisting of successive transformations of materials is succeeded by a network rationale which corresponds to production mechanisms consisting of the integration of products; in such a system, each producer is at the same time customer and supplier of the other producers, and the linearity of the chain is no longer maintained.

The exchange process is becoming a producer of relationships; the transaction has a cost, which increases as the functions increase in complexity. Productivity is no longer the prerogative of production alone, it now concerns the exchange process: the evolution of transactional mechanisms leads to no longer thinking only of production functions, but also of transaction functions. The consequences of that transformation are great: thus, it is urgent to add to production accounting, especially of the macro-economic type, a transaction accounting, which alone today would make it possible to reflect and act - with full knowledge of the facts - on important dimensions of our socio-economic systems.

2. Towards New Polarities

Markets traditionally form nodes in the economy. The market produces the meeting of supply and demand: that meeting is traditionally connected with a time and a place. Today, places take form which integrate a greater and greater supply of products, that establish a stronger and stronger commercial relationship and that little by little prescribe what is to be consumed. The development of these new forms of distribution/consumption is giving birth today to what we could call **transaction processing centers** (TPCs), which produce marketplaces that are immaterial, virtual and accessible from any place, at any time. Just like central purchasing agencies (that are concerned with distribution or more specific sectors like buying publicity space), and centralized reservation systems, expecially powerful in the air transportation sector, veritable transaction processing centers are being set up in numerous domains, often formed around existing businesses.

Consumer credit, associated either with retailing (Cofinoga of the Galeries Lafayette group or Finaref of La Redoute), or with the banking world (Cetelem of the Paribas group), assistance businesses, which are generally associated with insurance companies, publishers and large public utilites, are all developing or already possess processing centers that allow them to manage the complexity of modern transactions.

Each one has its own type of transactional mechanism: the "card issuers", those that issue credit cards (banks and financing companies, distributors, telephone companies, etc.) handle accounts that they try to mobilize for the largest possible range of transactions; the "assisters", who open files that generate complex services; the "informers", who associate their services with more and more diverse types of transactions. The integration of increasingly diverse products in these different categories of transactional mechanisms leads to the association of numerous types of skills: by developing transactional centers where the transaction becomes more and more generic, more and more businesses overlap their distribution activities; and since the latter represent a growing portion of their added value, a veritible black hole has been created by the current mutation of transactional mechanisms: the reconfiguring of distribution's gravitational fields could be considerable. Although it is true that integrated trade has not supplanted specialized trade, and that catalog sales have not replaced retailing, the redistribution of roles has nonetheless been considerable. The notion of trade name is being disconnected today from the circuits to which it has been attached and is becoming multi-circuit, giving birth to processing poles for trade information which go to form transaction processing centers.

The notion of processing center seems quite characteristic of the new networked configurations of the production system, which substitute for the linearity of former models, the radial form of the meshed model. Town centers and shopping arcades were already examples of these places where meetings were facilitated, where everything attractive, symbolic and collective that society can offer takes form. A corollary of the globalization phenomena, the notion of center (sometimes called base, as well) is emerging in many sectors: leisure centers, health centers, training centers... These centers are numerous - there can not be a unique center - and they polarize the places where exchanges occur. Back offices for the physical centers, front offices for the immaterial centers, these transaction processing centers - which just as telephone exchanges on telecommunications networks, or freight centers on transportation networks, or stations and harbors of all sorts on other communication networks - assure the interconnection, the interfunctioning, the routing and the processing of what circulates.

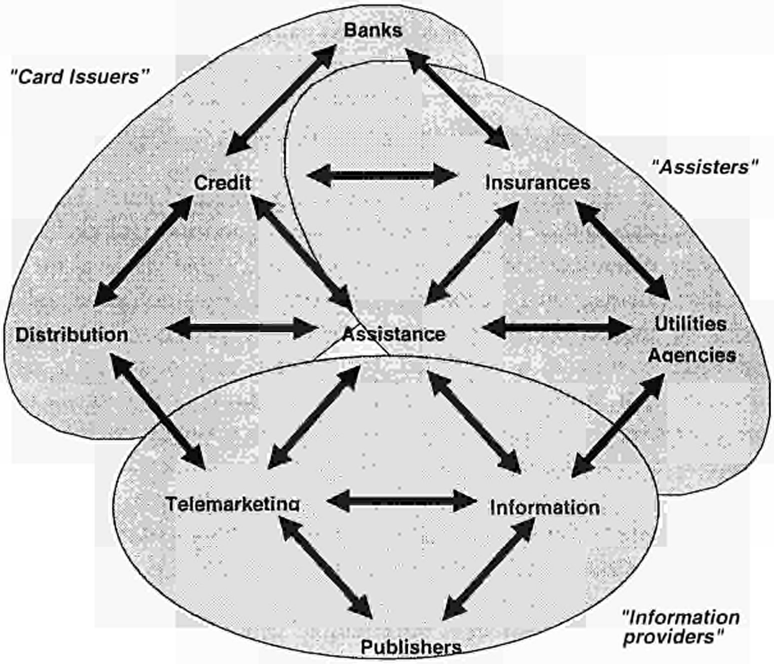
The TPCs which process the flow of information have nevertheless their own specific importance. In effect, the digital information constitutes an easily processed commodity , which can generate significant values. Each transactional center is first built on the fact that it monitors considerable transactional data relative to products for which it assures the circulation. The stocking and processing of the mass of transactional data allows a very fine analysis of the markets which can be rendered profitable either internally or externally. Internally, valorizing can come from an increasingly fine targeting of clientele, enabling the customizing of offers: in this way, American telephone companies, by analyzing the communications initiated by their customers, can propose advantageous terms to certain customers and thereby secure their loyalty to the telephone company , as well as finding new customers through sponsorship. Externally, some of the information proceeding from the activity of transactional centers can be sold to third parties, for example, information on the frequency of breakdowns per type of automobile, which results from the processing of requests for assistance by large assistance companies, or the sale of pharmaceutical products by area, which results from the compilation of sales managed by pharmaceutical distributors.

That capacity to master the adequation of supply and demand, acquired little by little by the TPCs, gives them - beyond their role of organizer of intermediation, of exchange (a role that we could qualify as metamediator) - a veritable arbitrator's role vis-à-vis the markets. The emergence of that polarization of economic networks is thus accompanied by profound transformations of the relationships between economic players. The subcontracting of vertically-organized businesses is replaced by the reticular contracting of networking organizations. Today, it is unthinkable for more and more professionals to not affiliate themselves with transaction processing centers which increasingly condition the access to markets. Garage owners affiliate with automobile assistance centers, artisans affiliate with the central agencies that are appearing in the maintenance sector, medical auxiliaries affiliate with medical assistance centers within the context of new services offered by the latter, and information providers affiliate in the same way, thus giving birth to new subordinations.

The capacity of these TPCs to process information, which is now mainly digital, coupled with the evolution of demand towards the globalization of the consumers-users' expectations, is tending to rapidly expand the scope of intervention of these centers. Thus, when a subscription to an economic daily is coupled with a banking service, when a radiotelephony service is coupled with a traffic assistance service, or when an insurance contract includes an assistance service, what appears is the extended superposition of skills. These TPCs now produce the most diverse packages of commodities and the traditional distributors of goods and services find themselves selling not only their own production, but also that of others. We thus witness the emergence of a veritable intermediation crystal where banks, insurers, assistance providers, as well as retailers, public utilities (whose activity consists for a large part in distributing), telemarketing, information companies, and even publishers cohabit.

Modern markets are becoming electronic, virtual, immaterial, and represent colossal investments and power: the cost of an airline reservation system attains billions of dollars. These TPCs are going to increase in number, differentiate, approach their clientele from diverse angles, while integrating products in new and different ways: a process of dividing markets is taking form which accentuates the meshing of these centers, which constitutes the interconnection of markets. Distinctions among skills are disappearing, with the emergence of new, hard to answer questions, like those concerning professional responsability, traditionally associated with lines of business: should these responsabilities now be associated with markets, what is the circulation of risk that is brought on by this new type of economy?

The Intermediation Crystal



Capable of integrating more and more complex functions, transactions will also modify the boundaries of public services. This observation can already be made in the social realm, where the cost of processing a social intervention, once defined, is probably inferior when provided by an assistance company than by a social organism. The development of different types of financing, the multiplicity and complexity of interventions to be deployed, necessitate more and more transactional mechanisms (mobilizing means, services, measurements, billing, verification of rights, reimbursements, compensations, etc.), which noncommercial services will find more and more difficult to provide. The customization of services, which can be provided by large TPCs, opens in parallel important possibilities for adapting to each person the aid and assistance required.

Thanks to new telematic tools, the power of TPCs makes it possible to envisage a real freeing of exchanges (no doubt accompanied by a degree of deregulation), with, of course, the impacts linked to the fluidity of the circulation of values that we have mentioned: it is not as much a question of densifying the exchange sphere as of extending it, making interchangeable the values which are not such today. The example of skill clearing houses, which are being set up in certain countries, illustrates these new mechanisms of exchange where it is becoming possible to exchange an hour of labor corresponding to a certain skill, for an hour or more of labor with a different skill.

These new exchanges, based on a modern notion of barter, illustrate as well the question of multiplying scales of value: money often remains the unavoidable unit of comparison of values, and thus of their inevitable compensations, but could cease to be the universal standard. With the example of local skill exchange trading systems, it can easily be imagined that a hourly accounting be substituted for a monetary accounting, with conceivably, certain skills being "worth" more hours than other skills. Each exchange, each TPC would manage in fine the accounts, in a unity of value that could be proper to that exchange. Of course, the globalization of exchanges presupposes a single standard to compensate the global circulation of values, but the recourse to specific measures constitutes no doubt a way of differentiating the TPCs, all the more pertinently in that the exchange with customers can integrate monetary relationships (for example, providing information, consuming, each unit consumed giving the right to new consumptions).

Each trade name creates or adheres to a demonetized bonus system: free air miles attributed by airline companies today represent the archetype of the couponing practices which distribute bonus points for all sorts of purchases. Current alliances among major retailers, financial players and telecommunications companies could confer tomorrow the role played today by mileage on telecommunication services (calls), for small purchases.

In such contexts, what will become of the notion of value? Will purchasing power be measured by the yardstick of multiple accounting units, units of weight and volume, monetary units, temporal units, units of information or communications, by points, miles or tokens of all sorts? The choice of these new units, the question of their measurement, their correspondance, the way public authorities will have to redefine fiscal concepts, are all questions that remain open. But, beyond the new forms that are going to give rise to new markets, it is the value of labor and purchasing power which may conceivably be called into question if we are not careful: will not the power of certain transaction processing centers and the globalization of markets that they may bring about induce a devastating deflationary process?

Conclusion

The mutation of transactional mechanisms that is taking place today in our economies leads us to wonder what will be the role that they could play in the phenomena of economic oscillation. The hypothesis which could be advanced depends on the coordination which is necessary between the progress occurring in the productive sphere and the progress occurring in the transactional sphere. In general, any progress in production leads to or accompanies a mutation of demand, of consumption, of uses: they must be accompanied by substantial mutations of the exchange mechanisms. In other words, progress depends at certain periods on the freeing of productive forces, but it necessarily depends, at certain other periods, on the freeing of exchange mechanisms which allows the production to spread within a new environment.

In addition to production cycles, it would therefore be well to wonder about possible exchange cycles: the question today concerns the contribution of information and communication technologies to growth. Of course, their role and their impact on the scope of production are considerable; but, there is much more at stake as regards their potential contribution to the evolution of transactional mechanisms, which is, in any case, an essential factor for their full contribution to the improvement of the productive sphere.

Information and Communication Technologies (ICTs) are probably not the primary driving force for the evolution of transactional mechanisms: technical progress can only be grafted onto more fundamental mutations of economies and societies. However, it can accelerate a movement which vehicles considerable transformations of our standards, our values, our regulations. If the process of dematerializing markets, which is already well engaged, seems unavoidable, it is becoming urgent to examine all incidences of that evolution and to set up a means to measurement (a transaction accounting) which will prove indispensable to control the process. The fluidity of values, the capacity of value flows to produce values (whereas until now we were involved in a reverse mechanism where the production of values generated the flow of values), the multiplication of scales of value, the disappearance of skills, the putting into circulation of risks, the new issues of opening and closing ... all the phenomena induced by the evolution of transactions, show the abundance of problems to be addressed.

New Payment Systems as the Key to New Multimedia Businesses

Kenji Ito

McKinsey & C°, Tokyo

1. The need for new payment systems in electronic commerce

Today, the number of on-line PC service subscribers in the U.S. – the most advanced market in the world – has already reached 7 million, and 30-40 million people worldwide are using services on the Internet. Even in Japan, a far less developed market, on-line services are rapidly gaining subscribers. The number of individual subscribers to on-line services, such as NIFTY-Serve and PC-VAN, has grown at nearly 50% over the past 2 years and has now reached more than 2 million subscribers (there is no overlap between users of both services). In addition, the number of Internet users has grown rapidly since some on-line services launched connection services for individual users in 1994.

With the increase in the number of individual users of on-line services, traditional off-line transactions – that is, sales of information, services, or products to individuals or households through face-to-face sales activities – will also be available on-line. Since electronic networks provide consumers with access to a wider range of IPs (Information Providers: Services/goods, information), on-line services are expected to continue to grow rapidly.

From the viewpoint of service/product providers, the advantages of this new on-line channel are enormous. They do not need to pay shop rent or labor, or printing/mailing costs. Furthermore, they have obtained a new channel that targets consumers who value the greater convenience, wider range of products, and competitive prices of on-line services.

When information on a service or product is delivered from one party to another on a network, payment transactions should also be made on-line. A new payment system is required for on-line payment transactions since cash or credit card payment methods are not feasible (the customer's authenticity cannot be confirmed by his signature). Many general merchandisers and department stores have not yet entered the electronic home shopping market because on-line payment systems are not yet established.

Requirements for on-line payment systems:

- **Security**

The most important requirement is to obtain the security needed to make payments over a network, given that hundreds of thousands of people are using that network. On the Internet, users can deliver information across national borders. If you deliver any 'defenseless' information, it can be viewed by any user and could be modified before reaching its destination.

Thus it is critical to establish a security system that can prevent hacking or abuse of information before payment information is delivered over networks, especially over the Internet. If a high security level is secured, electronic financial transactions can be made.

- **Payment cost**

The second requirement is to set a level of payment which is both profitable and acceptable to the user. Traditional payment methods – including bank transfers, credit cards, and checks – involve payment processing activities at banks, credit card companies and shops. The cost of these processing activities is not directly proportional to the volume of sales. Even in the case of on-line transactions, the settlement process of a credit card costs more than Y100 per transaction. The types of on-line transactions vary widely, from payment for information (several hundred yen per transaction) to more expensive purchases through home shopping (tens of thousands of yen per item). There will be strong demand for information, which costs only several hundred yen per transaction. Due to the present economics of settlement processing these transactions, which will probably become the mainstream of information delivery services, will not be profitable.

- **Providing value for the user**

The payment system should be accessible to all users. Currently cash or credit card payment options are available for ordinary purchasing. Credit cards can only be used by people over 18 years old. However, many users are children.

Second, on-line payment systems should enable anonymity. Given the rapid expansion of new information intermediaries, such as video and Dial Q2, adult entertainment services will almost certainly be available. People using such services will probably choose payment options which allow them to remain anonymous.

Information providers also have a set of requirements. Anyone can sell information to thousands of users on a network. However, when people want to sell information or a small software vendor wants to sell its own innovative product, how can they collect money? The safest option, with no risk of lending loss, is a credit card. However, it is difficult for individuals or small companies to become a member shop of a credit card company under the current off-line credit card system.

In networked markets in cyberspace, where commercial transactions are made between unspecified numbers of IPs and the general public, the establishment of electronic payment systems will further fuel the Multimedia Revolution. To facilitate recent developments in multimedia, it is desirable that payment systems should have a broad user base, guarantee anonymity and be available to smaller IPs, in addition to the fundamental requirements of high security and profitable payment costs.

To respond to these requirements, technology start-ups have been rapidly generating new ideas in various areas. For example, new payment systems that have attracted much attention from the media include 'DigiCash', 'CyberCash', 'First Virtual' and 'Mondex.'

2. Various new ideas for electronic payment

Much trial and error is involved in establishing an optimal payment system for on-line transactions. Many payment options are now available. They can be divided into two groups: application of existing financial systems and totally new systems developed specifically for on-line use.

Application of existing financial systems

- Utilization of telecom billing systems (phone, VAN, etc.)
- Credit card
- Encrypted credit card
- Credit card-based intermediary services between credit card companies and users/IPs

Systems developed specifically for on-line use

- E-cash (open): can be used between individuals and corporations and converted to money
- E-cash (closed): can be used only in a specific community, and issimilar to using a prepaid card system

(a) Utilization of telecom billing systems

As for on-line transactions of information, telecom service providers have been undertaking billing activities for IPs, using the existing billing systems for phone/VAN. The most notable examples are Dial Q2 and Videotex. In particular, Dial Q2 has attracted much media attention for its billing system which leverages a phone company's billing system. Under this system phone companies charge their subscribers for usage of Dial Q2 services, in addition to line charges. This system was convenient for both users and IPs, and the volume of transactions, with NTT alone, totaled about 270 billion yen at the end of 1993, of which commission fees are approximately 24 billion yen.

However, the billing system was beset by difficulties. For instance, some users of Q2 services were not also subscribers to the phone company. Other users were astonished that their bills were so high since they did not realize that Dial Q2 services were so much more expensive than traditional phone usage. In addition, the risk of bills being unpaid was high since no law specifies who should be responsible for payment. Furthermore, it is only possible to charge according to volume of usage by using the phone billing system.

(b) Credit-card-based settlement

This method is used by router network services such as Nifty in Japan or American Online and CompuServe in the U.S. All the required activities, from signing-up with a service to bill settlement, can be done by using the existing credit card payment systems and PCs. Moreover, some major router network services in the U.S. provide catalog shopping services with a wide variety of products. Their users can not only deliver or receive information, but also order and pay for products on-line using the following procedure. First, users input their credit card number (or code number) and confirm it over the phone with their router network service companies. Then the cost of the user's purchases through on-line shopping will be withdrawn from his card account according to the same process used for a regular off-line transaction.

For off-line transactions, credit card payments account for 30 percent of consumer transactions. However, credit cards are not likely to be widely used in cyberspace until several problems are overcome:

- **Convenience**

Credit card based settlement services target adults who are eligible to become card holders. However, credit card payment services cannot be used by children, major users of the new and growing area of "Edutainment." In addition, many IPs are individuals or start-up companies whose future is difficult to predict. Thus users are unable to settle payments by credit card

- **Payment cost**

If the user purchases a small amount of information every month, or pays only a basic charge, the credit card company may not be able to break even. For credit card companies to become profitable, their minimum requirements are that the monthly charge must exceed

3,000 yen and the charge per transaction, 2,000 yen. It is uneconomic for IPs to pay a high commission fee to the card company for each inexpensive use of its software service.

- **Maintaining security**

In the case of the catalog shopping service provided by American Online, the user can select his purchases and immediately make payment by inputting his credit card number. However, the user risks having his card number stolen. The risk of doing on-line shopping through the Internet, which is more open than usual on-line networks, is more serious and harder to overcome.

Over the Internet, your card number or code number is delivered to the IP of your destination through a relay method across countries. To prevent your number from being stolen and abused on the way to its destination, you are required to inform the catalog company of your card number over the phone. Currently, it is almost impossible for you to send your card number directly over a network, particularly on open networks like the Internet.

(c) Payment through encrypted credit cards

One way of overcoming this problem is scrambling card numbers so they can pass safely on electronic networks to credit card companies. Credit card companies and software houses are already working to design a system using encryption technology. One of the most notable examples is the navigation software developed by Netscape, a software vendor for the Internet. Already, 60 to 80% of 300,000 Internet subscribers are purported to be using this software, which is equipped with an encryption tool, Secure Sockets Layer (SSL), through which card numbers are automatically encrypted when input/transmitted by software users. This technology drastically reduces the risk that card numbers are hacked or deciphered over networks. Apple, IBM, MCI, Bank America, and many other credit card companies have adopted this technology, which is quickly becoming the industry standard. While some may argue that any code can be decoded, Netscape's technology has taken us a giant step further toward establishing the security level required for encrypted credit card-based payment.

(d) Payment support services

As previously noted, existing credit card-based payment systems have numerous limitations, including the restrictions on credit card-based sales when the IP is an individual or a small company, the relatively higher settlement cost of small payments, and vulnerability to crime (hacking and abuse of card/code number). To resolve these issues, First Virtual Holdings Inc., a financial service company that has an office only on a network, set up a support service last year.

What is the payment-support service provided by First Virtual like? First, users register with First Virtual and receive I.D. numbers in exchange for their card numbers. When they want to buy something electronically, they simply supply their I.D. numbers to the IP. The IP transmits the user's I.D. number and the bill to First Virtual. Once the user's individual purchase is confirmed, First Virtual charges the user's credit card company the total purchase amount per month. When individual IPs want to sell their information over the network, they can sell through their I.D. numbers without registering with a credit card company. First Virtual takes 50% of the transaction fee that the IP pays to the credit card companies as transitory income.

This service has increased the security level of transactions over electronic networks as well as reduced processing and transaction costs for credit card companies - a development that signals the dramatic expansion of potential markets for credit card-based payment on electronic networks.

Let's look at new electronic payment systems, also known as "electronic currency," an "electronic wallet" or "digicash." These require a new financial system that functions only on electronic networks. Electronic currency is a fairly new concept whose definition is still being debated, even among professionals. For our purposes, however, we can say that it consists of two elements: 1) electronic cash (open), which can be used just like real money, distributed nationwide between general individuals/companies and converted to money; and 2) electronic cash (closed), which can be used only in limited areas, such as a certain community, and which functions more like a prepaid card.

(e) Electronic cash (used on open networks)

Typical examples of "open" electronic cash include "ecash," "Mondex," and "Danmont." "Ecash" is an operation software for electronic currency launched by a software house, Digicash. "Mondex" and "Danmont," which are promoted by financial industries in Europe, grew out of a need to reduce social infrastructure costs. These systems provide checks or coins that can be handled electronically to reduce bank/retailer check processing costs and bank branch network costs.

Mondex

Mondex money uses IC cards as an intermediary and can be freely deposited and withdrawn. It is now being promoted by such players as NatWest, BT and Midland Bank. Users can load any amount of money onto their IC cards from their bank accounts through ATM, IC public phones, or their own terminals. The advance payment loaded onto their IC cards can be widely used for payments to public institutions, such as public transport, local retail shops, or entertainment facilities. Merchants or service providers who receive electronic advancement payment through IC cards can instantly transmit the amount to their accounts. In this system, the transmission of E-money, between either individuals or businesses, does not involve banks.

If public/mobile phones could be used as an ATM, busy consumers would enjoy greater convenience. What's more, financial institutions would be able to reduce costs required for branch-network operations, ATM maintenance, check processing, money transfers, and so forth. Not all retailers or businesses will be willing to accept Mondex money in the near term. However, after this system was piloted in the U.K. in July 1995, it spread across the country in a matter of months. The IC card can be put into a terminal and used for electronic payments as well. In this way, Mondex offers an integrated payment system that handles both on-line and off-line transactions.

"Ecash"

"Ecash", invented by DigiCash in Amsterdam, translates into E-money and its operation software. DigiCash eventually plans to focus its business on providing software to licensees, leaving the actual issue and operation of ecash to financial institutions. The mechanism works as follows:

First, the bank, end user and IP introduce "ecash" software and its operation scheme. The functioning of the overall mechanism resembles that of a checking account. The end user opens an account with the bank. The requested amount of "ecash" is loaded over the network onto the user's computer by the bank, much as a user withdraws needed cash from a bank account. The user electronically pays the amount charged for his purchase of information, etc. out of the loaded "ecash" to the IP. The IP electronically transfers the received "ecash" to the bank. Finally, the bank transfers the cash to the IP's account. To clear the security level required to prevent counterfeiting or to distinguish between the "genuine article" and an imitation, DigiCash's "ecash" is embedded with encryption and electronic signature technology. At present, "ecash"' is not assigned any monetary value, and is undergoing a "dry run" over the Internet.

"Mondex" and "ecash" offer greater convenience, just as cash does: they are available to any user and protect detailed information on users' purchase records from third parties. Moreover, the operation cost is low since everything is processed electronically. On the other hand, building and maintaining the social infrastructure required to support "Mondex" and "ecash" will be a major challenge. Isn't electronic cash equivalent to money? In what way are payments in electronic cash regulated by the Foreign Exchange Control Law in the borderless electronic world? These and other issues must be addressed and clarified.

(f) Electronic cash (used on closed networks)

"Closed" electronic cash can be used between individual partners in specific systems and cannot be converted to money. In the off-line world, "electronic quasi-money in closed systems" based on IC card systems have already been established in some communities, including the shopping mall of Yokohama Landmark Tower. Also, in the on-line world, it is possible for gateway service providers to establish original payment systems that may be similar to prepaid systems. In light of these developments, Mizuki Corporation created a monetary unit (lot), which it used in the 'Virtual City' the company on a PC and on-line network. Mizuki's 'lots' are more like the coins inserted in machines at video arcades. At least for now, these lots can neither be purchased with money nor converted to money. However, 'lots' have been invented so that they can be virtually converted to real money or goods. In the not-too-distant future, it is very likely that consumers will be able to buy 'lots' with cash like prepaid cards. It is also likely that 'lots' will become "currency" that can be exclusively used in the Virtual City marketplace. In this case, additional services should be established, including conversion or transfer services between retailers such as Mituskoshi and Takashimaya. With the precedent already established in the off-line world, electronic currency appears to have major potential to be used widely on on-line networks. Future challenges include: 1) identifying appropriate prepaid systems, 2) building and maintaining social infrastructure, including the establishment of financial services such as cashing services for IPs participating in electronic cash systems.

3. Perspective for On-line Payment Systems

Which of the above-described payment options are likely to become mainstream in future? The direction of payment system evolution will probably depend on a combination of factors: convenience to users, easy access to the system, and the business opportunities each system offers its provider. Let us now examine the likely development of payment systems from the viewpoint of consumers, IPs, and payment system providers, such as financial institutions.

First, considering the extension of user bases that can be covered, credit card-based payment systems are, as previously stated, not suitable for children. However, automatic fund transfer and utilization of telecom billing services may result in lending losses for lead payment system providers. For this reason, ways should be found to provide electronic cash, which functions like a prepaid card or cash.

Second, let us consider those issues related to payment cost, including the economics of a payment system for its provider per value of settlement and users' needs for payment systems. For the time being, major transactions on networks, like trading digital information or selling a small amount of information, will involve relatively marginal payments. In these purchases, credit-card-based settlements that involve cost per transaction will naturally become less profitable and less attractive to credit card companies, giving rise to the need for companies that integrate the customer's transactions and electronic cash (open), like First Virtual Holdings. On the other hand, to settle big-ticket purchases made through emerging electronic home shopping, credit cards will be definitely needed because of consumer needs for spread or deferred payment options.

Third, people looking for specific information, such as adult entertainment (which, incidentally, stimulated the development of the video industry and the Dial Q2) often seek anonymity. Some consumers are inundated by direct mail sent by various databases. It is natural for these consumers to feel anxious about the kind of services provided by credit card companies or companies like First Virtual who can obtain every bit of data on individuals' utilization status. Given consumers' needs for anonymity, there appears to be substantial room for the growth of electronic cash (open), which functions just like cash.

Not all these payment options are needed from the beginning. Appropriateness of payment system depends on network environments - *closed* (Nifty, American Online, etc.) or *open* (Internet) - that determine the possibility for each payment system to be installed, the credit risk accompanying a transaction, the required safety level and the possibility of mutual confirmation of identification between IPs and users.

Take **open networks** like the Internet, for instance. Since neither IPs nor users can control "who" is coming in "for what", credit risk is very high, and payment cannot be made on subsequent days via checks or transfers. Overall, there are three major constraints on payment systems for open networks:

- People happen to meet each other and engage in payments over the Internet. Under these circumstances, those payment methods, including electronic funds transfer or utilization of telecom billing systems, are not applicable.
- Given the vulnerability of the network to hackers and other criminals, no non-encrypted credit cards can be used.
- Transactions on the Internet require no membership. Payment system providers need to assign individual IDs that enable mutual confirmation of identification, just like credit card-based systems.

Considering these constraints, payment systems on open networks require encrypted credit cards, financial services provided by, say, First Virtual, and electronic cash.

On the other hand, on **closed networks** (Nifty, American Online, etc.) where individual users make a contract to use the network, payments only occur between companies and their members or limited IPs and members. For this reason, requirements for payment systems are relatively lenient, as discussed below:

- When establishing subscriber contracts, the network operator can, to some extent, select individuals. Credit risk and mutual identification-related issues are relatively minor, compared with those on open networks like the Internet.
- Which payment method to be used - automated fund transfer or utilization of telecom biling systems, etc. – can be agreed and contracted beforehand.
- Direct transactions with network service providers by phone make hacking more difficult
- Payment system providers do not need to provide IDs in addition to registered membership numbers.

In the closed network environment, IPs and gateway service providers are able to select the most appropriate payment method for each individual member based on his credit strength. These include automated funds transfer, original prepaid methods, and credit cards.

Conclusion

The multimedia revolution led to the advent of electronic commerce, a new commercial channel. It seems to be inevitable that new electronic payment systems will be created and established to facilitate electronic commerce transactions. It is important to consider the implications of establishing payment systems on electronic commerce networks for players who do business with general consumers (retailers, makers who manufacture/sell their own products) and financial institutions that sell personal financial services.

In the emerging electronic commerce channel, the key strategy will be collecting and accumulating consumer information and effectively using the information for the development and marketing of new products.

The establishment of superior payment system on networks will dramatically change traditional methods of trade or sales/marketing. In addition, it will determine the growth potential of new electronic commerce which could provide totally new business opportunities. However, to establish payment systems on a network, particularly issuing electronic cash, multiple issues need to be resolved.

Technical Innovations, Policy and Strategy [75]

Robin Mansell

Head of the Science Policy Research Unit's Centre for ICT, University of Sussex, UK

The security of advanced information and communication networks is an issue which has received unprecedented public attention in recent years. This is due both to the need to provide security for sensitive data within organisations and the need to protect data in increasingly complex global network environments. Security and encryption techniques are pivotal for the development of electronic trading networks of all kinds and debate is focusing on new applications and implementations of encryption. In the absence of major advances in the techniques available to secure networks, electronic commerce may fail to expand globally to encompass all sectors of the economy. This paper reviews developments in the use of a range of technical means of securing advanced information and communication networks and assesses their implications suppliers and users.

1. Securing Electronic Networks and Security Evaluation

There are increasing risks of data interception as digital communication networks become more widely diffused. In many cases, however, the physical security of the network is a less pressing problem than the organisational problems of conducting adequate security audits, instilling appreciation of security issues, and dealing with the ever more widespread access of 'authorised' personnel to secure information. Some security problems may be addressed

---

[75] This paper draws upon R. Mansell and W. E. Steinmueller (1996) 'The Way Forward: Socio-Economic and Policy Issues & Advanced Communication Technologies and Services'. A report for the European Commission ACTS FAIR Project AC093, 5 March. Contributions by Arthur Oppenheimer, Independent Consultant and David Sayers, Independent Consultant are gratefully acknowledged. The views expressed in this paper are those of the author and not those of any organisation or institution.

through the use of 'end-to-end' encryption. Encryption, however, also presents difficult organisational problems involving the agreement to common standards and procedures for the transfer of 'keys' among users. Substantial challenges remain in developing a level of security that will encourage broad public trust in the safety, reliability, and confidentiality of the information infrastructure at a cost which is acceptable to suppliers and users of advanced networks and services.

The technical architecture of today's digital networks enables a variety of new forms of uninvited intrusions into private communication. Eavesdropping on normal commercial telecommunication transmissions while they are in transit requires specialised equipment. De-multiplexed communication channels are easier to handle in terms of interception; but the high capacity of modern transmission methods means that the final de-multiplexing is often on, or near, the final point of network access so that any public channel would contain a jumbled series of communication channels. In addition to the entry and eavesdrop approach, other forms of corruption of network security are becoming possible. They rely on the use of general purpose computers, typically running a commercially available operating system. These computers are open to 'normal' security attack methods and their defence relies upon the methods available to commercial information and communication technology users.

The use of digital control methods for all forms of telecommunication introduces a form of data about telecommunication use which, until a few years ago, was not available. Name-linked data about an increasingly large set of individual actions will be created and stored digitally. This class of data about transmitted data is called *metadata.* Metadata are generated throughout the information infrastructure. For example, data on mobile telecommunication cell transfers provides location data, approximate with the present cell size within a few kilometres. With micro- or even pico-cells, the fineness of this location data will 'improve' and may come to be regarded as an invasion of privacy.

'A chain is as strong as its weakest link' is a truism often applied to security systems and their management. The chain model points to the importance of balancing system defences across the whole of the system. Management usually requires measures to balance economic resources to protect against network intrusions. For example,

- A meaningful transmission can be coded so that it is decoded easily only by those sharing the secret of the code-decode process. This is the basis of the practice of cryptography. The *minimal cover time* of a security system is the shortest time for which a particular system will resist a well-informed attack.

- In applications where the main threat is believed to be a commercial loss, this idea can be extended, intuitively at least to a *minimal attack cost,* the cheapest way of assembling the know-how to effect penetration.

- Some security systems need the combined know-how of several staff, co-operation, etc. to operate, dismantle, disable or suborn; giving rise to the concept of a *minimal attack team size*.

Most security measures fall back on 'conformity to best practice' which guarantees nothing more than being subject to the weaknesses of the market leaders. Verification of the security of a complex, multi-component system, such as a telecommunication system, is possible using a branch of applied mathematics called probabilistic safety assessment using fault tree analysis. It is slow, needs highly skilled engineers and applied mathematicians, and requires a great length of time because of the need to analyse the interactions of all the sub-systems of the system in conjunction in normal operational mode and with abnormal functions of parts of the whole, in combination. The global telecommunication system is the largest man-made system in existence. A thorough security review in a 'safety case' manner could take a long time to complete. Yet over 30 per cent of the products made by the holder of an approximate 60 per cent share of the European GSM market, Ericsson, are less than three years old.[76] Technological innovations do not allow such a high level of security assurance to be offered.

2. Security and Commercial Environments

Encryption is already an integral part of many electronic and communication systems and as private networks merge into the larger world-wide public networks there will be an increasing need for encryption systems that can be trusted and easily implemented. Encryption is not just the coding or scrambling of messages. As well as ensuring that a message is delivered without interception, there are other important requirements for the secure commercial use of telecommunication networks and applications. These include authentication, copyright protection, unrepudiability, and legal validiity. There is a comparatively limited number of encryption techniques which can be employed. These can be variously combined and implemented, but common patterns of security and implementation are visible.

Security and secure systems are focused on those areas where security is seen as necessary and encryption is seen as a specialist area, relevant only to those applications where it is considered to be an initial design parameter. Those systems which have been seen to require security appear to have security implemented as part of their *initial design specification*. Examples include ATM (Automatic Teller Machine) networks and government and security environments where the security of the information and the need to preserve confidentiality of information is seen as vital. In other areas such as EDI, bank clearing, foreign currency

---

[76] L. Ramquist, President of Ericsson (1994) 'Innovation Generated by Professionalism, Respect and Perseverance; The 1994 UK Innovation Lecture' London.

interchange and settlement, and the suppliers of third party specialist networks, encryption is not regarded as necessary and is therefore not implemented. In some cases, the potential threats to security are not recognised as users have acquired great confidence in the use of electronic networks.

Data which remain within an organisation's private computer system can be protected by internal systems, passwords, in-house monitoring, and supervised using monitoring and audit tools. Access can be restricted to specific groups, single sign-on systems can be mandated and, should an attack or loss of data occur, it should be possible very swiftly either to tighten the controls and identify the culprit or increase the audit trails. The moment data leave an organisation the protection offered by in-house security, however incomplete, disappears.

With older closed financial networks the suppliers could demand and specify all aspects of the system including hardware, software and communication protocols. This gave them end-to-end control over the system design and operation and enabled users to feel secure. Today's vision of a global seamless open network generates fears of loss of data and control.

Several major trends are influencing public trust and confidence in global networks. Organisations are converting private networks to interconnect and interoperate with public networks and audit trails are much more complicated and difficult to implement. Re-engineering networks to close security holes which emerge after implementation is expensive and time-consuming and it is difficult to rebuild user confidence. It has proved much better to build security into the initial design.

The security of Internet transactions brings the need for an open system available which is non-proprietary and accepted by the majority of service suppliers, information providers, card companies and financial institutions. For the credit card companies a single solution has many advantages. Visa/Microsoft and Mastercard/Netscape/IBM announcements towards the end of 1995 promised co-operation in the definition and production of a standard open specification for secure trading on the Internet. However, as of January 1996 there was confusion between the two consortia as both parties have published a secure trading specification and wish to make it the *de facto* industry standard.

As more trading and commerce occur through advanced communication networks there is an increasing need for speedy, secure, reliable, and available payment systems. An alternative to the credit card based systems proposed by Visa and Mastercard is 'Electronic Cash'. One example is Digicash which employs cryptographic digital signatures to generate cash anonymously. It is this anonymity that concerns opponents of the concept. Money currently can be traced - the tax systems and banking regulations of most countries insist on this as part of ensuring legitimate actions by individuals and adherence to corporate tax law by commercial organisations. Many countries impose severe limitations on the handling of large amounts of physical cash in order to try to prevent the black economy, money laundering and illegal drug profits from entering the financial system. Large-scale availability of anonymous digital cash flowing through a global network threatens this structure.

The protection of copyright material involves handling digital rights, access and transmission. Many organisations in the publishing, performance, communication and electronic publishing fields are collaborating to produce systems which will provide guaranteed security and control of information usage. The techniques of public key cryptography are being used to address some of these issues. The Cryptolope is a method which provides an integrated system embracing the payment, distribution, copyright and security issues that concern the availability of copyrighted information on public communication networks.

An encryption package called Pretty Good Privacy (PGP) encrypts e-mail and data. PGP is one of the most widely available and popular encryption packages used on the Internet. PGP was designed and implemented to enable public-key cryptography to be freely used across a wide spectrum of computer platforms and applications.

Existing ATM networks operate both individually and in partnerships linked to banks and financial service institutions to provide secure networks handling many millions of daily cash withdrawals. These communication networks tend to employ leased lines or X.25 communication links. They rely on hardware protected devices for cryptographic security. Messages within an ATM network comply with international or banking standards and the only data that are encrypted tend to be the PINs (Personal Identification Numbers).

3. Institutional Responses

Most leading-edge network security technologies were available ten years ago, although cryptographic techniques have advanced a little since then. The perceived need for their use has grown immeasurably as a result of international electronic trading, electronic mail, Internet applications, and technical improvements in the cost-power ration of information and communication technology equipment. In the future it is expected that a variety of means of securing networks will offer the possibility of extending private networks into the public domain.

This is unlikely to occur in the absence of widespread changes in institutional practice. Many of the key problems concern the institutionalised means of establishing and maintaining trust relationships among those involved in information exchanges and electronic transactions. National laws and international agreements which have been regarded as satisfactory when networks were either private or restricted to national or industry sector frameworks are being challenged by innovative technologies and applications, many of which are in their infancy. The alliances and partnerships between information technology and communication companies are mirrored in the encryption and security business.

The most appropriate form of encryption that should be designed into advanced communication technologies and services depends on analysis of industry factors; security requirements imposed by legal and regulatory conditions; originating and receiving environments; value and content of the transmission; transmission frequency and the need for recording, confirmation, etc.; ability to place tamper-resistant security at end points and gateways; key management possibilities; and network constraints.

These issues all relate to the problem of unambiguously identifying who it is that is gaining access to data or is receiving or transmitting communication. At a minimum, addressing these issues will require substantial linkages among personal data files to assess credit quality and authenticate access. Thus, even with new standards for the protection of the use of personal information files there will be growing pressure to permit access to these files for commercial purposes and to compel users to release substantial amounts of personal information so that they can participate in electronic commerce.

4. Conclusion

It seems appropriate to accept the premise that all applications need to be submitted to a full security audit. Cryptographic tools can then be added as appropriate. However, the costs of achieving security requirements in open networks have not been fully assessed. Nor have practical means of implementing alternative means of securing networks been achieved within the normal time frames available to competing suppliers of advanced communication technologies and services. The following issues need further consideration:

- From what environment is a particular type of electronic commerce transaction initiated?
- What security threats are important to the economic viability of electronic commerce?
- How do the security threats balance against the costs of security?

The Development of an Institutional Environment for Electronic Commerce

Takashi Uchida

Professor of Law at Faculty of Law, University of Tokyo

The expansion of electronic commerce has the potential to fundamentally transform both the structure of markets and the framework of corporate organization. Today, when developed countries have entered a mature phase of economic growth, the need to increase business efficiency and also to expand transactional opportunities has made it difficult to resist the transforming current. However, whether this transformation will progress smoothly depends on the state of the institutional environment. In particular, insofar as a feature of electronic commerce is that it is not confined within national boundaries, it will be necessary to maintain international harmony as we proceed with provision of an institutional environment for electronic commerce. This paper focuses on the provision of an institutional environment as an issue that is posed by the expansion of electronic commerce.

Three Types and Four Stages in Electronic Commerce

Electronic transactions are many and varied, and the institutional issues they pose are not identical. Ordinarily they can be divided into the following three types, according to the parties to the transaction and the mode of formation.

First, EDI transactions associated with **closed** networks between specific **corporations** (Closed EDI). A classic example is the manufacturer and retailer who are directly linked through ECR (Efficient Consumer Response)-type electronic commerce.

Second, electronic commerce in which **corporations** can select transaction partners from a range of unspecified corporations **within a network** (Open EDI). For example, in the manufacturing sector, this kind of Open EDI is sought in order to procure cheap materials from around the world.

Third, **consumer** transactions occurring **within a network** (Electronic Mall-type consumer transactions). Consumer transactions that use the Internet are already occurring, but there is a strong likelihood that with the expansion of users connected directly to networks, and the development of Electronic Mall stores, this kind of transaction will expand rapidly.

These three transaction types represent, to a certain extent, the order in which electronic commerce has developed and at the same time responded to institutional problems which emerged during the process of expansion. Below I consider the growth of these institutional problems by dividing them into four **stages**.

Stage One

Electronic commerce began as Closed EDI. At the time, individualized communications networks were established through a series of links between specific corporations. At the very earliest stage of electronic commerce the first institutional issues revealed were the problems accompanying the shift to paperless transactions. In other words, legal systems that had been developed with paper-based transactions in mind were identified as potential obstacles to electronic commerce and the central question was how to remove such obstacles. Typical problems included how to deal with the legal concepts of writing, signature, originals and preservation of records in an electronic environment.

In principle such problems ought to be dealt with under the domestic law of individual countries. However, when electronic data crosses national boundaries it must abide by different regulations, and this hinders the global expansion of electronic commerce. For this reason, an UNCITRAL Working Group commenced work in 1993 on drafting an internationally uniform Model Law that would address this problem. The draft of the UNCITRAL Model Law on EDI is now largely complete, and it is hoped that it will be adopted at this year's General Meeting of UNCITRAL. In all it comprises just 14 provisions, and embodies the minimum rules necessary for removing the problem of legal impediments to electronic commerce.

What was really brought home to us in the course of Committee work on this Model Law was the difficulty of unifying the commercial laws of various countries. Considering

UNCITRAL's mandate, the focus should have been restricted to international transactions, but in light of the peculiar characteristics of electronic commerce, we decided to draft a Model Law that did not distinguish between international and domestic transactions. For this reason drafting the Model Law became that much more difficult. We spent three years just reaching agreement on these rules, and we anticipate more difficulties when it becomes legislation in each country. When we consider this kind of difficulty, it seems prudent not to rely solely on legislation to remove institutional impediments, but to look for alternative strategies as well.

From this perspective, ***Electronic Notary Systems*** is a valuable case to bear in mind. At the first stage of development, many institutional problems originate in the fact that electronic data, unlike paper documents, appears comparatively simple to tamper with. Technically even if it is possible to create electronic data that is harder to forge or falsify than would be a document, the problem is the difficulty in proving that the electronic data in question has been stored in a state that protects it from forgery or falsification. One effective means of avoiding this difficulty is to establish a so-called Electronic Notary System. On the Internet there is a commercial corporation already providing this service and it would be worthwhile to consider its establishment as a public system in some circumstances.

Stage Two

Within Closed EDI, in order to expand the possibilities for tie-ups between corporations which are linked through a network, standardization of communication protocols and business protocols is necessary. The trend toward standardization has made people realize that, from this point onwards, EDI is the infrastructure for transactions between corporations. In particular, the standardization of business protocols that can be seen in UN/EDIFACT can be expected to change the structure of markets and as it does so, standardize industry transaction practices. This will inevitably provoke numerous problems, both legal and practical, particularly in markets such as Japan that have complex distribution structures and numerous variations in commercial practices between industries.

For example, when standardization of transaction forms involves cost, and smaller, weaker corporations cannot absorb the burden, they are likely to excluded from the network. In some cases, this may be regarded as an `unfair business practice' of the kind that would breach the Antimonopoly Law. While it may be that the movement toward standardization is inevitable, the issue of how to bolster the ability of industries to cope with electronic commerce is an important one for economic policy.

Stage Three

Even within Closed EDI, the number of parties connected to a common network is increasing. The trend toward electronic commerce extends not only to contracting but also to distribution of goods and settlement of accounts (Financial EDI). In this way, when we reach the stage of completing the so-called "EDI loop", the effects of any breakdown in the network become that much greater. The same problem occurs on a larger scale once electronic commerce expands into Open EDI and Electronic Mall consumer transactions.

In Open Network-type electronic commerce (Open EDI/Electronic Mall consumer transactions) computer networks are not merely a means of sending information; they are virtual reality. They represent a new world, in which it is possible to build malls and open retail businesses. Commercials are shown, negotiations proceed, goods are transported, and banks open retail shopfronts.

However, computer networks involve a variety of latent risks. The risk that the data you send does not arrive; the risk that the data changes form; the risk that a third party deliberately attacks the data; the risk that the network goes down physically and many others. Because networks are vulnerable to these kinds of risks, it becomes a difficult question to determine who should bear responsibility and under what conditions, when a network party incurs damage.

Of course, a real shopping mall can also be destroyed by earthquake or fire. However, the complexity of the computer network situation is that the parties to the contract are stratified. For example, in the case of an electronic mall consumer transaction, before the consumer arrives at the store of their choice, he or she must proceed via contractual relationships with multiple parties. First is the connection with network provider (of whom there can be more than one), which is a contractual relationship. In the case of a dial-up connection, the contractual relationship with the telephone provider also intervenes. Next, when the consumer connects to the electronic mall, a standardized contractual relationship is created between him or her and the party who establishes the mall. Finally, a sales or other kind of contractual relationship is established with the desired store.

When the consumer incurs damage as a result of a reason attributable to the fault of one of the parties who form part of this strata, the question of who bears responsibility and according to what conditions is, at present, determined by a standard-form contract of which the consumer may not be aware, or by the domestic laws of particular countries. For example, where a store conducts a fraudulent transaction, whether the network provider or party establishing the mall bears any responsibility toward the consumer depends on the standard form contract between these parties, or the content of the individual country's consumer protection laws.

However, when we consider the borderless character of open network transactions, it is hardly appropriate that the measures to deal with such disputes must be governed by the choice of law in private international law, and the varied measures adopted by individual countries. Accordingly, in addition to exchanging information about the content of laws in individual countries, we also need a forum in which to debate the unification of standards. But in practice it is virtually impossible to unify domestic laws. Even in the process of drafting the UNCITRAL Model Law we considered this difficulty and avoided debate on the question of liability by deeming it to be a problem for individual countries' domestic laws. We need then, to look for choices beyond the unification of domestic law. The first would be the widespread use of standard form contracts with rational content, so we should attempt to draft and work on rational model contracts of this kind. Second, it would be profitable to put in place schemes whereby the inevitable damage that occurs is covered by insurance.

Once information about a transaction partner is accumulated through electronic commerce, processing or cross-referencing that information is simple. Protecting the amassed data becomes a question of the trade secret protection between the two corporations, and in the case of electronic mall consumer transactions, a privacy problem. The extent to which data amassed in this way can be used freely calls for an institutional response which establishes guidelines.

Stage Four

At the cutting edge of electronic commerce we see the arrival of completely new transactional techniques using an electronic medium. Those currently under debate are the electronic negotiable instrument and electronic money.

In the first instance, in the field of electronic negotiable instruments we can note that electronic bills of lading are already at the trial stage. The 1990 International Maritime Committee's CMI Rules have been adopted as legal rules governing these. Further, from 1996 the UNCITRAL Working Group on EDI has commenced work legal rules relating to Bills of Lading and the computerization of related documentation. Transfer of title, which was not the focus of the CMI Rules, might be included within this.

If this is realized, it will signify a new form of transfer of title. Technically, if we create a central registry and put in place supervisory mechanisms for the key, we can computerize an transfer of title. For example, computerization of promissory notes or checks will be possible. In this case, it will also be necessary to consider an institutional framework for protecting distribution, such as that which currently exists in relation to negotiable instruments.

By utilizing encryption technology, it is possible to transfer titles electronically without using a central registry. The strongest possibility for realizing this rests with electronic money, for which practical trials have already been carried out. It will be possible to use it to transfer of large monetary amounts between corporations, but in the meantime its use for lower value consumer transactions is also recognized.

In relation to the so-called digitalization of money, we can point to the Mondex-type which utilizes smart cards, and to the e-cash type which aims at settlement of accounts via the Internet. However in each case electronic cash is simply a metaphor; how to construct this in legal terms remains an unresolved issue.

One means of resolution would be to deal with this as an analogy for the existing settlements system. In other words, if we conceptualize Mondex-type electronic money as that which has the highest incidence of use among `widely-used prepaid cards', a legal construction as an assignment of a sort of receivable becomes possible. By extension, a similar construction of e-cash type electronic money is also not without possibilities. In other words, it would be construed as a right as against the originator.

However, if this kind of construction is possible, then there should be no obstacle to construct actual cash as a right as against the state or the central bank. This, in the end, leads unavoidably to the fundamental question `What is Money?'. One of the most important functions of currency is regarded as being the finality that it brings to settlement of accounts. However, if this is a right as against the central bank, it provokes the question of how this differs from a right to savings which involves an obligation of payment , and reopens the question of what finality means.

In this sense, electronic money may lead us to open the Pandora's Box marked `What is Money?'. This will also lead us to fundamentally question the authority of the central bank to control money supply. In reality, it is also conceivable that if credit can be established within the network using electronic currency, it will invite a flood of currency that completely overwhelms the breakwater of national borders and causes disorder in the regulation of currency.

At present, legal evaluation of electronic money is taking place at the national level, but before we invite its use in a damaging way without trial, it will be necessary to create an international forum in which to debate an appropriate response.

The Role of Intermediaries in Electronic Commerce

Yoko Takeda

Jiro Kokuryo

University Graduate School of Business Administration, Japan

Computer networks provide an electronic "cyberspace" in which countless opportunities exist for the creation of new businesses. Of particular interest is their capability in creating electronic marketplaces in which commercial transactions are handled electronically.

This paper discusses the roles of intermediaries, which we call *platform businesses*, in electronic commerce. Imai and Kokuryo [1994] proposed the concept of "platform businesses," which are defined as follows: *Businesses that provide, as a private entity and in an open manner (i.e., with explicit and fair conditions to anyone who wishes to receive them), such products or services that stimulate trade among third parties and/or the creation of new businesses.* Platform businesses mediate such vital factors of commercial transactions as trust.

The existence of such players are essential in utilizing the capabilities of computer networks to match buyers and sellers who do not know each other (and therefore lack the basis to trust each other) prior to the transactions.

Figure 1 shows various types of electronic commerce. While the electronic forms of commercial transactions existed from as early as the 1960's, an emergent trend exists which stimulates a renewed interest. That is, the creation of "open" computer networks such as the Internet. Many of the old generation of computer networks, most notably those that were built in Japan under the banner of "strategic information systems"(SIS), had "closed" architecture, used only among a closed groups of firms.

Electronic Data Interchange (EDI), which adopts standardized business protocols, as well as such communications technologies as TCP/IP, provides an opportunity for realizing commercial trade over computer networks that goes beyond the boundary of the closed club of firms. Any combination of firms that adopt standardized communications protocol and are connected to an open computer network can readily exchange large amounts of information.

Computer networks by themselves, however, lack some important functions that are necessary in realizing commercial transactions. As already mentioned, most notable among them is the formation of trust. If you receive an electronic mail one day instructing you to send ten thousand dollars worth of your products, and if you knew nothing of the sender of the mail, how would you verify the financial credibility of the buyer? This is the basis for the existence of platform businesses.

Platform businesses provide, on an open computer network, functions that are essential in trade. We categorized the following five functions: (1) provision of partner search function, (2) creation of trust among trading partners, (3) evaluation of economic value, (4) provision of standardized interface, and (5) integration of functions. Platform businesses enable firms to utilize the emerging computer network as a means of commercial activities.

Figure 2 shows how platform businesses can play a role in creating trust. In a situation when trade partners regularly trade with each other, alliances are formed that employ direct contractual relations created prior to the electronic transactions. This has been the norm in most traditional EDI transactions.

On the other hand, there are instances in which a firm needs to make ad-hoc electronic transactions with a formerly unknown trade partner. To facilitate such transactions, platform businesses can create a situation in which all trade partners have prior contractual relations with the platform business if not directly with each other (Electronic Market (A) in *Figure 2*) . Credit card companies, for example, have contracts a with diverse range of consumers and merchants. This creates a situation in which all member consumers are indirectly linked with member merchants by contracts.

Without such contractual relations, consumers and merchants have to rely on the "bare legal system," just as in situations in which we walk into a store and buy a cabbage (Electronic Market (B) in *Figure 2*). Such an arrangement is often too weak for large scale business transactions.

Case studies implemented by the authors and others at Harvard and Keio Business Schools show the critical roles of platform businesses in realizing transactions that would fail in their absence. AUCNET[77] (which provides the electronic auction of used cars on a satellite based multimedia system) and Misumi (a wholesaler of dye and mould parts that actively promotes EDI) are cases in Japan.

Here we present two of the many implications of platform. The ***first*** has special significance in the Japanese context. Platform businesses and open computer networks jointly have the

77 To be accurate, AUCNET implements its service on a closed network. Thus it is not a platform business on an open computer network. It is, however, one of the purest form of platform business that the authors observed so far. We believe the lessons from the system provide many lessons for the future platform businesses in open environments.

potential for breaking the traditional keiretsu relations which can be characterized as a "closed network of firms." Many Japanese firms now face the increasing costs of domestic procurement. This is prompting them to question their old policy of owning exclusive networks of local vendors and distributors.

Computer networks seemingly give advantages to firms that aggressively seek the most capable partners globally and openly. Thus platform businesses have the potential power to transform the Japanese economy into a more open structured system. (*Figure 3*) New entrants, both foreign and domestic, that have competitive products would find it easier to enter the market.

Misumi, as an example, provide opportunities for small firms to sell to large numbers of buyers nationwide. This is an important departure from the traditional arrangement whereby typical small firms only sold to a few nearby large factories. Platform businesses allow even the small firms to sell globally and enjoy the scale economy. The flip side of this, is the reality that many buyers of their product now source globally. This eliminates the advantages of small firms that survived by their geographical closeness to the buyers. The traditional long term exclusive relations, in any case, are to be phased out.

Second, the popular notion that electronic commerce "eliminates middlemen" needs a second thought. Our research suggests that increased opportunities for formerly unknown trade partners to transact actually increases the need for intermediaries.

For example, the emergence of AUCNET nationalized the distribution of used cars that was traditionally localized. Such expansion required strong intervention by AUCNET in inspecting and guaranteeing the quality of cars. AUCNET also give lines of credit to buyers of the cars in the system. With this system, a seller of a car needs only to trust the financial solvency of AUCNET without any knowledge of the buyer of the car.

As we discussed above, platform businesses provide essential functions of trade, and thereby realizes the potential of the emerging computer networks. They are vital if we want electronic commerce to flourish. At the same time, we should recognize that the establishment of the electronic distribution systems often involve the destruction of the status quo in the respective industries. Players that enjoyed profits and created jobs may lose their grounds for business. AUCNET for example, faced resistance from incumbents that traditionally hosted non-electronic auctions.

Another source of resistance is the effect that platform businesses often have in making prices transparent. By hosting the transaction of numerous buyers and sellers, platform businesses make visible the cost and the price structure that were traditionally held secret by each player. Revelation of the margin structure often work against the industry that enjoyed excess profit through asymmetrical information structure.

Such potential resistance against the creation of platform business is the reason why we should explicitly recognize the roles they play. Rule makers in economies should make a conscious effort in removing the potential resistance against platform businesses.

A possible public policy issue with the platform businesses is their tendency to be monopolistic. This is because strong network externalities exist for platform services. That is, the benefit of the services improves as a greater number of customers starts using it.

As a platform business builds a reputation that its vendors are of high quality, the customers begin to access the service more frequently. This increases the attractiveness of the platform and more and better vendors start to gather. Now the platform business enters the virtuous circle of attracting good vendors and customers. Followers would have a very difficult task recreating such a mass. Both AUCNET and Misumi executives who were the first movers in their respective industries, were confident that they already created a sustainably advantageous position.

The authors are cautiously optimistic on this issue, since the biggest asset to the platform business is the trust that the users place on it. Unlike monopolies based on the fixed costs of facilities, "monopolies based on trust" is lost very quickly once the perception spreads that the platform business is taking advantage of the users. In this regard, the President of Misumi emphasized the importance of disclosing the company's operational data. The low fixed cost of platform businesses means that entry is easy. Thus the leader's position is solid only as long as the leader is acting in good faith.

Figure 1

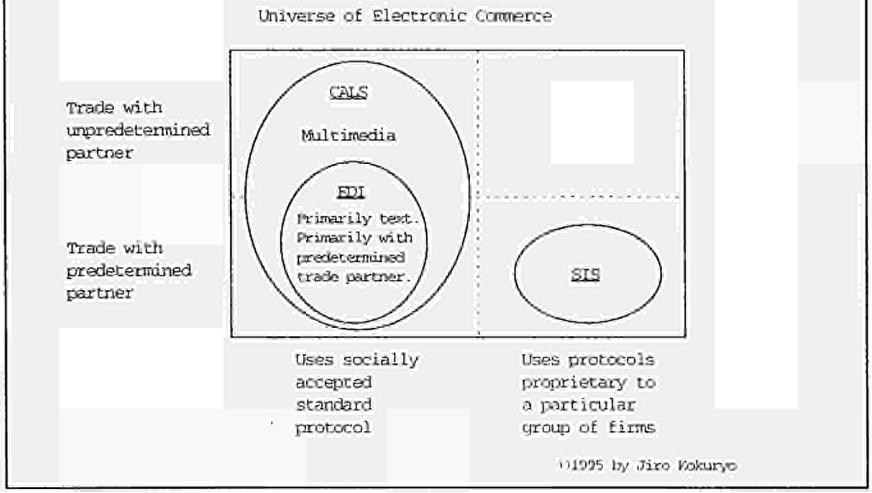
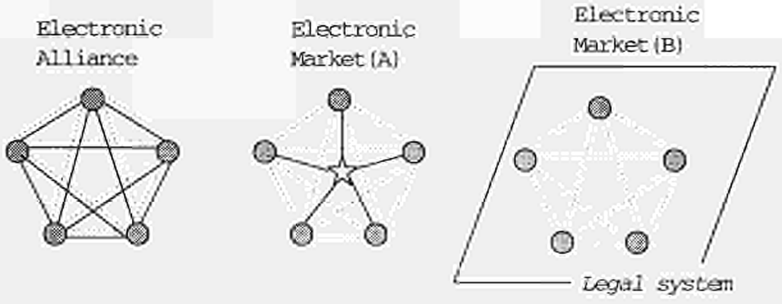


Figure 2 Forms of Electronic Commerce

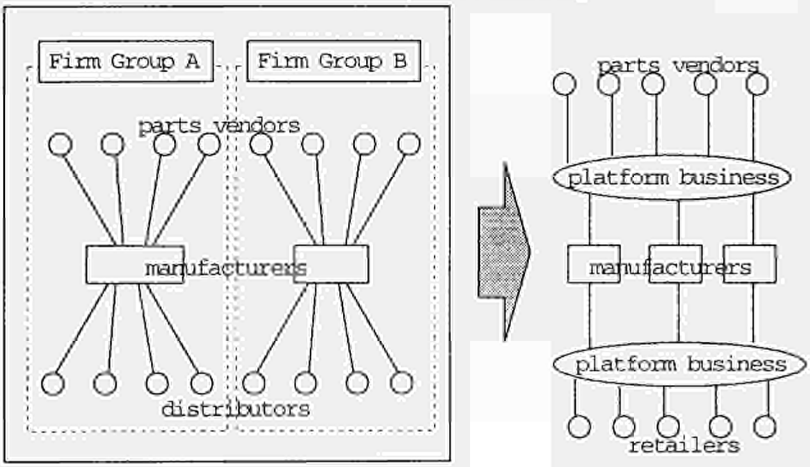


Electronic transaction contracts (arranged prior to the start of electronic transactions.

Actual buyer-seller relations.

☆ Electronic commerce intermediaries (platform businesses).

Figure 3 Platform Business and the Transformation of the Japanese Industry



References

Akerlof, G.
The Market for 'Lemons': Qualitative Uncertainty and the Market Mechanism, Quarterly Journal of Economics, Vol. 84, (1970)

Antonelli, Cristiano
Localized Technological Change and the Evolution of Standards as Economic Institutions, Information Economics and Policy, Vol. 6, No. 3-4, (1995)

Brousseau, Eric
EDI and Inter-firm relationships: Toward a Standardization of Coordination Processes? Information Economics and Policy, Vol. 6, No. 3-4, (1995)

Ciborra, Claudio U., (1993)
Teams, Markets and Systems, Cambridge University Press

Diamond, Douglas W.
Financial Intermediation and Delegated Monitoring, Review of Economic Studies, Vol. 51, (1984)

Hepworth, Green and Gillespie
The Spatial Division of Information Labour in Great Britain. Environment and Planning, London 1987

Ito, Motoshige and Akihiko Matsui
KigyouNihon-Teki Torihiki Keitai in , Ito, Motoshige and Kazuo Nishimura eds., Ouyou Mikuro Keizai-Gaku, The University of Tokyo Press, (1989)

Keen, P.G.W.
Competing in Time: Using Telecommunications for Competitive Advantage. Cam, Mass. Ballinger. (1988)

Koike, Kazuto
Ouyou Mikuro Keizai-Gaku, The KinyuKinyu University of Tokyo Press, Chuukai Riron no Shin-Tenkai in Ito Motoshige and Kazuo Nishimura eds., (1989)
Jouhou Gijutu Kakushin to Ginkou Kinou no Sai-Hensei, Kinyu-Kenkyu, Vol. 10, No. 3, Bank of Japan, (1991)

Leland, Hayne E. and David H. Pyle
Informational Asymmetries, Financial Structure and Financial Intermediation, Journal of Finance, Vol. 32, No. 2, (1977)

Malone, Thomas W., Joanne Yates, and Robert I. Benjamin
Electronic Markets and Electronic Hierarchies, Communications of the ACM, Vol. 30, No. 6, (1987)

Miyazawa, Ken-Ichi
Seido to Jouhou no Keizai-Gaku, Yuuhi-Kaku(1988)

Rayport, Jeffrey F., and John Sviokla
Managing in the Market Space, Harvard Business Review, Vol. 72, No. 6, November-December (1994)

Stigler, G. J.
The Economics of Information, Journal of Political Economy, Vol. 69, No. 3, (1961)

Monitoring the Development of the Information Society

CHAPTER 4

In order to implement policies in a timely and optimal manner a continuous review of the *status quo* is necessary. Accurate, reliable and internationally comparable statistics and indicators on the development of the information society are a vital tool for policy guidance and formulation. An internationally recognised common framework for gathering and classifying such data is therefore necessary to allow policymakers worldwide to monitor and compare progress as the information society is realised.

Michael Minges and **Tim Kelly** examine the difficulties of measuring the precise economic impact of the information sector which is increasingly important for economies as we shift from the production of commodities to a more nebulous informatised economy based on the exchange of intangible goods and services. The definition of the information industry from a statistical perspective is itself problematic, since the major industries involved in processing and distributing information - telecommunications, broadcasting and computing - have traditionally been analysed separately, and in most cases international statistics agencies fail to adequately cover these sectors. The authors review some of the efforts of a number of OECD countries (Canada, Japan, the EU) to measure the economic impact of information and report on their findings. Turning to information services trade, in the absence of official statistics, the authors recommend basing estimates on telecommunication services trade (in terms of both international telephone traffic and foreign direct investment, e.g. acquisitions) and overseas computer sales. Finally, Minges and Kelly explore various impacts on employment in the information sector. They refer to the significant job losses experienced in the capital-intensive information-communication companies worldwide where employment has declined by 2.2% since 1992/3. Although new operators and services provide employment, the authors point out that this does not offset the large cuts made by the previously state-protected incumbent.

Mika Kawachi argues that in the light of different practices in data collection and classification across the OECD area, a common framework for GIS indicators and standard definitions needs to be developed in order to help policy makers to formulate policies, monitor and compare progress, and assess the effectiveness of regulatory reforms. Ms. Kawachi makes an initial attempt to internationally compare GIS developments according to an experimental framework using currently available data from five selected countries: France, Germany, Japan, U.K., and U.S. Ms. Kawachi concludes that the development of indicators for the GIS requires broadening the scope along two dimensions: the integration of computing, communications, and content sectors (vertical convergence), and the international dimension (horizontal expansion). At present, national statistics tend to emphasise vertical convergence within a country whereas international statistics provide international comparisons but for a specific sector such as telecommunications. Ms. Kawachi concludes that to overcome such limitations, international efforts should be initiated in developing a comprehensive set of indicators that sufficiently captures both dimensions along the lines of her proposed GIS framework for international comparison.

Olof Gärdin explores the difficulties in developing a statistical frame of reference which includes concepts, definitions, variables, data collection and survey systems necessary to understand and measure the information society. Many of the difficulties in establishing such a framework, argues Gärdin, are related to the nature of information itself: it is immaterial, it can be used and re-used in different places simultaneously - it is not consumed or worn by usage. The existing system's frame of reference is the industrial economy which is based on material goods and is supply or production oriented. Gärdin describes the COINS project, launched by Eurostat and the European Commission's DG XIII whose aim is to establish a set of reliable, stable variables for telecommunication services. He also describes the European (Eurostat and DG XIII) proposal to revise the Classification of Products according to Activity (CPA) system, which currently does not reflect the increasing importance of mobile and other new services. A new version would structure telecommunications services so that the categories are broad enough to be more stable over time. Finally, Gärdin stresses the importance of collecting data from the user and usage side (organisations, firms, individuals) in order to trace the transfer and diffusion of technology, services and applications in society and the economy.

Fred Gault presents some of the data sources at Statistics Canada which are relevant to the Information Society. Data includes measures of the use of information products by people and the economic activities of firms that use and produce information products. As new information products enter the economy, they cause economic and social change and introduce gaps in the on-going measurement programmes of the statistical agency. Gault points out that measurement programmes have to adapt and change to provide the information necessary to address social and other issues and explains that this is part of an on-going review process. He raises a number of questions on the future role of statistical agencies and how they should look at the information society and the information economy in particular, including the social and economic impacts of change. He examines their role in the provision of data on the information society and the relative importance of official statistics, private sector surveys, and surveys of policy ministries. Gault reports on a number of statistical surveys being undertaken or under consideration in Canada. Among the issues identified by Gault for future consideration is the need to understand how the system of innovation, which involves all sectors of society, is able to capture ideas and convert them to wealth and jobs. He argues that not only is this information necessary for a single country,but it must be produced in such a way that the information is internationally comparable.

The Economic Impact of the Information Society [78]

Michael Minges

Tim Kelly [79]

International Telecommunication Union, United Nations

One paradox in understanding the Information Society is that although many agree that information is increasingly important for economies, we know so little about it. A growing number of critics claim that the traditional methods of measuring economic performance are deficient because they do not adequately reflect the impact of information.[80] Some argue that a better classification would be goods, services and information.[81] Estimates suggest that information processing functions are a large component of economic activity. In Japan, information activities are estimated to contribute 41 per cent of economic output.[82] This represents a significant transition from the production of commodities to a more nebulous, informatized economy, a movement from the tangible to the intangible.

---

78 This article is adapted from the 1995 World Telecommunication Development Report.

79 The views expressed are those of the authors and do not necessarily reflect the opinions of the ITU or its Members.

80 "But these accounts involving total output of goods and services are not capturing the full effect of such things as computer software, securities-market derivatives that vault international boundaries and advances in telecommunications technology that defy attempts at adjustment for higher quality and lower prices." See Hershey Jr, Robert. "Statistics may never lie, but they increasingly mislead in America." International Herald Tribune. 17 January 1995. p. 17. "And as information increasingly dominates economic activity, the need to value it properly will become more urgent. Otherwise statisticians' picture of the world's economy will stay distorted." See "Grossly distorted picture". The Economist. 5 February 1994. p. 75.

81 "From employment to trade, almost all of the government's economic data is based on dividing the economy into two sectors: businesses that produce goods and businesses that provide services...It makes a lot more sense to create a new statistical system designed for the Information Age. It would consist of three economic sectors: goods-producing, services and information." See "The spawning of a third sector: information." Business Week. 7 November 1994.

82 Ministry of Posts and Telecommunications. 1987. Communications in Japan White Paper. Tokyo.

1. Measuring the information sector

The economic impact of the information sector is difficult to measure. From a statistical perspective, the major industries involved in processing and distributing information—telecommunications, broadcasting and computing—have traditionally been analyzed separately. These classification differences can be overcome but a far greater problem is that most national and international statistics agencies fail to adequately cover these sectors. Statistical yearbooks have profuse agricultural, industrial, and trade statistics but sparse data on services, let alone the information industry.

A further complication is that there are no precise definitions on what constitutes the information industry. Should it include both services and equipment? Should it include non-electronic information creation and distribution industries such as publishing and postal services? The examples presented later illustrate the disparate ways the information sector is measured on a national, regional and global level.

Some countries have initiated steps to measure the impact of information industries more effectively. Industry Canada (the ministry responsible for telecommunications policy), Statistics Canada (the national statistical agency) and Canadian Heritage (the cultural ministry) are undertaking a major revision of the classification system used to standardize industries.[83] A new Information Technologies and Telecommunications (ITT) classification is proposed that combines telecommunications, broadcasting and computer services as well as the consumer electronic, telecommunication equipment and computer hardware industries. The reasons for the revision are that, under the present classifications, it is difficult to analyze the ITT industry or understand it clearly enough for program and policy development. Furthermore, the current classification does not reflect technological or regulatory changes that have taken place in ITT industries. The proposed revisions are being coordinated with US and Mexican statisticians to enhance comparability within the North American Free Trade Area (NAFTA).

As part of the revision process, the present contribution of ITT industries to the Canadian economy has been studied. The total value added by the telecommunications, broadcasting and computer services industries was C$ 22.2 billion (US$ 17.2 billion) in 1993, equivalent to 4.7 per cent of Gross Domestic Product (GDP). If telecommunication and computer equipment are included, the figure rises to over 6 per cent. The total benefits to the economy of information are higher since these measurements only reflect the value added by ITT industries and exclude information services produced by non-ITT companies (e.g., a bank managing its own telecommunication services). The ITT project aims to overcome this by measuring ITT-related activities of other industries.

In Japan, the impact of information on the economy has been monitored for a number of years. The Japanese Ministry of Posts and Telecommunications (MPT) does extensive

---

83 See Industry Canada. September 1994. *The North American Definitions for Measuring the Information Technologies and Telecommunications Industries in the 21st Century*. Working Document.

analysis into what it calls the *Info-communications* sector. It comprises companies involved in the production, processing and transmission of information and the production of information equipment. It includes the postal, telecommunication, broadcasting, computer software and publishing services sectors as well as communications, computer and broadcast equipment manufacturers. The 1992 domestic production value of the info-communications sector was ¥ 86'460.9 billion (US$ 683 billion). It is growing faster than GDP and increasingly contributes more to the economy; its share of the national economy rose from 5.8 per cent in 1980 to 9.5 per cent in 1992.[84] Interestingly, the share of the info-communications sector has fallen since 1990, a reflection of falling communication costs.

Measurements of the information sector on a regional and global level face the same limitations as national analyses. The fragmented manner in which the different industries are currently treated poses problems for arriving at a consolidated figure. Despite these methodological difficulties, sufficient data exists to make reasonable estimates. The European Information Technology Observatory (EITO) estimates the size of the European Information and Communication Technology (ICT) market to be 282 billion ECUs (US$ 329 billion) in 1994; an increase of 5.1 per cent over the previous year. It forecasts annual growth of 6 per cent until 1996.[85]

The size of the global information sector was estimated at US$ 1'352 billion in 1993. This estimate, which is drawn from a number of data sources, defines the information sector as:

- telecommunication services and equipment;
- computer software, services and equipment;
- sound and television broadcasting and equipment;
- audio-visual entertainment.

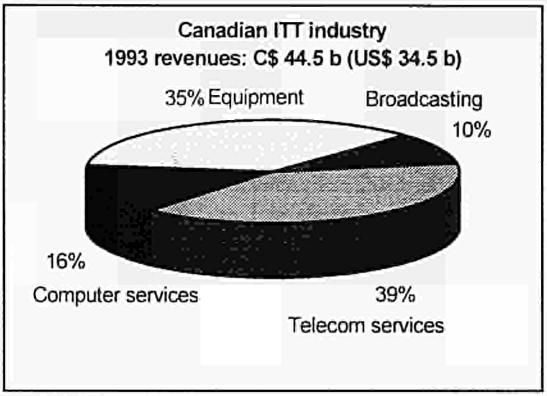
The data suggest that the global information sector is growing faster than overall economic growth. The information sector also appears to be immune to economic downswings. For example, while the global economy contracted by 3.3 per cent in 1991, the information industry grew by 6 per cent. The contribution of the information sector to the global economy is expanding and stood at 5.6 per cent in 1993

[84] See Ministry of Posts and Telecommunications. Various years. *Communications in Japan White Paper*. Tokyo.

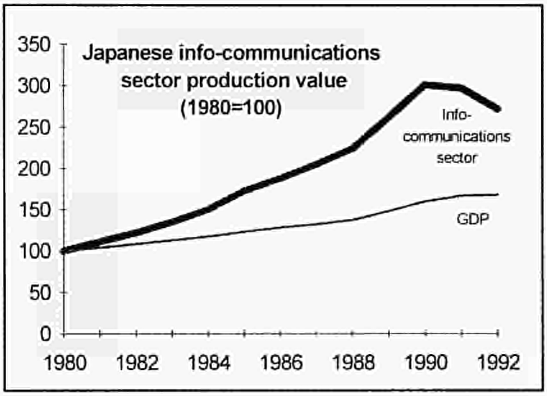
[85] European Information Technology Observatory. 1995. *European Information Technology Observatory 1995*. Frankfurt/Main.

Figure 1: National information industries

Canadian Information Technology and Telecommunication (ITT) sector revenues by sub-industry, 1993



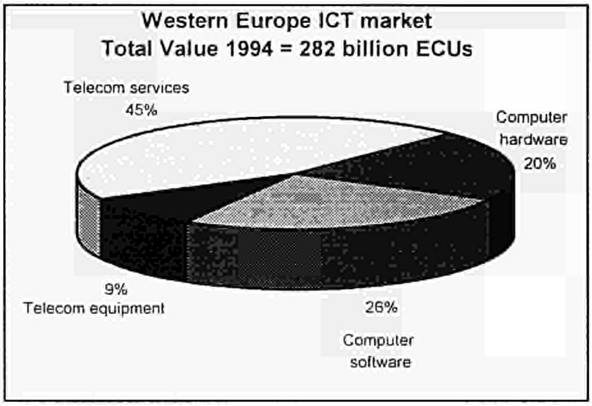
Growth of Japanese info-communications sector, 1980-92.



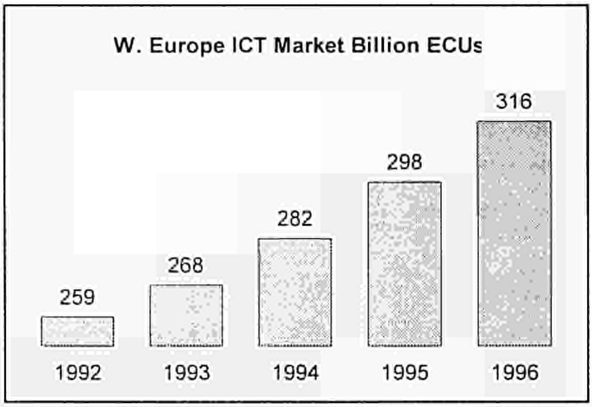
Source: ITU adapted from Industry Canada and Japan Ministry of Posts and Telecommunications reports.

Figure 2: Regional information industries

West European Information and Communication Technology (ICT) market by product, 1994



and
by value 1992-1996, ECUs



Note: Data for 1995 and 1996 are EITO forecasts.
Source: ITU adapted from EITO.

2. Information services trade

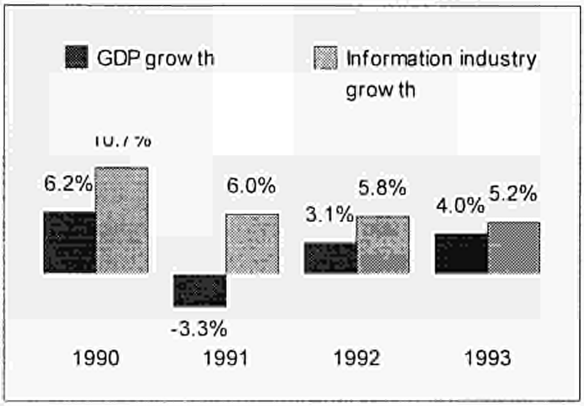
Trade in information and communication services is harder to measure than equipment trade. There are few reliable statistics on service trade flows let alone on what constitutes information-communication services trade. The scope could be enormous: it could include communication flows as diverse as electronic financial transactions, voice telephone traffic, data communications, international broadcasting and international consulting and marketing activities. It is also unclear whether the exchange of information products such as books, magazines, filmed entertainment and computer software should be classified as goods or services trade. It seems arbitrary to classify a printed book as a *good* when the text of the book can be stored on a digital computer system and traded electronically over international communication networks.

Although there are no official statistics on information-communications services trade, there are many examples to suggest it is significant:

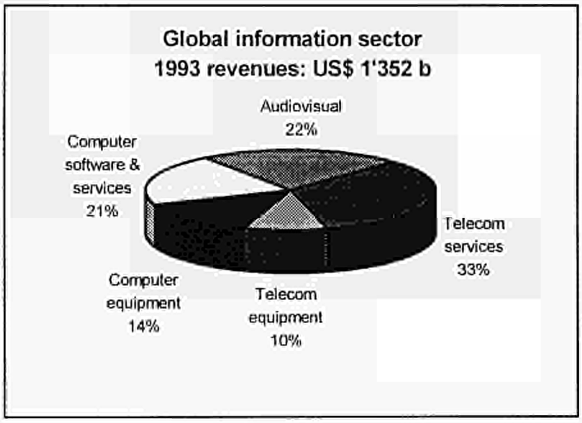
The biggest part of telecommunication services trade is in the form of international telephone traffic which amounted to some 53 billion minutes in 1994, up three-fold over the past decade. It is only recently that international telecommunications traffic has come to be regarded as *trade*. The country which receives calls may be regarded as exporting call termination services for which it receives payments. These fees have traditionally not been visible because traffic flows in both directions and, where the flow is roughly equal, no money changes hands. But increasingly the flows are not in balance. It is estimated that between 10-20 per cent of the total US$ 50 billion or so revenue generated each year by international traffic is transferred from net call exporting countries to net call importing countries in the form of settlement payments.

Figure 3: The global information industry

Information industry and GDP growth, world, 1990-93



Distribution of information sector revenues, 1993



Source: ITU, OMSYC, World Bank.

A second form of telecommunication services trade arises from foreign direct investment (FDI). This may take the form of acquisitions such as the privatizations of telephone companies in Argentina, Hungary, Malaysia and elsewhere. The sums involved are significant: between 1988 and 1992, there were 14 privatizations of telephone companies in developing countries with a total value of US$ 11.8 billion.[86] This amount is 60 per cent of all infrastructure privatizations in developing countries and 19 per cent of total privatizations and is likely to grow as market-opening initiatives multiply.

For computer companies, the main form of trade is overseas sales. EDS, a US-based consulting company for information technology, obtained a fifth of its US$ 8.5 billion in revenues from foreign sales. Microsoft, the US software company, gets almost a third of its revenues from abroad: its Windows personal computer operating system software is *localized* into more than 25 languages. Audio-visual companies also make a large share of their revenues and a much greater share of their profits from foreign sales. However, this form of trade is dominantly one way: from the United States (Hollywood) to the rest of the world. Telecommunications companies currently gain relatively little of their income from sales of service abroad, but this is now growing, especially as a result of the formation of alliances such as Concert (BT and MCI) or Unisource (the Dutch, Spanish, Swedish and Swiss PTOs, now joined by AT&T) which intend to sell one-stop-shopping and network management services in foreign markets.

Adding all these forms of services trade together, it is likely that information services trade now matches, if not exceeds, information equipment trade. Opportunities for information-communication trade are expanding with rapid economic growth in many developing countries. Indeed, for information sector companies in developed countries, new growth is dependent on foreign activities. Thus, there is a greater push for trade liberalization. Trade in equipment has been gradually liberalized with steadily declining import tariffs. However, trade in information-communication services is more complex and subject to other non-tariff barriers. These include restrictions on foreign investment, employment and information access in sectors such as telecommunications, broadcasting and film. Efforts to liberalize trade in information are specified in the Annex on Telecommunications Services in the World Trade Organization's (WTO) General Agreement on Trade in Services. The Annex calls on Members to ensure that any other Member may use communications networks for the movement and access to information. However, many developing countries maintain a trade deficit in both equipment and services trade. This is one reason why they have sometimes been reluctant to promote fusther deregulation in the telecommunication services market.

---

86 The World Bank. 1994. World Development Report 1994. Infrastructure for Development. Washington D.C.

3. Employment in the Information sector

The information sector is perceived as a high growth, dynamic industry. Thus it might be assumed that information industries will create jobs. However, the reality is more complex. For example, data for the world's top 25 information-communication companies show employment declining by 2.2 per cent since 1992/93. The impact of the information sector on employment varies depending on technology, market structures, specific industries and indirect effects.

On the one hand, technological progress frequently results in job losses. The information sector is a capital-intensive industry dependent on communications infrastructure and computer hardware and software. Continuous quality and functionality improvements in equipment mean fewer staff are needed. For example, digital telephone exchanges have resulted in higher functionality, quality of service and reliability resulting in a need for less maintenance staff. This is borne out by employment statistics for the telecommunication service industry. The world-wide public telecommunications service industry employs just over five million people. Employment in the public telecommunication services sector has declined by 6 per cent since 1982 with particularly notable drops in the Pacific area (-25 per cent) and the Americas (-23 per cent, mainly North America).[87]

Policies regarding privatization and competition also affect employment in the information sector. The privatization of telecommunication operators has resulted in employment losses in most countries in order to cut costs. Indeed the spectre of telecommunication privatization has resulted in labour strife in a number of countries, most recently a strike by over 400,000 telecommunication workers in India. Competition tends to result in a direct net loss in telecommunications employment. Although new operators provide employment, this does not offset the large cuts made by the previously state-protected incumbent. In the United Kingdom, for example, new operators Mercury and Vodafone added over 1,000 employees from 1991 to 1992. However, the incumbent British Telecom has shed almost 90,000 jobs.

On the other hand, new technology does create new jobs. For example, the United States cable television industry employs over 100,000 people. The United States cellular industry, which only began in the early 1980s, has directly created over 50,000 jobs: an estimated 250,000 jobs can be added to this if related service and manufacturing activities are included.[88] The construction of information infrastructures will result in employment gains-albeit possibly temporary-as workers are hired to install communications equipment. For example, in Japan, it is estimated that there will be 2.43 million new jobs created to build a nationwide fibre-optic network. It is also expected that the availability of information infrastructures will lead to growing demand for information, generating employment in

---

87 Minges, Michael and Kelly, Tim (1994) *Telecommunications Liberalization and employment*. Unpublished manuscript, ITU, Geneva.

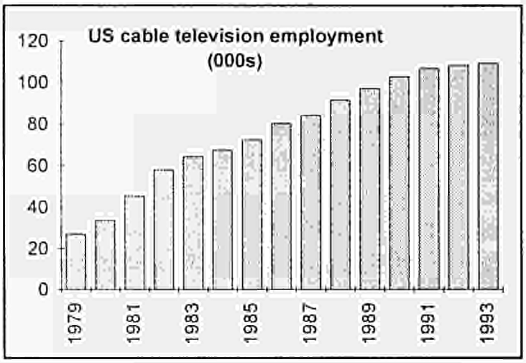
88 CTIA. "1994 wireless industry survey results: 'American success story' continues". Press Release. 13 March 1995. Washington DC.

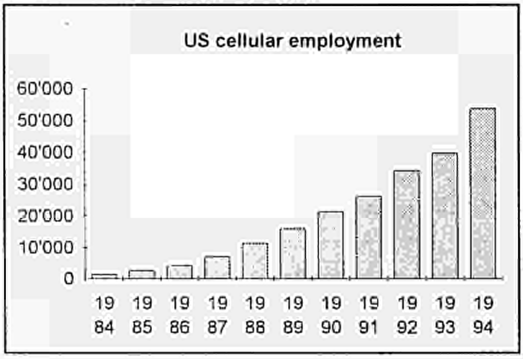
content-creating industries such as television/film programming and computer software. In the US, employment in the computer software industry has almost tripled since the advent of personal computing. From 1992-2005, demand for computer analysts/programmers is forecast to double: it will be the second fastest growing occupation after home health workers.[89]

Some suggest that the lower communication costs triggered by improved technology, privatization and competition will result in job growth outside the information sector. For example, lower communication costs will benefit businesses who can then expand operations and hire more staff. This assertion is difficult to prove because of a lack of data showing a direct linkage between communication costs and employment. At the same time, the development of new information services may reduce or displace employment in traditional industries. Home shopping, for example, could reduce the need for retail shopping establishments.

Figure 4: New services, new jobs

Employment in the US cable television and cellular industries





Source: US National Cable Television Association, US Cellular Telecommunication Industry Association.

---

89 "Technology and unemployment". *The Economist*, 11 February 1995.

Indicators for the Global Information Society: A Review and Compilation of Available Statistics [90]

Mika Kawachi

Consultant, OECD

With the prospect of an approaching Global Information Society (GIS), it is essential that indicators are available to assist policy makers in formulating policies, monitoring progress, and assessing the effectiveness of regulatory reform. However, statistics and indicators developed and reported so far do not fully or accurately represent what is actually taking place. Practices in data collection and classification as well as the frameworks employed in each country vary considerably, and international comparisons of the development in particular has proved to be difficult. Therefore, a common framework for the GIS indicators and standard definitions need to be developed, tested, and shared among the OECD countries for better understanding and comparing the progress made towards an information-based society.

The aim of the paper is to identify issues associated with indicators that should allow quantitative comparisons across the OECD countries. It is done so by putting together currently available data of both public and private sources that are currently dispersed and by rearranging them according to the experimental framework presented in the paper. Issues are identified such as the definitions, availability, accuracy, and comparability of data. Collected data, compiled for five selected countries: France, Germany, Japan, U.K., and U.S., are presented in the tables (see annex) to provide the 'first-cut' quantitative picture of GIS development for international comparisons.

---

90 This is a summarised version of the original paper "Indicators for the Global Information Society: Review and Compilation of Available Statistics" presented at the OECD Tokyo Workshop on the Economics of the Information Society in March 1996.

1. A Common Framework

In the absence of a comprehensive approach to monitoring the GIS development in the OECD area, international efforts should be initiated to adopt a common framework that captures the broad scope of the GIS and to standardise definitions.

For such work to be undertaken in an international context, it is proposed that a common framework consisting of **three** elements be adopted:

- equipment diffusion and use;
- the quality of communication infrastructure;
- demand for services and content.

Each of these elements is an essential component of the GIS, and lack of any single element is likely to hinder the balanced development of the GIS.

Of the three elements, services and content in particular face a major issue of categorisation and indicator development. For this reason, particular extended attention is given to services and content. It is proposed that services and content be classified into four broad categories:

- communication services;
- on-line services;
- the Internet;
- packaged content.

While on-line services and the Internet are part of the communication services in a broad sense, these should be selected for closer analysis.

2. Summary of Findings

A summary of the findings based on a review of statistics for each elementis provided below. *The tables can be consulted in Appendix 2.*

2.1 Equipment

Data on the diffusion of **equipment** such as PC, cable TV set-top box, game console, and telephone are available from official household surveys and market research reports. Information on the use of equipment as well as user profiles are relatively scarce, and when available, they often fail to provide insight into how households are actually using their equipment, how networking is taking place, and what services and content are consumed. In-depth user surveys such as those conducted by governmental agencies in Canada and the U.S. should be widely promoted.

The European Information Technology Observatory (EITO) presents market research data provided by Inteco Corp. on most of the equipment mentioned above (**Table 1**).

2.2 Communication Infrastructure

Statistics on main telephone lines, an indicator for the availability of the basic **communication infrastructure,** are extensively provided by the ITU for a large number of countries. Indicators concerning the quality of infrastructure should be available such as the level of digitalisation of subscriber networks, the geographic availability of ISDN, and cable access.

Data such as the number of main telephone lines per 100 inhabitants, and the share of residential main lines are extensively compiled by the International Telecommunication Union (ITU) for a large number of countries (**Table 2**). ITU also record data enabling an assessment of the degree of digitalisation of subscriber networks (**Table 2**). The **geographic availability of ISDN** is an indication of the quality aspect of the communications network, and is provided by the EITO for European countries (**Table 2**). **Cable access**, defined as the number of households passed by cable, is also another important indicator demonstrating the availability of cable-based, high bandwidth communications. The EITO provides such data for European countries and the U.S. (**Table 2**)

2.3 Communication Services

Communication services here refer to all wired and wireless services except on-line services and the Internet (see **Figure 1** below).

Statistics are abundant for **communication services** particularly for telephony and data communications provided by public telecom operators, and data on relatively new services such as mobile communications and cable have been compared across countries by the ITU and OECD in an attempt to monitor the market development. Detailed indicators are required for such communication services as leased lines, ISDN service, and packet switching for different data transmission rates. Tariff comparisons, such as those undertaken by the OECD, are increasingly complex as a result of different pricing practices adopted by service providers and remain one of the most challenging tasks in this area.

Figure 1: Categorisation of Services and Content

<table>
<tr><td rowspan="5">a) Communi-
cation
services</td><td rowspan="4">Wired</td><td colspan="2">Telephony services</td></tr>
<tr><td rowspan="2">Data
Communi
cation</td><td>Leased lines
ISDN service
Packet switching
Frame relay, etc.</td></tr>
<tr><td>Value-added services:
b) On-line services
c) Internet access</td></tr>
<tr><td colspan="2">Cable broadcasting and telephony</td></tr>
<tr><td>Wire-
less</td><td colspan="2">Cellular and radio services (telephony, paging)
Over-the-air broadcasting
Satellite services (broadcasting, data transmission, telephony)</td></tr>
<tr><td>d) Packaged
content</td><td colspan="3">CD-ROMs and other software</td></tr>
</table>

The **number of subscribers** or users is an important indicator for measuring demand for various services. The ITU publishes data on the number of subscribers to various services such as telephone, leased lines, ISDN, public packet-switched data networks, mobile telephone, radio paging, cable TV, and satellite broadcasting (**Table 3**).

Comparing **communication charges** across countries is a complicated task. In the area of telecommunication services, the OECD has been undertaking tariff comparisons since 1989[91]. Based on a basket approach, telephone charges are calculated for residencies and business, each consisting of fixed and usage charges expressed as the average annual spending (**Table 4**).

(a) Online Services

In the area of on-line services, statistics are available fragmentally, explaining only parts of the overall market. As on-line service is a broad concept, a framework needs to be established which takes the form of a matrix of channels and type of services and content.

---

91 For a full description of the tariff comparison methodology, please see OECD, ICCP Series No. 22, "Performance Indicators for Public Telecommunications Operators"

Different channels for providing services and content - such as commercial on-line service packagers, videotex service providers, direct links offered by original content providers, and Internet - need to be considered all together. For each channel, the number of subscribers, sales, and available services - e.g., publishing, retailing, stock trading, home banking - need to be gauged. This will require analysis of a large number of service providers in each country.

The estimated number of subscribers to different services is provided from various sources (**Table 5**). On-line **service charge** and **service menu** differ considerably from provider to provider. To understand the cost to end users and what services people are actually getting, a closer examination on the level of service providers is required (**Table 6**).

(b) The Internet

Internet, one of the channels for end users to obtain various on-line information and services, still remains a 'blind point' with few reliable statistics. At present, only 'physical' data on network development are available, and the way of measuring the market development such as the number of users and network usage is just being developed. To assess market development, it is necessary to look at both sides - providers of Internet access services and users. The measurement of the provider side should include not only Internet Access Providers but also various other companies entering the market. User profiles and the use of different services on the Internet need to be identified from market research data.

The starting point for understanding the Internet development is the number of **host computers** directly linked to the worldwide Internet network. This data is provided for each country from the Internet Society and is used for estimating the number of **Internet users**. The Economist[92], for example estimates the number of users by assuming an average of 5 users per host whereas the ITU assumes 5.5 users per host, although in reality one host computer can serve from one to over a thousand users (**Table 7**). Although the **sales of Internet access services** is not yet available with accuracy, revenues of Internet Access Providers for access provision services (i.e., revenues from consulting, training, security services, hardware, "CyberMalls" are not included) in the U.S. were estimated, according to Maloff Company, to be US$521 million, at an average monthly growth rate of 28% from March 1994 to January 1995 (**Table 8**).

(c) Packaged Content

In its broadest term, packaged content, which distinguishes itself from digitised information obtained from networks, includes all packages containing content such as games, educational and reference material etc. A narrower definition refers to CD-ROMs. Packaged content is often treated separately from information and services transmitting over a communications link. They are, however, related in that they compete with each other for the same content to be delivered in a different format or that they can serve distinctive markets. Data are compiled by trade associations but lack comparability for detailed analysis. Comparable data

92 The Economist April 15th 1995

on the sales of CD-ROMs for PC platform, CD-ROMs based on all platforms, and all multimedia content including CD-ROMs and other software need to be made available.

Comparing the market for PC CD-ROMs across countries is not straightforward. In the U.S., the Software Publishers Association provides data on sales of **computer software programs on CD** which represent sales of 52 US leading publishers of software on CD. The sales accounted for US$647.5 million for 22.8 million units in 1994, and the breakdown of these figures by segments is also provided (**Table 9**). In Japan, the Multimedia Association of Japan compiles and publishes sales data on PC CD-ROMs. Based on the survey involving manufacturers, the sales was estimated to be US$ 598.8 million in 1994 (**Table 10**). In the case of Europe, Inteco Corp. estimated the European PC CD-ROM market to be US$ 260 million in 1994.

Obtaining the figure for the total CD-ROM market regardless of platforms across countries is also problematic. As an example, the Japanese market was estimated to be US$ 1,519.4 million in 1994, in which the PC CD-ROM accounted for 39% (**Table 10**). Extending the scope even further, the Multimedia Association of Japan estimated the entire market for multimedia content and services to be US$ 6,981 million in 1994 in which PC CD-ROMs accounted for only 8.6% (**Table 11**).

Conclusions

The further development of indicators for the GIS requires broadening the scope along two dimensions: the integration of computing, communications, and content sectors, and the international dimension. At present, statistics do not represent the entire picture of the GIS: national statistics tend to put emphasis on the vertical convergence within a country whereas international statistics stress international comparison but for a certain sector such as telecommunication. To overcome such limitations, international effort should be initiated in developing a comprehensive set of indicators that sufficiently captures both dimensions.

For such statistical work to be undertaken in the future, it is proposed that the GIS framework for international comparison be adopted. It is intended that this paper provides a basis for a more comprehensive and reliable set of indicators to be developed in the future. In addition, it is hoped that these indicators would provide a preliminary quantitative picture of the current GIS development for selected countries, although in-depth analysis is left for future work.

Various efforts are already being initiated and undertaken by national and international organisations. Governments and responsible agencies of the OECD countries are encouraged to review the statistical work in their countries and to promote greater availability, accuracy, and comparability of data for better policy discussion and formulation

Statistics for the Information Society and the Networked Economy

Olof Gärdin

Statistics Sweden and Eurostat

1. Statistics for the Information Society

Services and information take up an increasing share of the economy, both in the market and in enterprises. Production and use of immaterials is more and more important in relation to material products..

Production in the Industrial economy is stationary and the products material. In the Information society production is mobile and the products immaterial. The problem when trying to understand the networked economy and the transition to the information society is that economic statistics are based on concepts, definitions and theories whose frame of reference is the industrial society and economy.

We lack the measurement system needed to capture an advanced information market economy in operation, because we lack the guiding theory.

Much effort is needed to develop the statistical frame of reference, i.e. the concepts, definitions, variables, data collection and survey systems necessary to study and understand the information society.

The existing economic statistics are basically supply- or production-oriented. For example, cars produced and sold are counted and the number makes sense. To count pieces of produced information would not make sense. The reason is that, in spite of numerous varieties of cars, a car is a reasonably well-known concept with a known general function or use. A piece of information could be anything. One has to add information on the subject and usage or application to give meaning to the "piece of information".

Another difference between information and material products is that information can be used by many at the same time in different places independently of each other. The information is not consumed or worn by usage. It's depreciation depends on other factors.

This simplified description serves to illustrate that statistics for the information society should focus more on the demand or use side than present economic statistics do.

It is important to have different time perspectives in mind when analyzing and trying to understand the way into the Information Society. Technological development and change is a social process. Studies of the diffusion and acceptance of innovations etc. show that it often takes decades before today's available best technology has become the commonly used, normal, technology depending on social and economic factors.

The implication for the statistics for the Information Society is that the latest avant-garde applications and technological developments should not be allowed to conceal the "bulk information" and "grey" everyday telecommunications services and applications that count for the predominant part of the economy.

Some general directions for the development of the statistics for the Information Society are:

- **Enterprise statistics:** a taxonomy of enterprises and their ways to interact; better statistical coverage of small enterprises; statistical concepts and categories bringing statistical and accounting practices closer together; the definitions of the telecommunications and information services products.

- **Emphasis on the human resources:** employment; training, education, skills, competence levels; occupations, professions.

- **Geographic localization, concentration patterns:** enterprises: regional, national and global clustering of different economic activities; persons: regional, national and global clustering of professions, competences etc.

- **Communication patterns:** telecommunications role in the total communications system and the interaction with other forms of persons, goods or messages communication.

- **Emphasis on use and demand:** enterprises: extent of use, costs, investments, different services and applications; persons: extent of use, spending, different services and applications.

2. Telecommunication Services Statistics - the COINS Project

Eurostat has in partnership with the European Commission's Directorate-General XIII (Telecommunications, Information Market and Exploitation of Research) launched a project (COINS) for developing Information and Communication Statistics. The aim is to establish a basic set of reliable, comparable regular European statistics, that gives the main trends. The statistics should be comparable between countries and over time. The need for more detailed data for analysis of special topics should be met by special surveys.

The COINS project is organised in four subsections

- - Telecommunication Infrastructure
- - " - Services Producers
- - " - Services
- - " - Services Users and Usage

Of the four main sections of the European Commission's *Action Plan: Europe's way to the Information Society*, the first "the regulatory and legal framework" is important for the definitions and categories to use and for the analysis of user needs. The second "networks, basic services, applications and contents" concerns all four sectors of the telecommunication statistics. Contents is outside this project, but there is another Eurostat project for Audiovisual Services - AUVIS. The last two sections, "social, societal and cultural aspects" and "promotion of the information society" have a direct bearing on the user and usage part of the project.

Domains of variables

The aim of the COINS project is to establish a set of reliable, stable variables for the telecommunication services, that meet the basic needs for data and is possible to collect with good quality. The information should be possible to use as benchmark statistics when using information from other sources for analyses. The policy domains that should be covered are

1) Structural information on markets
Data a) on the economic weight of the sector within the total economy, particularly its productivity and its contribution to gross domestic product and national income, b) on concentration ratios in the sector, c) on the relevance of SMEs in the sector, d) on the relevance of public enterprises in the sector, e) on public subsidies or other public support of the sector.

2) Enterprise economic information
Data a) on turnover, revenues, costs, value-added investment, employment etc, b) on the portions of different service products of total sector output.

3) Information on infrastructure
Data a) on the physical capacity and performance of technical networks or other facilities, that are necessary for supplying several service products, and b) on the use of special technologies which are of key political interest.

4) Volume information relating to the supply side
Data on the development of the output of the sector in "real" terms, i.e. in physical or performance parameters which are typically used in the sector.

5) Demand and usage information
Data a) on the level of demand or use of the specific service products - in value terms and/or in physical terms, b) on the relative portions of consumer and enterprise demand and use.

6) Quality of service performance information
Data on the quality standard of the service products offered by the public and private enterprises of the sector.

7) Prices information
Prices and price indices for "typical" specific service products, defined by a commonly used volume indicator and a distinctive quality standard

8) International trade information
Data on the international connections of the sector on the output side (product markets) as well as on the input side (factor markets).

The following figure gives an overview of the subsections, the domains of variables and their relations. The international trade information is not included in the figure. Such information might concern all four subsectors and presents many statistical problems. The results from on-going activities within the frame of the General Agreement on Trade in Services (GATS) and WTO are to be taken into account.

Telecommunication Networks

* Infrastructure statistics

Producers	Services	Users
- *Network Operators* - *Services Providers*	- *Transmission Services* - *Network Value Added Services*	- *Enterprises/Administrations* - *Persons*
* Structural Indicators * Enterprise economic statistics	* Volume statistics * Quality statistics * Price information	* Statistics on demand and usage

Converging industries

The technological, regulatory and commercial developments lead to a growing convergence of the telecommunications services, computer and related services and broadcasting industries. It will be increasingly difficult to assess these industries on the basis of industrial statistics.

The relevant delimitation of the industry varies with the analysis to be made or the question to be answered. Difficulties will always exist due to restructuring of the society, industries and economic activities. The solution is to create appropriate "statistical building blocks" that can be used in different combinations for different purposes. The way to do this is to improve our definitions of the services or information products.

If the appropriate data are collected on products as well as on industries a matrix can be created, from which the relevant cells can be chosen. A clear distinction between the collection of data and the analysis and publication of statistics is important.

Confidentiality

A balance between the legitimate interests of the operators for business confidentiality and the equally legitimate need for transparency of this essential sector has to be found.It is crucial to reach an understanding between the concerned parties on what statistical information should be provided and that all operators contribute on equal terms.

2.1 Statistics on Telecommunications Infrastructure

The telecommunications infrastructure is the basic foundation of the information society. Information on the characteristics of the telecommunications networks is crucial for all actors in the field. This is also the domain where traditionally the statistics are best developed, e.g. number of telephone main lines: analog and digital, residential and business; switching capacity; subscribers to mobile telephone, leased lines, public data networks, ISDN.

Due to technological and commercial developments there is also need for new data. New definitions and specifications should be internationally comparable. One instrument for this is the ITU Telecommunication Indicator Handbook.

The statistics relate to the public telecommunications sector. The term public refers to the access arrangement rather than the ownership of the network. The public telecommunications sector does not include private networks that do not automatically connect to the public network or have limitations on membership. The private networks importance increases. Statistics on the private networks would therefore greatly increase the possibilities to describe and analyze the networked economy.

2.2 Statistics on Telecommunications Services Producers

The European market for all basic telecommunication services is to be opened up for competition the first of January 1998, with delays allowed for Spain, Portugal, Ireland, Greece and Luxembourg.

With the markets opening up the number of enterprises, both operators and service providers, increases. In terms of classification of economic activities, these enterprises are classified to NACE Rev.1 64.2. At present, enterprise statistics for the telecommunications services are very scarce at the European level.

One measure to improve the situation is to create a legal basis for European statistics. The Commission has submitted a proposal for a Council Regulation concerning structural business statistics. The regulation is divided into two modules. One is a common module to be compiled annually for all services industries. The other is a detailed module for specific activities, e.g. statistics specifically related to telecommunications services. The special modules have still to be developed.

Eurostat plans a pilot survey of the telecommunications services providers to test methodologies, concepts, definitions and the feasibility of data collection. The results from the pilot study will be used as a basis for developing regular European enterprise statistics on telecommunication services.

2.3 Statistics on Telecommunications Services

A crucial element in the development of statistics on the telecommunication services is the definition of the services and the creation of a classification system. This system has to be defined so that it takes into account the rapid growth of new products and services, led by both the liberalization and the technological evolution.

The Classification of Products according to Activity (CPA) is the European classification of products or services. The worldwide counterpart is the Central Product Classification (CPC). Eurostat has, in collaboration with DG XIII, elaborated a proposal for revising CPA, because the present version does not reflect the increasing importance of mobile and other new services.

The aim is to structure the Telecommunications Services so that the categories are broad enough to be more stable over time. At the same time the categories should correspond to relevant segments of the Telecommunications Services Market.

The proposal consists of 7 categories and 30 subcategories:

• Fixed network telecommunication services	(10 subcategories)
• Mobile telecommunication services	(8 " -)
• Interconnection services	(1 " -)
• Communications management services	(4 ")
• Value added network services	(4 " -)
• Broadcast services	(2 " -)
• Radio and television cable services	(1 " -)

Data should be collected from both the supply - the producers side and from the demand - the users side. The telecommunications services should be covered by statistics on:

- **Traffic/volumes.** Traffic can be measured in different units (calls, minutes, pulses etc); number of telegrams and telex messages.
- **Price information.** Installation, subscription and call or access etc charges. Tariffs comparisons e.g. according to the OECD Tariff Models.
- **Quality.** Article 5 of the proposal for a European Parliament and Council Directive on the application of open network provision (ONP) to voice

telephony stipulates the supply time and quality of service indicators that are required.

2.4 Statistics on Users and Usage of Telecommunications Networks

An important aspect is the transfer and diffusion of technology, services and applications in the society and economy. To track this down it is necessary to have data from the user and usage side that are related to the universe of enterprises and persons respectively. Where possible the data should be collected by adding or changing questions to existing surveys.

Organizations as users

The two main types of data needed are economic data and more qualitative data, like persons directly involved, equipment used, applications. The statistics should cover the extent of the usage of different services used; different applications; investment and cost or spending on telecommunications

A prerequisite for reliable surveys of enterprises is good quality registers over the universe of enterprises, that make it possible to draw good samples. The current implementation of Business Registers in the European Union (Council Regulation (EEC) No 2186/93 of 22 July 1993 on Community Coordination in drawing up business registers for statistical purposes) will improve the sampling possibilities.

Statistics or studies of business usage is often done by investigating user panels. This gives good information for marketing purposes but is not helpful for policy makers, who need information and statistics for the universe of businesses. The non-users are of as great relevance and interest as the users.

An example of a computer use survey that gives data for the universe of enterprises is an annual survey of the use of computers in enterprises in the Netherlands.

Persons as users

It is important to underline that to get data on the use of telecommunications networks etc by persons it is necessary to survey persons. To do this new surveys have to be developed or existing ones revised. The information we are interested of is ***who*** uses the networks, the ***extent*** of the use, ***spending*** and ***different services*** and ***applications***.

In the following four examples of such surveys are given. It might be possible to develop these surveys so that they give better data for describing the networked economy.

- **Household Budget Surveys:** All EU Member countries do household budget surveys, which are harmonized by Eurostat. They collect data on the availability of telephones, and household expenditure on telecommunication.

- **Time Use Surveys:** At present a European Time Use Survey is being launched within Eurostat, which touches on the use of telephone and computers.

- **Computer Use Surveys:** In Sweden the use of computers by persons at work and at home has been surveyed three times by adding questions to the ordinary labour force surveys.

- **Communication Pattern Surveys:** In Sweden a pilot survey of the use of telecommunication as an element in the total communication system is being planned. The aim is to develop regular, official, statistics on the interaction between telecommunication and physical communication.

Canadian Statistics on the Information Society

Fred D. Gault

Director of the Services, Science and Technology Division, Statistics Canada

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

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

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

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

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

1. Data Sources Now Available

For a full list of printed and electronic sources, which could be used to describe the information economy, reference should be made to the Statistics Canada Catalogue. Statistics Canada information is also available on the Internet.[93]

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

2. Plans for Development

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

---

93 Gopher: talon.statcan.ca, World Wide Web: http://www.statcan.ca.

2.1 The Voorburg Model Survey

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

2.2 Resellers and Cellular Service Providers

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

2.3 Price Indices

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

2.4 Standard Industrial Classification (SIC)

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

3. Future Needs

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

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

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

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

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

Conclusions

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

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

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

References

Baldwin, J. and D. Sabourin
Survey of Innovation and Advanced Technology, 1993: Technology Adoption in Canadian Manufacturing, Catalogue 88-512, Statistics Canada, Ottawa, 1995

Ducharme, L.M. and Fred Gault
Surveys of Advanced Manufacturing Technology, Science and Public Policy, 19, 393, 1992

Mozes, D. and G. Sciadas
Demand for Telecommunication Services, 1st Quarter 1995, Vol. 2, no. 1, Catalogue 63-016, Statistics Canada, Ottawa, 1995

Northcott, J. and G. Vickery
Surveys of the Diffusion of Microelectronics and Advanced Manufacturing Technology, STI Review, no. 12, 7, 1993

OECD
Communications Outlook: 1995, OECD, Paris, 1995

Statistics Canada
A Model Survey for the Telecommunication Sector, Proceedings of the Voorburg Group Conference, Williamsburg, Virginia, USA, October 19-23, 1992

United Nations Statistical Office
A Model Survey of Computer Services, Series M, no. 81, United Nations, New York, 1991

Conclusions

Policy implications of the development and impacts of the information society

John Dryden

OECD

The implications for policy of the development of the information society arise not only from the consequences of the technological development, diffusion and application of information and communications technologies (ICTs) and networks, but from the continuing economic globalisation and reform of the regulatory framework. The three Workshops covered in this volume, however, have identified the review of the regulations governing the communications industry as the key issue on the policy formulation agenda, and most of the selected papers discuss this important issue as the area where the most urgent policy efforts are to be made. Nevertheless, the impacts, both direct and indirect, of ICTs on the economy and on society are fundamental, pervasive, enormous and global. The dynamics of market liberalisation provide new drivers for unprecedented economic opportunity which are accompanied by new challenges for enterprises, workers, citizens - and for policymakers. Review and co-ordination is required across the whole range of policy areas and institutions and administrative levels - local, state, national and international.

Impacts of the Development of the Information Society

The previous chapters suggest that ICTs are engendering fundamental changes in the way industrial organizations are set up. Organizational structures are becoming flat and can be physically dispersed. The demand for new and higher-level skills by organizations is increasing while traditional and lower-level skills are required less. It is likely that the changing demand for skills is accompanied by a redefinition of the objectives of the organizations as they restructure. Such changes cannot take place gradually or consecutively. If organizations are changing shape in order to seize market opportunities, or simply to remain viable, all these changes must take place rapidly and at once. As technological development and new business practices and regulation are enabling networked electronic transactions to proliferate among applications and among enterprises, inter- and intra-organizational relationships are changing. Firms are presented with enormous opportunities for rebuilding industrial relationships and redefining value chains. These developments have already induced significant restructuring of the organization of industry and this is likely to continue on a global scale. New economic perspectives based upon network transactions justify outsourcing, divestiture and relocation of offices, branches, and factories. Regulatory reform permitting, more international transactions will be conducted, and there may be greater market efficiencies, with easier global sourcing of inputs and global markets. There will also be further effects on financial markets, with greater mobility of assets and capital.

Adjustments in individual lifestyles are inevitable. Changes in the organization and organizational relationships must be accompained by changes in the way the individual behaves. Although the information society may empower the individual, he may also have to take on new responsibilities, including that to acquire the knowledge and skills which better fit the new ways in which organizations are built, operate and interconnect. The further the development of the information infrastructures progresses, the stronger and more pervasive will be the forces prompting change, regardless of the type of organization. As information management is a fundamental component of any organization, and due to the networking effect, the more the benefit of adopting the changes will increase.

Policy Implications and Research Agenda

There must be some policy "management" of such fundamental and drastic changes - at the very least, in order to avoid economic chaos, market failure and unacceptable social upheaval. The changes entail the "destruction" of many existing regimes, but do not necessarily provide the quickest or most efficient way to re-build the new regulatory regimes or economic and social institutions and structures. Policies must be developed to provide the vision, paths, environment and tools both for promoting change and for ensuring that the information society is and enriching and humane place to live and work. However, for building such a policy framework, much further research and study is necessary. Even during the period of the three Workshops covered in this volume it became clear that the research agenda for investigating the vision of the information society was expanding rapidly and in many different directions.

Clearly, continued regulatory reform in the communications industry is imperative. Further liberalization is necessary so that communication markets can flourish, and new services develop, in a competitive environment. Furthermore, the principle of a competitive environment can be extended more generally to that of information infrastructures, opening up growth and job-creating opportunities both within and beyond the communications sectors. Organizational changes imply major shifts in the human resources requirements of both public and private sector organizations. Delay in forming the necessary policy measures and mechanisms which provide for re-allocation of human resources would exacerbate unemployment and extend the period of adjustment. First, a redefinition of the role and goals of human resources is needed in the new perspective of the organization in the information society.

Second, new relationships between the organization and the individual need to be established. Among the issues where further research is needed are:

- How will new kinds of working relationship evolve?
- What new forms of employment contract can be used?
- Which skills will be most in demand, and how will they be supplied?
- How are such skills and knowledge developed and transferred?
- How can the transition of human resource requirements across organizations be smoothed out?

Changes in the relationships among organizations imply the adoption of new industrial and commercial practice. New markets will emerge. Many new small firms will be formed. Many inter-firm alliances will be formed and broken. Competition will be enhanced at the global level, but policy measures might be necessary to keep competition fair, to ensure that market access is non-discriminatory and to stimulate entrepreneurship where necessary. New rules for cross border transactions might be needed, for example, some extension of consumers protection measures may be necessary in the light of increased transaction risks.

Before such policy measures can be developed, though, a clearer vision is needed of the likely consequences of these changes, for instance, analysis of the impact of electronic transactions. Such a research agenda might include:

- What "new markets and industries" are emerging?
- How will the industry value chain change?
- How will competition take place in such markets?
- What benefits and risks will electronic transactions bring?
- What kind of risks will affect consumers using new types of network or on-line transactions?
- What rules are needed to resolve conflicts over these transactions?

Another aspect of the implications for policy concerns governments. Governments, themselves organizations, are equally susceptible to the challenges and opportunities afforded by the impact of ICTs. Therefore, governments also need to develop their future visions and paths for coping with change. Examples for the research agenda are:

- How can ICT be applied to the provision of public services?
- What organizational structure will be the most efficient and effective for government?
- Does the development of ICTs endanger social values such as the protection of privacy, security or intellectual property rights?
- Is the capability for law enforcement affected by the penetration of ICTs?

Finally, the emergence of the information society is a global concern. Some harmonization and co-ordination of policies and rules across borders is essential. Electronic transactions and data flows between governments firms and individuals can take place instantaneously and seamlessly across borders.

However, geographical borders define territories where different rules and regulations apply, and responsibilities and liabilities may differ. Reconciliation between the rules which apply to physical territories and to cyberspace is necessary. To this end, international organizations, such as OECD, can play an important role in providing fora where discussion of international harmonization and co-ordination can take place.

Developing Measurement Tools

Each Workshop underlined the need for a new generation of measurement tools to complement the research effort. The lack of comprehensive and internationally comparable data is a severe problem in a rapidly changing information society. These tools are needed to assist in formulating poicies, monitoring progress, assessing the effectiveness of policy measures, evaluating applications and impacts and identifying barriers. A great effort is therefore required to develop the new generation of statistics, indicators and reporting systems.

Market liberalisation, regulatory reform, competition and private sector dynamism have made the information society an exciting place, but it has also meant that existing statistical systems, notably those of official statistical agencies, have been unable to keep up with the demand. Worse, data previously easy to obtain in a regulated environment now tends to have a commercial value. New products and services, new pricing regimes, new players in the market and the pervasiveness of IT in government, enterprises and households has made the task of statisticians and analysts all the more difficult. If the research agenda is to deliver what policymakers are expecting of it, governments and international agencies must develop a coherent programme, in co-operation with private sector data providers and consultancy groups, and using the opprtunities afforded by ICTs themselves, to fill these gaps.

Future Activities

Investigation of the topics raised in the research agenda for information society should not be delayed. Already there are many initiatives concerning the appropriate directions of such research. Many academics, industrial experts and government officials are making efforts to establish their visions for the information society and the path to achieve it. Given the complexity of the issues and the magnitude of their impacts, the research efforts under way seem unlikely to be sufficient. The OECD, in collaboration with the European Commission, will continue to develop views and ideas concerning those issues both through its own work programme and various conference and workshop activities to gather together leading-edge research and to facilitate international discussion aimed at raising the recognition and awareness of the issues, and, it is to be hoped, in an effort to contribute to their resolution.

Towards a policy framework for the knowledge-based economy[94]

Alain Dumort

Timothy Fenoulhet

European Commission

The combined forces of rapid technological change and globalisation are transforming the functioning of the economy. By reducing the cost of communication, information technologies have given rise to globalised production and financial markets, whilst globalisation has spurred technology by intensifying competition and encouraging the diffusion of technology through foreign direct investment.

As a result, the nature of production and of products themselves is changing. Cheap and efficient communications networks allow companies to locate different parts of their production process in different countries while remaining in close contact. Meanwhile, the shape of the economy is altering as it becomes more knowledge-based, with production increasingly in the form of intangible rather than material goods.

These profound changes are a challenge not only for businesses, but also for economic theory itself. Economic analysis is becoming more difficult as the share of the economy which can be measured accurately is shrinking. It appears that such economic indicators as productivity and GNP growth may in fact be underestimated today. As our economies become increasingly dominated by the services sector, where information technology investments have been proportionately higher than in traditional manufacturing and where productivity is notoriously hard to measure, many of the benefits are difficult to quantify and as a result fail to be captured by standard economic statistics. This problem is compounded by the fact that firms are increasingly interacting over communications networks causing

---

94 The opinions expressed do not necessarily reflect the European Commission's official point of view.

many benefits to spillover into different sectors and intangible economic inputs and outputs such as knowledge and R&D to be widely diffused.

In many service industries such as finance, health care and education, defining the unit of output is problematic. A significant proportion of the output gains achieved through IT investments do not show up as cost savings but as quality improvements, wider consumer choice, better customer service, time savings and convenience. Indeed, it is often assumed that output rises are proportional to increases in the number of hours worked, yet new technologies often have the effect of reducing the time needed to produce a given volume of output. For example, in telecommunications, output is typically measured in minutes of calls and fails to take into account the vast quantities of information that are transmitted thanks to improvements in transmission speeds and line capacity.

Furthermore, the statistical boundaries between manufacturing and services are blurring as intangibles make up an increasing proportion of the value of finished products. For example, service activities such as design, sales and advertising typically contribute over three-quarters of the value of a "manufactured" product such as a car. As we move towards an economy that is increasingly knowledge-based this trend is likely to intensify. It is already estimated that the value of the stock of intangible investment (R&D, education and training) in the US overtook the value of its capital stock during the 1980s.

A further difficulty for economic theory is that knowledge doesn't obey the basic rule of "scarcity" which has been applied to traditional goods. Unlike the latter, the more one uses and transfers knowledge, the more it proliferates. It does not get used up - it can be reproduced cheaply and consumed over and over again.

These examples give an idea of the scale of the challenges faced by economists and statisticians as the combined forces of globalisation and rapid technological change drive us towards the information society. Furthermore, failure to accurately measure or understand the complex processes of the knowledge economy makes it considerably difficult for international policymakers to define an appropriate response and provide citizens and businesses with the tools and environment they need to cope better with change. Just as economies are becoming harder to measure, they are also getting more difficult to tax or to regulate.

As commerce is increasingly conducted over networks and as use of the Internet continues to rapidly expand, governments and international organisations need to respond to a wide range of new legal, economic and ethical issues. For example, they must define the appropriate framework for electronic payment systems, for the authenticity of digital signatures and content, universal service, network security, protection against harmful content, and intellectual property rights. The costing and financing of new network-based services and conditions for their use will require the definition of an international framework in these areas based on common rules.

For its part, the European Commission is pushing ahead with its agenda which is aimed at defining the regulatory framework and accompanying measures for the information society in the European Union. The liberalisation of the telecommunications sector has been successfully launched and will be completed by 1st January 1998. With regard to universal service, the Commission will soon issue a series of guidelines for Member States which are designed to develop best practice in national approaches to the costing and financing of universal service. The Commission is also preparing legislation to ensure that the necessary conditions are met for the introduction of electronic commerce in the Single Market (e.g. copyright, data protection, digital signatures, etc). In an effort to anticipate the impacts of new technologies on employment and work organisation, a widespread consultation on living and working in the information society has also been launched following the recent publication of a Green Paper.

As outlined above, political initiatives in these areas place new demands on economists and statisticians whose role is to feed policymakers with accurate data derived from internationally-defined methodologies and tools designed to measure the complex economic and commercial interactions of the knowledge-based economy.

The OECD, the European Commission and Eurostat are already engaged in several joint projects (e.g. COINS) and are cooperating with other national and international agencies (e.g. the ITU) in an effort to define a common statistical framework for collecting and analysing data in the converging information and communication industries.

Although neither new information technologies nor globalisation require the basic rules of economics to be re-written, they do require a re-appraisal of the ways in which the economy is monitored and measured. The papers presented in this volume are examples of the leading-edge of international economic and statistical research in this field. By bringing researchers and policymakers together in the framework of "The Economics of the Information Society" workshop series, the OECD, the European Commission and the participating research institutes and agencies have provided a framework in which to better define research and policy priorities for the future. By supporting the policy formulation process in this way it is hoped to give more accurate guidance to policymakers so that they can gain a better understanding of economics and thereby define the appropriate response.

Appendices

Appendix 1

Indicators

1 - OECD countries : basic indicators
2 - Developing regions: basic indicators
3 - OECD countries: education, culture and television
4 - Developing regions: education, culture and television
5 - OECD countries : telecommunication and information technologies indicators
6 - Developing regions : telecommunications and information technologies
7 - Synopsis

Appendix 2

Statistics

(see M. Kawachi, chapter 4)

1 - Household Ownership of Equipment
2 - Communication Infrastructure
3 - Communication Service Subscribers and Traffic
4 - Communication Service Charges
5 - On-line Services
6 - Major On-line Service Providers and Subscribers
7 - Internet
8 - Major Internet Access Providers
9 - Sales of Computer Software Programs by 52 Publishers (U.S.)
10 - CD-ROM Disk Sales by Platform (Japan)
11 - Multimedia Content and Services (Japan)

OECD countries contribute up to 82% of the worldwide GDP

	Demographic indicators		Economic indicators	
	Population (million)	Life expectancy at birth (year)	Total GDP (B US$)	GDP per capita ($)
Ref. year	*1994*	*1993*	*1993*	*1993*
G7	**668,5**	**77**	**15.924**	**23.820**
USA	260,5	76	6.260	24.028
Japan	124,8	80	4.214	33.773
Germany	81,1	76	1.911	23.549
France	57,7	77	1.252	21.682
Italy	57,2	78	991	17.347
United Kingdom	58,1	76	819	14.099
Canada	29,1	78	477	16.397
EU 15	**370,2**	**77**	**6.712**	**18.130**
Austria	7,9	76	182	23.017
Belgium	10,1	77	211	20.890
Denmark	5,2	75	116	22.357
Finland	5,1	76	74	14.591
Greece	10,4	78	63	6.075
Ireland	3,5	75	43	12.136
Luxembourg	0,4	76	10	25.250
Netherlands	15,4	78	309	20.093
Portugal	9,8	75	86	8.715
Spain	39,6	78	479	12.101
Sweden	8,7	78	167	19.078
OECD	**970,4**	**73**	**18.854**	**19.430**
Norway	4,3	77	103	23.935
Switzerland	7,1	78	234	32.847
Iceland	0,3	78	6	21.852
Australia	17,8	78	284	15.914
New Zeland	3,5	76	45	12.635
Mexico	91,9	71	344	3.746
Turkey	60,8	65	174	2.867
World	**5.501,5**	**66**	**23.113**	**4.201**

Sources: World Bank, 1995

Africa and South Asia still far behind

	Demographic indicators		Economic indicators	
	Population (million)	Life expectancy at birth	Total GDP (B US$)	GDP per capita ($)
Ref. year	*1994*	*1993*	*1993*	*1993*
East Europe and Central Asia	**494,6**	**69**	**1.094**	**2.212**
focus on:				
Russian Federation	148,7	65	329	2.215
North Africa and Middle East	**262,5**	**66**	**550**	**2.094**
focus on: Egypt	56,4	64	36	634
Israël	5,2	77	70	13.411
Jordan	4,1	70	4	1.083
Morroco	25,9	64	27	1.028
Sub-Saharian Africa	**559,0**	**52**	**269**	**482**
focus on: Botswana	1,4	65	4	2.724
Ethiopia	51,9	48	6	111
Ghana	16,4	56	6	371
Mauritus	1,1	70	3	2.527
Mozambique	15,1	46	1	91
Namibia	1,5	59	2	1.406
Senegal	7,9	50	6	730
South Africa	39,7	63	106	2.661
Tanzania	28,0	52	2	75
Zimbabwe	10,7	53	5	466
South Asia	**1.194,0**	**60**	**314**	**263**
focus on: Bangladesh	115,2	56	24	208
India	898,2	61	225	251
East Asia and Pacific	**1.719,7**	**68**	**1.375**	**800**
focus on: China	1.178,4	69	426	361
Hong Kong	5,8	79	90	15.517
Korea (rep)	44,1	71	331	7.502
Malaysia	19,0	71	64	3.392
Singapour	2,8	75	55	19.698
Taïwan-China	21,3	..	214	10.280
Vietnam	71,3	66	13	180
Latin America and Caribbean	**466,3**	**69**	**1.406**	**3.016**
focus on: Argentina	33,8	72	256	7.562
Brazil	156,3	67	444	2.843
Peru	22,9	66	41	1.793
World	**5.501,5**	**66**	**23.113**	**4.201**

Rem: italics refer to other year than that specified,<..> to non available data

Sources: World Bank, 1995

Relatively uniform levels

	Education and culture			Television	
	Adults illetteracy rate	Pupils schooling rate	Published books per 1 million inhab.	TV sets per 100 inhab.	Cable-TV subscribers per 100 households
Ref. year	*1990*	*1992*	*1993*	*1994*	*1994*
G7	**<5%**	**..**	**..**	**64,1**	**38,3**
USA	<5%	*98%*	..	77,9	63,1
Japan	<5%	*100%*	291	62,1	24,5
Germany	<5%	*89%*	837	55,1	39,8
France	<5%	100%	757	58,0	7,2
Italy	<5%	..	486	42,9	0,0
United Kingdom	<5%	*97%*	1.490	45,4	4,1
Canada	<5%	100%	..	65,0	74,6
EU 15	**..**	**..**	**927**	**47,9**	**22,2**
Austria	<5%	91%	479	48,0	33,2
Belgium	<5%	95%	1.380	45,5	91,0
Denmark	<5%	*95%*	1.973	54,0	28,1
Finland	<5%	..	2.206	50,2	38,9
Greece	7%	..	391	21,1	..
Ireland	<5%	*90%*	757	32,5	39,1
Luxembourg	<5%	..	1.300	33,8	89,0
Netherlands	<5%	95%	890	49,4	88,8
Portugal	15%	*100%*	654	24,6	0,0
Spain	5%	*100%*	988	42,7	2,6
Sweden	<5%	100%	1.358	47,1	50,0
OECD	**..**	**..**	**..**	**54,0**	**34,4**
Norway	<5%	*99%*	899	42,4	32,1
Switzerland	<5%	96%	2.085	40,0	66,9
Iceland	<5%	..	5.837	31,1	1,1
Australia	<5%	98%	601	48,2	0,0
New Zeland	<5%	100%	807	51,0	0,0
Mexico	13%	100%	28	18,0	10,2
Turkey	19%	*100%*	105	26,3	2,0
World	**..**	**..**	**..**	**21,9**	**..**

Rem: italics refer to other year than that specified,<..> to non available data

Source: World Bank, Unesco, ITU

Education before information

	Education and culture			Television	
	Adults illetteracy rate	Pupils schooling rate	Published books per 1 million inhab.	Television per 100 inhab.	Cable-TV per 100 households
Ref. year	*1990*	*1992*	*1993*	*1994*	*1994*
East Europe and Central Asia	**5,0%**	..	..	**25,1%**	..
focus on:					
Russian Federation	2,0%	..	277	37,8%	..
North Africa and Middle East	..	..	..	**13,1%**	..
focus on: Egypt	*48,6%*	..	26	8,9%	..
Israël	..	..	426	30,8%	49,7%
Jordan	20,0%	99,0%	..	16,7%	..
Morroco	56,3%	59,0%	..	7,1%	..
Sub-Saharian Africa	**50,0%**	**42,0%**		**3,2%**	..
focus on: Botswana	*30,2%*	96,0%	113	2,0%	0,0%
Ethiopia	*64,5%*	..	5	0,3%	..
Ghana	*35,5%*	..	21	1,4%	..
Mauritus	..	89,0%	51	19,1%	..
Mozambique	*59,9%*	42,0%	4	0,3%	..
Namibia	..	81,0%	..	3,1%	..
Senegal	*66,9%*	45,0%	5	3,5%	
South Africa	*18,2%*	..	122	10,3%	..
Tanzania	..	47,0%	6	0,2%	..
Zimbabwe	*14,9%*	..	33	2,5%	..
South Asia	**54,0%**	**42,0%**		**4,6%**	..
focus on: Bangladesh	*61,9%*	*69,0%*	10	0,6%	0,0%
India	52,0%	..	16	5,6%	6,3%
East Asia and Pacific	**24,0%**	**96,0%**	..	**26,6%**	..
focus on China	27,0%	96,0%	63	23,3%	13,6%
Hong Kong	..	..	836	36,1%	2,3%
Korea (rep)	<5%	*100,0%*	667	32,7%	21,4%
Malaysia	22,0%	..	93	23,7%	0,0%
Singapour	<5%	100,0%	688	38,2%	0,0%
Taïwan-China	..	..	..	31,5%	54,4%
Vietnam	12,0%	..	27	11,2%	0,0%
Latin America and Caribbean	**15,0%**	**89,0%**	..	**21,1%**	..
focus on Argentina	*3,8%*	..	143	32,5%	45,0%
Brazil	*16,7%*	86,0%	113	25,0%	1,0%
Peru	*11,3%*	*100,0%*	21	9,4%	..
World	**33,30%**	..	..	**21,9%**	..

Rem: italics refer to other year than that specified,<..> to data non available
1) Russia, Published books: including brochures
2) Sub-Saharian Africa, TV: do not include Gambia, Guinea-Bissau, Malawi, S. Tomé & Principe
3) South Asia TV : do not include Bhutan (68.000 inhab.)

Ready to enter into the new information age

	Information society infrastructures				
	tel. lines per 100 inhab.	Telecom network digitisation rate	Mobile phone per 100 inhab.	PC per 100 inhab.	Host connected to Internet
Ref. year	*1994*	*1994*	*1994*	*1994*	*1994*
G7	**53,4**	**68,7%**	**5,9**	**17,9**	**4.035.170**
USA	60,2	*65,0%*	9,3	29,7	3.179.170
Japan	48,0	*72,0%*	3,4	12,0	96.632
Germany	48,3	45,0%	3,1	14,0	207.717
France	54,7	89,0%	1,4	14,0	93.041
Italy	42,9	67,4%	3,9	7,2	30.697
United Kingdom	48,9	82,7%	6,5	15,1	241.191
Canada	57,5	*88,0%*	6,5	17,5	186.722
EU 15 (1)	**47,6**	**66,7%**	**3,6**	**9,2**	**930.456**
Austria	46,5	46,3%	3,5	10,7	29.705
Belgium	44,9	60,0%	1,3	12,9	18.699
Denmark	60,4	53,3%	9,7	19,3	25.935
Finland	55,1	77,0%	12,8	15,9	71.372
Greece	47,8	31,4%	1,6	2,9	4.000
Ireland	35,0	*68,0%*	2,5	13,8	6.219
Luxembourg	55,5	91,4%	3,2	..	614
Netherlands	50,9	100,0%	2,1	15,6	89.227
Portugal	35,0	62,0%	1,8	5,0	5.999
Spain	37,1	47,8%	1,0	7,0	28.446
Sweden	68,3	*67,0%*	15,8	17,2	77.594
OECD (2)	**46,1**	**67,4%**	**4,8**	**14,3**	**4.700.632**
Norway	55,4	71,0%	13,6	19,0	49.725
Switzerland	59,7	57,0%	4,7	28,8	51.512
Iceland	54,9	84,0%	8,1	..	4.735
Australia	49,6	51,0%	7,0	4,8	161.166
New Zeland	47,0	98,0%	9,1	19,0	31.215
Mexico	9,2	82,7%	0,6	2,3	6.656
Turkey	20,1	55,6%	0,3	0,9	2.643
World	**11,8**	**61,9%**	**1,0**	**..**	**4.846.822**

Rem: italics refer to other year than that specified,<..> to non available data

Source: ITU
1) EU 15, PCs: do not include Luxembourg
2) OECD, PCs: do not include Iceland

The last entrants will have the newest technologies

	Information society infrastructures				
	tel. lines per 100 inhab.	Telecom network digitisation rate	Mobile phone per 100 inhab.	PC per 100 inhab.	Host connected to Internet
Ref. Year	*1994*	*1994*	*1994*	*1994*	*1994*
East Europe and Central Asia	**12,2**	**..**	**0,1**	**..**	**40.591**
Focus on: Russian Federation	16,2	..	0,0	0,8	1.849
North Africa and Middle East	**6,4**	**..**	**0,1**	**..**	**13.719**
Focus on: Egypt	4,2	55,0%	0,0	..	161
Israël	41,1	81,0%	1,2	7,9	13.251
Jordan	7,5	70,0%	0,0	..	0
Morroco	3,8	91,8%	0,1	..	0
Sub-Saharian Africa	**1,1**	**..**	**0,1**	**..**	**27.130**
Focus on: Botswana	3,1	*99,7%*	0,0	..	0
Ethiopia	0,3	44,5%	0,0	..	0
Ghana	0,3	58,0%	0,0	..	0
Mauritus	11,8	100,0%	0,5	..	0
Mozambique	0,4	57,0%	0,0	..	0
Namibia	4,7	78,3%	0,0	..	0
Senegal	0,9	87,0%	0,0		0
South Africa	9,7	66,2%	0,9	2,2	27.040
Tanzania	0,3	45,8%	0,0	..	0
Zimbabwe	1,3	32,0%	0,0	..	0
South Asia	**1,0**	**64,4%**	**0,0**	**..**	**359**
Focus on: Bangladesh	0,2	16,0%	0,0	..	0
India	1,1	66,0%	0,0	-	359
East Asia and Pacific	**8,0**	**65,9%**	**0,6**	**..**	**343.231**
Focus on: China	2,3	38,0%	0,1	0,2	569
Hong Kong	54,3	100,0%	7,4	11,4	12.437
Korea (rep)	40,0	61,8%	2,2	11,3	18.049
Malaysia	15,1	92,5%	3,0	3,4	1.606
Singapour	47,6	100,0%	8,4	15,4	5.252
Taïwan-China	39,9	83,8%	2,7	8,1	14.618
Vietnam	0,6	100,0%	0,0	..	0
Latin America and Caribbean	**8,6**	**61,6%**	**0,4**	**..**	**15.118**
Focus on: Argentina	14,3	62,6%	0,6	1,4	1.262
Brazil	7,5	35,7%	0,4	0,9	800
Peru	3,4	*28,7%*	0,0	..	171
World	**11,8**	**61,9%**	**1,0**	**..**	**4.846.822**

Rem: italics refer to other year than that specified,<..> to non available data

Source : ITU

The "haves" and "have nots" at a glance

	Socio-economic indicators				Information society infrastructures				
	Population (million)	Adults illetteracy rate	Total GDP (B US$)	GDP per capita ($)	tel. lines per 100 inhab.	Telecom network digitisation rate	Mobile phones per 100 inhab.	Television per 100 inhab.	Host connected to Internet
Ref. year	*1994*	*1990*	*1993*	*1993*	*1994*	*1994*	*1994*	*1994*	*1994*
G7	668,5	<5%	15.924	23.820	53,4%	68,7%	5,9%	64,1%	4.035.170
EU 15	370,2	nd	6.712	18.130	47,6%	66,7%	3,6%	47,9%	930.456
OECD	970,4	nd	18.854	19.430	46,1%	67,4%	4,8%	54,0%	4.700.632
East Europe and Central Asia	494,6	5%	1.094	2.212	12,2%	..	0,1%	25,1%	40.591
North Africa and Middle East	262,5	..	550	2.094	6,4%	..	0,1%	13,1%	13.719
Sub-Saharian Africa (1)	559,0	50%	269	482	1,1%	..	0,1%	3,2%	27.130
South Asia (2)	1.194,0	54%	314	263	1,0%	64,4%	0,0%	4,6%	359
East Asia and Pacific	1.735,2	24%	1.500	864	7,9%	65,9%	0,6%	26,4%	343.231
Latin America and Caribbean	466,3	15%	1.406	3.016	8,6%	61,6%	0,4%	21,1%	15.118
World	5.501,5	..	23.113	4.201	11,8%	61,9%	1,0%	21,9%	4.846.822

rem: <..> corresponds to non available data
1) South Asia TV : do not include Bhutan (68.000 inhab.)
2) Sub-Saharian Africa, TV: do not include Gambia, Guinea-Bissau, Malawi, S. Tomé & Principe, Cape Verde, Mayotte
Source: World Bank, ITU, Unesco

Technical notes

Population: mid-year estimates from the United Nations.

Adult illetteracy rate:15 years old people and older who cannot read or writen intelligibly a short and simple text in their daily life (Unesco).

GDP : current data price data in national currency converted to US$ by applying the official average annual exchange rate (World Bank).

Tel. lines, or main telephone lines: refer to telephone lines connecting a customer's equipment (e.g. telephone set, fax machine) to the Public Switched Telephone Network (PSTN) and which have a dedicated port on a telephone exchange (ITU).

Telecom network digitization rate: at the local loop level, calculated by dividing the number of main lines connected to a digital exchange by the total number of main lines (ITU).

Mobile phones: refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology that provides access to the PSTN (ITU).

Television: represent the estimated total number of both black and white and colour television sets in use (ITU).

Hosts connected to internet: refer to the number of computers in the economy that are directly linked to Internet (ITU).

Table 1: Household Ownership of Equipment — Appendix 2

(see Mika Kawachi Chapter 4)

	(1994 otherwise stated)	US	Japan	UK	Germany	France
1	No.of households ('93; million)	96.4	42.5	22.3	35.3	22.5
2	Share of households with TV set		99%	97%	99%	96%
3	Share of households with CATV	65%	21%(1)	4%	47%	9%
4	Share of households with satellite	...	27%	11%	20%	2%
5	Share of households with VCR	88%	73%	84%	65%	69%
6	Share of households with video game	42%	...	19%	8%	20%
7	Share of households with fax machine	...	8%	2%	4%	3%
8	Share of households with PC	35%	14%	22%	15%	13%
9	Share of households with PC modem	15%	...	4%	3%	1%
10	Share of households with CD-ROM drive	14%	...	2%	4%	2%

Estimated by dividing the total number of subscribers by the number of households

Source:
- 1 UN, Eurostat
- 2 Japan: EPA; Europe:
- 3,4,5 US & Europe: EITO, Inteco Corp.; Japan: Economic Planning Agency
- 6 EITO, Inteco Corp.
- 7,8 US & Europe: EITO, Inteco Corp.; Japan: EPA
- 9,10 Inteco Corp.

Table 2: Communication Infrastructure — Appendix 2

	(1994 otherwise stated)	US	Japan	UK	Germany	France
1	Number of main telephone lines (mil)	156.8	59.9	28.4	39.2	31.6
2	Main telephone lines per 100 inhabitants	60.2	48.0	48.9	48.3	54.7
3	Capacity used	95.6%	...	78.7%	86.7%	92.8%
4	Share of residential main lines	59.0%	69.0%	76.1%	88.0%	...
5	Share of digital main lines	65.0%	72.0%	82.7%	45.0%	89.0%
6	No.of international telephone circuits ('000)	84.2	24.7	51.0	4.3	...
7	Geographic availability of ISDN ('93)	...	...	95%	70%	100%
8	Number of households passed by cable ('93)	83%	...	16%	56%	23%
9	Fibre optic cable	7,916,470 fibre miles	131,90 cable km	2,337,0 00 km	...	...

Source:
- 1-6 ITU
- 7,8 EITO (IDC)
- 9 Communications Outlook 1995, OECD

Table 3: Communication Service Subscribers and Traffic **Appendix 2**

	(1994 otherwise stated; '000)	*US*	*Japan*	*UK*	*Germany*	*France*
1	Population (million)	260.53	124.78	58.09	81.14	57.73
2	Subscribers to telephone	156,770	59,870	28,389	39,200	31,600
3	Number of leased circuits	13,500	1,032	500	817	543
4	Number of high-speed digital circuits	...	30.8[1]	...	...	...
5	Subscribers to ISDN	352	239	50	428	103
6	Subscribers to packet switched data networks	...	399	46	93	106
7	Subscribers to cellular mobile telephone	24,134	4,300	3,757	2,501	804
8	Subscribers to radio paging	24,500	8,064	700	554	290
9	Subscribers to cable TV	60,495	10,400	916	14,600	1,626
			(2,010)[2]			
10	Subscribers to home satellite	3,800	5,863	3,390	8,320	1,010
11	Number of telephone calls ('90)	467.9	75.1	...	35.4[3]	104.7
12	Telephone traffic (no.of calls/ subscribers x days; '90)	10.13	3.85	...	3.30[3]	10.43
13	International telephone traffic (outgoing minutes per inhabitant)	50.4	11.3	55.5	61.1	43.3

1 number in brackets represents that of urban cable TV
2 the number is part of the total number of leased circuits
3 that of former Federal Republic of Germany

Source:

1	UN
3,5,7,8,10,13	ITU
4	Japan's MPT
6	ITU, UK: EITO
9,11,12	ITU, Japan: MPT

	(1994 otherwise stated)	*US*	*Japa n*	*UK*	*Germany*	*France*
1	Local residential telephone(1): Installation (US$)	43.5	712.3	178.0	40.1	55.5
	Monthly subscriptions	*11.3*	*15.2*	*12.6*	*15.2*	*8.1*
2	Local business telephone(1): Installation (US$)	76.8	712.3	178.0	40.1	55.5
	Monthly subscription	*42.6*	*23.0*	*20.5*	*15.2*	*17.1*
3	Residential telephone(2)Fixed (average annual spending)	171	112	188	131	92
	Usage	*219*	*210*	*183*	*227*	*277*
4	Business telephone(3)Fixed (average annual spending)	220	170	240	131	155
	Usage	*740*	*669*	*570*	*856*	*810*
5	Int'l telephone charges(4)Residential (Index: OECD average as 100)	103.5	78.7	101.4	94.7	98.5
	Business	*113.2*	*91.8*	*96.1*	*96.7*	*94.7*
6	Leased line charges(5)9.6 kbit/s (US$ PPP)	45,542	38,910	39,514	68,582	47,622
	64 kbit/s	76,565	70,771	43,229	78,075	71,705
	1.5/2.0 mbit/s	423,435	558,271	211,233	414,346	435,291
7	Packet switched data comm(6)Fixed (US$ PPP)	6,348	1,855	7,804	2,441	3,337
	Usage	*2.419*	*10.547*	*6.243*	*11.783*	*4,509*
8	Mobile telecom tariffs(7)Fixed (US$ PPP)	496	911	504	380	928
	Usage	*1.264*	*948*	*840*	*1,109*	*1,010*

1 Monthly subscription refers to the recurring fixed charge for subscribing to the PSTN; some countries include a number of free local calls in the subscription
2 Include tax; the usage charge includes a basket of 966 calls; US is for Nynex, UK for BT
3 Excluding tax; the usage charge includes a basket of 2,694 calls
4 Based on call pair methodology; the residential basket includes tax and business basket excludes tax
5 Excludes tax; US is for Nynex, Japan for NTT, UK for BT
6 Excludes tax; the usage charge includes a basket of 1,197 calls of trunk or local calls made at different times of the day
7 Excludes tax; the usage charge includes a basket of 741 calls; US is for Nynex, Japan for NTT Mobile, UK for Vodafone, Germany for DBP

Source:
1-2 ITU
3-8 OECD. 1995. Communications Outlook

Table 5: On-line Services **Appendix 2**

	(1994 otherwise stated; '000)	*US*	*Japan*	*UK*	*Germany*	*France*
1	Subscribers to commercial on-line services	6.197	2,597		<1,000 (Europe)	
2	Subscribers to videotex services	...	166	95	708	7,000
3	Spending on electronic information (US$bil)	13.6 ('93)	1.7 ('92)		3.8 (EC; '92)	
4	Sales of databases ('93; US$mil)	11,800	2,100(1)	(1,890)	(460)	(575)
5	Share of households with PC	35%	14%	22%	15%	13%
6	Share of households with PC modem	15%	...	4%	3%	1%
7	Share of households with commercial on-line subscription	5%	...	1%	1%	0%

1: Calculated at 1 dollar = 100 yen

Source:

1 US: SIMBA (as of 12/1994); Japan: Association for New Media Development (as of 6/1994)
2 Japan: MPT; Europe: ITU
3 U.S. Department of Commerce, International Trade Administration
4 US: LINK Resources Corp.; Japan: MITI's survey ("Database White Paper 1995")
5,6 Inteco Corp.
7 US: Jupiter Communications; Europe: Inteco Corp.

Table 6: Major On-line Service Providers and Subscribers **Appendix 2**

US (9/1995)	*('000)*	*Japan (6/1994)*	*('000)*
America Online	3,800.0	PC-VAN	764.0
CompuServe	3,540.0	NIFTY-Serve	690.0
Prodigy	1,720.0	Asahi Net	180.0(2)
Microsoft Network	525.0(1)	People	180.0(2)
Delphi (News Corp.)	125.0	ASCII-Net	97.0
eWorld (Apple)	115.0	J&P Hotline	37.7
GEnie (GE)	...	NTT PC Network (3/94)	33.0
		EYE-Net	24.0
		Tokyo BBS	21.5
		Nikkei Mix	18.0
		Tele-Star	15.0
		Lions	15.0
		Master Net	14.0
		K-Net	13.8
		Pana-VAN/Silk	12.0
		YOMI-Net	12.0
		PCOM-Host	10.0
		Super Links	5.0

1. Quoted by Financial Times (11/1995)
2. The number represents the total number of users of Asahi Net and People that are interlinked

Source: US: IISR via PR Newswire, Japan: Association for New Media Development (Names are that of networks)

(1994 otherwise stated)		US	Japan	UK	Germany	France
1	Number of Internet hosts (7/95)	4,268,648	159,776	291,258	350,707	113,974
2	Number of Internet networks	15,255	824	769	896	1,051
3	Estimated no.of Internet users ('000)	17,485	531	1,326	1,142	512
4	Users per 10,000 inhabitants	671	43	228	141	89
5	Number of Internet domains (7/95;'000)	80.2	5.5	5.2	3.7	1.7
6	Traffic(2) (bytes into NSFNET; 10(4)MB)	888.0	4.4	7.6	4.9	6.7
	(bytes from NSFNET; 10(4)MB)	838.0	8.0	10.7	8.5	5.0
7	Revenues for Internet access provisions (US$mil)	1,071 (521.4)(3)	204.4(1)	11.6	5.4	8.3
8	IAP monthly charges(4) (8/95; US$PPP)	20.64	53.04	14.67	108.06	61.37
9	Internet access annual charges(5) (IAP&PTO; US$PPP)	384	1,707	903	1,676	1,280

1 Calculated at 1994 year average exchange rate of 102.21 yen per US$
2 Montly average
3 Number in brackets represents revenues of IAPs only
4 Monthly charge for 'dial-up' service at 20 hours/month
5 Includes IAP and PTO (at standard PSTN rate) charges; Numbers represent the lowest charges surveyed in each country

Source:
1,2 Internet Society
3,4 ITU
5 http://www.catalog.com/zone/www/dist-bynum.html
6 Mark Lottor (4/1995)
7 US: Maloff Company; Japan: Nikkei Communications (4/1995); Europe: Ovum Ltd.
8,9 OECD

Table 8: Major Internet Access Providers — Appendix 2

US	US$mil(1)	Japan	no.of subscribers (2)	Europe (3)
UUNet Technologies	46.78	Internet Initiatives Japan	3,200	Pipex Ltd. (UK)
NETCOM	31.22	Fujitsu	1,100	EU-Net Deutschland (Germany)
Sprint	29.94	Japan ENS AT&T	500	Worldnet (France)
Performance Systems International	22.92	NEC		
Supernet (Colorado)	10.37	IBM Japan		
Advanced Network & Services	10.30	Winsystem		
CERFnet	8.00	Catena Enterprises		
BBN	6.82	Japan Media Services		
World (Software Tool & Die)	4.75	PSI Japan		
SURAnet (BBN)	4.35	Rapid System		

1 Revenues from Internet connectivity services only and do not include other sources such as consulting, training, security services, hardware, or "CyberMalls"; annualised as of January 1995
2 The number of contracts for subscription; the total estimated was 5,000
3 No data available

Source: US: Maloff Company; Japan: Nikkei Communications (4/1995); Europe: Business Week (4/1995)

Table 9: Sales of Computer Software Programs by 52 Publishers (U.S.) — Appendix 2

(1994)	Sales (US$mil)	Share	Units ('000)	Share
Games/other home products	169.2	26%	7,551	33%
Content(1)	156.0	24%	6,279	28%
Home education	106.6	16%	6,238	27%
Languages & Tools	102.6	16%	490	2%
Others	113.1	17%	2,231	10%
Total	647.5	100%	22,789	100%

1 Includes encyclopedias, guide books, reference works etc.

Source: Software Publishers Association

Table 10: CD-ROM Disk Sales by Platform (Japan) Appendix 2

(1994)	*Sales (US$mil)*(1)	*Share*
PC	598.8	39.4%
Karaoke video (business use)	475.5	31.3%
Video game	323.8	21.3%
Karaoke video (home use)	48.9	3.2%
PDA	41.1	2.7%
Car navigation	31.3	2.1%
Total	1,519.4	100%

1 Calculated at 1994 year average exchange rate of 102.21 yen per US$
Source: Multimedia Association of Japan

Table 11: Multimedia Content and Services (Japan) Appendix 2

		Sales (US$mil; '94)	*Share*
CD-ROMs	for PC platform	598.8	8.6%
	for other platforms	920.6	13.2%
	sub total	1,519.4	21.8%
Game cartridges		3,675.8	52.7%
Other software	Game soft used at game centers	440.3	6.3%
	Software dev. for multimedia PC in firms	374.7	5.4%
	Others	366.9	5.2%
	sub total	1181.9	16.9%
	Multimedia content - total	6,377.1	91.4%
Network services	On-line services	386.5	5.5%
	Internet access service	29.4	0.4%
	Multimedia portion of ISDN/leased lines(1)	187.8	2.7%
	Network services - total	603.7	8.6%
	Grand total	6,980.8	100%

1 Calculated by assuming the multimedia portion to be 6.0% of ISDN revenues and 2.2% of leased circuits and high-speed digital circuits revenues
Source: Multimedia Association of Japan

European Commission

EUR 16676 — The Economics of the Information Society

Luxembourg: Office for Official Publications of the European Communities

1996 — 298 pp. — 16.2 x 22.9 cm

ISBN 92-827-9523-3

Price (excluding VAT) in Luxembourg: ECU 31.50

Venta • Salg • Verkauf • Πωλήσεις • Sales • Vente • Vendita • Verkoop • Venda • Myynti • Försäljning

BELGIQUE/BELGIË

Moniteur belge/Belgisch Staatsblad
Rue de Louvain 40-42/
Leuvenseweg 40-42
B-1000 Bruxelles/Brussel
Tél. (32-2) 552 22 11
Fax (32-2) 511 01 84

Jean De Lannoy
Avenue du Roi 202/
Koningslaan 202
B-1060 Bruxelles/Brussel
Tél. (32-2) 538 51 69
Fax (32-2) 538 08 41
E-mail: jean.de.lannoy@infoboard.be

Librairie européenne/Europese Boekhandel
Rue de la Loi 244/
Wetstraat 244
B-1040 Bruxelles/Brussel
Tél. (32-2) 295 26 39
Fax (32-2) 735 08 60

DANMARK

J. H. Schultz Information A/S
Herstedvang 10-12
DK-2620 Albertslund
Tlf. (45) 43 63 23 00
Fax (45) 43 63 19 69
E-mail: schultz@schultz.dk
URL: www.schultz.dk

DEUTSCHLAND

Bundesanzeiger Verlag
Breite Straße 78-80
Postfach 10 05 34
D-50667 Köln
Tel. (49-221) 20 29-0
Fax (49-221) 20 29 278

Nur für Veröffentlichungen des Gerichtshofes

Carl Heymanns Verlag KG
Luxemburger Strasse 449
D-50939 Köln
Tel. (49-221) 94 373-0
Fax (49-221) 94 373-901

GREECE/ΕΛΛΑΔΑ

G.C. Eleftheroudakis SA
International Bookstore
Panepistimiou 17
GR-105 64 Athens
Tel. (30-1) 331 41 80/1/2/3
Fax (30-1) 323 98 21
E-mail: elebooks@netor.gr

ESPAÑA

Mundi Prensa Libros, SA
Castelló, 37
E-28001 Madrid
Tel. (34-1) 431 33 99/431 32 22
Fax (34-1) 575 39 98
E-mail: mundiprensa@tsai.es
URL: www.tsai.es/mprensa

Boletín Oficial del Estado
Trafalgar, 27-29
E-28071 Madrid
Tel. (34-1) 538 22 95 (Libros)/
384 17 15 (Suscripciones)
Fax (34-1) 538 23 49 (Libros)/
384 17 14 (Suscripciones)
URL: www.boe.es

Mundi Prensa Barcelona
Consell de Cent, 391
E-08009 Barcelona
Tel. (34-3) 488 34 92
Fax (34-3) 487 76 59

FRANCE

Journal officiel
Service des publications des CE
26, rue Desaix
F-75727 Paris Cedex 15
Tél. (33-1) 40 58 77 01/31
Fax (33-1) 40 58 77 00

IRELAND

Government Supplies Agency
Publications Section
4-5 Harcourt Road
Dublin 2
Tel. (353-1) 661 31 11
Fax (353-1) 475 27 60

ITALIA

Licosa SpA
Via Duca di Calabria, 1/1
Casella postale 552
I-50125 Firenze
Tel. (39-55) 64 54 15
Fax (39-55) 64 12 57
E-mail: licosa@ftbcc.it
URL: id382.cilea.it/Virtual_Library/bibliot/vetrina/licosa/tt1.htm

GRAND-DUCHÉ DE LUXEMBOURG

Messageries du livre Sarl
5, rue Raiffeisen
L-2411 Luxembourg
Tél. (352) 40 10 20
Fax (352) 490 661
E-mail: mdl@pt.lu

Abonnements:

Messageries Paul Kraus
11, rue Christophe Plantin
L-2339 Luxembourg
Tél. (352) 499 88 88
Fax (352) 499 888 444
E-mail: mpk@pt.lu
URL: www.mpk.lu

NEDERLAND

SDU Servicecentrum Uitgevers
Christoffel Plantijnstraat 2
Postbus 20014
2500 EA 's-Gravenhage
Tel. (31-70) 378 98 80
Fax (31-70) 378 97 83
E-mail: sdu@sdu.nl
URL: www.sdu.nl.

ÖSTERREICH

Manz'sche Verlags- und Universitätsbuchhandlung GmbH
Siebenbrunnengasse 21
Postfach 1
A-1050 Wien
Tel. (43-1) 53 161 334 / 340
Fax (43-1) 53 161 339
E-mail: auslieferung@manz.co.at
URL: www.austria.EU.net:81/manz

PORTUGAL

Imprensa Nacional-Casa da Moeda, EP
Rua Marquês de Sá da Bandeira, 16 A
P-1050 Lisboa Codex
Tel. (351-1) 353 03 99
Fax (351-1) 353 02 94/384 01 32

Distribuidora de Livros Bertrand Ld.ª
Rua das Terras dos Vales, 4 A
Apartado 60037
P-2701 Amadora Codex
Tel. (351-1) 495 90 50/495 87 87
Fax (351-1) 496 02 55

SUOMI/FINLAND

Akateeminen Kirjakauppa / Akademiska Bokhandeln
Pohjoisesplanadi 39/
Norra esplanaden 39
PL/PB 128
FIN-00101 Helsinki/Helsingfors
Tel. (358-9) 121 41
Fax (358-9) 121 44 35
E-mail: akatilaus@stockmann.mailnet.fi
URL: booknet.cultnet.fi/aka/index.htm

SVERIGE

BTJ AB
Traktorvägen 11
PO Box 200
S-22100 Lund
Tel. (46-46) 18 00 00
Fax (46-46) 18 01 25
E-mail: btj_tc@mail.btj.se
URL: www.btj.se/media/eu

UNITED KINGDOM

The Stationery Office Ltd (Agency Section)
51, Nine Elms Lane
London SW8 5DR
Tel. (44-171) 873 9090
Fax (44-171) 873 8463
URL: www.the-stationery-office.co.uk

ICELAND

Bokabud Larusar Blöndal
Skólavördustig, 2
IS-101 Reykjavik
Tel. (354) 55 15 650
Fax (354) 55 25 560

NORGE

NIC Info A/S
Østenjoveien 18
Boks 6512 Etterstad
N-0606 Oslo
Tel. (47-22) 97 45 00
Fax (47-22) 97 45 45

SCHWEIZ/SUISSE/SVIZZERA

OSEC
Stampfenbachstraße 85
CH-8035 Zürich
Tel. (41-1) 365 53 15
Fax (41-1) 365 54 11
E-mail: urs.leimbacher@ecs.osec.inet.ch
URL: www.osec.ch

ČESKÁ REPUBLIKA

NIS CR - prodejna
Konviktská 5
CZ-113 57 Praha 1
Tel. (42-2) 24 22 94 33
Fax (42-2) 24 22 94 33
E-mail: nkposp@dec.nis.cz
URL: www.nis.cz

CYPRUS

Cyprus Chamber Of Commerce & Industry
38, Grivas Digenis Ave
Mail orders:
PO Box 1455
CY-1509 Nicosia
Tel. (357-2) 44 95 00/46 23 12
Fax (357-2) 361 044
E-mail: cy1691_eic_cyprus@vans.infonet.com

MAGYARORSZÁG

Euro Info Service
Európa Ház
Margitsziget
PO Box 475
H-1396 Budapest 62
Tel. (36-1) 11 16 061/11 16 216
Fax (36-1) 302 50 35
E-mail: euroinfo@mail.matav.hu
URL: www.euroinfo.hu/index.htm

MALTA

Miller Distributors Ltd
Malta International Airport
PO Box 25
LQA 05 Malta
Tel. (356) 66 44 88
Fax (356) 67 67 99

POLSKA

Ars Polona
Krakowskie Przedmiescie 7
Skr. pocztowa 1001
PL-00-950 Warszawa
Tel. (48-2) 26 12 01
Fax (48-2) 26 62 40

TÜRKIYE

Dünya Infotel A.S.
Istiklâl Cad. No: 469
TR-80050 Tünel-Istanbul
Tel. (90-212) 251 91 96
(90-312) 427 02 10
Fax (90-212) 251 91 97

BĂLGARIJA

Europress-Euromedia Ltd
59, Bld Vitosha
BG-1000 Sofia
Tel. (359-2) 80 46 41
Fax (359-2) 80 45 41

HRVATSKA

Mediatrade Ltd
Pavla Hatza 1
HR-10000 Zagreb
Tel. (385-1) 43 03 92
Fax (385-1) 44 40 59

ROMÂNIA

Euromedia
Str. G-ral Berthelot Nr 41
RO-70749 Bucuresti
Tel. (40-1) 210 44 01/614 06 64
Fax (40-1) 210 44 01/312 96 46

SLOVAKIA

Slovenska Technicka Kniznica
Nàmestie slobody 19
SLO-81223 Bratislava 1
Tel. (42-7) 53 18 364
Fax (42-7) 53 18 364
E-mail: europ@tbb1.sltk.stuba.sk

SLOVENIA

Gospodarski Vestnik
Zalozniska skupina d.d.
Dunajska cesta 5
SI-1000 Ljubljana
Tel. (386) 61 133 03 54
Fax (386) 61 133 91 28
E-mail: belicd@gvestnik.si
URL: www.gvestnik.si

ISRAEL

R.O.Y. International
17, Shimon Hatarssi Street
PO Box 13056
61130 Tel Aviv
Tel. (972-3) 546 14 23
Fax (972-3) 546 14 42
E-mail: royil@netvision.net.il

Sub-agent for the Palestinian Authority:

Index Information Services
PO Box 19502
Jerusalem
Tel. (972-2) 27 16 34
Fax (972-2) 27 12 19

RUSSIA

CCEC
60-letiya Oktyabrya Av. 9
117312 Moscow
Tel. (095) 135 52 27
Fax (095) 135 52 27

AUSTRALIA

Hunter Publications
PO Box 404
3167 Abbotsford, Victoria
Tel. (61-3) 9417 53 61
Fax (61-3) 9419 71 54

CANADA

Uniquement abonnements/
Subscriptions only:

Renouf Publishing Co. Ltd
1294 Algoma Road
K1B 3W8 Ottawa, Ontario
Tel. (1-613) 741 73 33
Fax (1-613) 741 54 39
E-mail: renouf@fox.nstn.ca
URL: fox.NSTN.Ca/~renouf

EGYPT

The Middle East Observer
41, Sherif Street
Cairo
Tel. (20-2) 39 39 732
Fax (20-2) 39 39 732

JAPAN

PSI-Japan
Asahi Sanbancho Plaza #206
7-1 Sanbancho, Chiyoda-ku
Tokyo 102
Tel. (81-3) 3234 69 21
Fax (81-3) 3234 69 15
E-mail: psijapan@gol.com
URL: www.psi-japan.com

SOUTH AFRICA

Safto
5th Floor Export House,
CNR Maude & West Streets
PO Box 782 706
2146 Sandton
Tel. (27-11) 883 37 37
Fax (27-11) 883 65 69

UNITED STATES OF AMERICA

Bernan Associates
4611-F Assembly Drive
MD20706 Lanham
Tel. (301) 459 2255 (toll free telephone)
Fax (800) 865 3450 (toll free fax)
E-mail: query@bernan.com
URL: www.bernan.com

MÉXICO

Mundi-Prensa Mexico, SA de CV
Río Pánuco, 141
Delegación Cuauhtémoc
ME-06500 México DF
Tel. (52-5) 553 56 58/60
Fax (52-5) 514 67 99
E-mail: 104164.23compuserve.com

RÉPUBLIQUE DE CORÉE

Kyowa Book Company
1 F1. Phyung Hwa Bldg
411-2 Hap Jeong Dong, Mapo Ku
121-220 Seoul
Tél. (82-2) 322 6780/1
Fax (82-2) 322 6782
E-mail: kyowa2@ktnet.co.kr.

ANDERE LÄNDER/OTHER COUNTRIES/AUTRES PAYS

Bitte wenden Sie sich an ein Büro Ihrer Wahl / Please contact the sales office of your choice / Veuillez vous adresser au bureau de vente de votre choix

NOTICE TO THE READER

All scientific and technical reports published by the European Commission are announced in the periodical **'euro abstracts'**, published every two months, and in the R&TD publications database of CORDIS, the Community Research and Development Information Service.
For subscription (1 year: ECU 65) please write to the address below.

10 15 17 CD-NA-16-676-EN-C

Price (excluding VAT) in Luxembourg: ECU 31.50

ISBN 92-827-9523-3

OFFICE FOR OFFICIAL PUBLICATIONS
OF THE EUROPEAN COMMUNITIES

L-2985 Luxembourg

9 789282 795231