Telecommunications

Capello, R.; Nijkamp, P.

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Telecommunications: Implications and Policies for a Sector in Transition

R. Capello
P. Nijkamp

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Telecommunications:

Implications and Policies for a Sector in Transition

Roberta Capello and Peter Nijkamp

1. Introduction (*)

Major structural changes have affected the telecommunications industry during the past two decades. These changes have encompassed technology, regulatory frameworks, market structures, and industry output. The result of these profound changes is the transformation of this industry's image from that of a public utility offering a limited and monopolistic service and operating in a stable and unchanging market structure, to an industry at the forefront of technological change, providing a host of different services and products, operating in a highly competitive market system and destined to transform societies and economic structures (OECD, 1988a and 1988b).

The significance of telecommunications in a modern economy has little to do with the "traditional" telephony function of interpersonal communications. Its significance lies in its "technological convergence" with computing technologies, which has greatly expanded the economic potentialities of telecommunications. By enabling computers to communicate over space, and by enabling people to communicate through computers, the new Information and Communications Technologies (ICTs), emerging from this "technological convergence", ly at the heart of a compound set of technological and economic transformations conveyed by the term "Information Economy" (Gillespie et al., 1987; Jonscher, 1983; Porat, 1977).

The growing awareness of the changing role of telecommunications in the economy raises a fundamental question about the reasons of these structural changes. Although technological dynamics are generally pinpointed as the major causes for modifications in the telecommunications sector, an analysis of this transformation process focusing only on the technological aspects would be misleading in trying to conceptualise the new characteristics of the telecommunications sector.

In this context, at least four factors can be regarded as prominent causes of the transformation of the sector:

- technological dynamics. Although it is not the unique reason for change, the technological revolution is certainly playing

an important role in the development trajectories of the ICT sector. A host of product innovations takes place, from digitalisation of switching and transmission equipments to a broad range of new services which offer high transportation possibilities of data, voice, text and images (section 2);

- institutional dynamics, changing the market structure from a monopoly to a competitive market, imposing new "game rules", after decades of traditional static oligopoly (in manufacturing firms market) and monopoly régimes (in the service market) (section 3);

- market dynamics, stemming from an increased awareness of users about the strategic importance of these infrastructures, and stimulated through customers' attempt to influence suppliers towards specific products and innovation, thus acting as "technological gatekeepers" (section 4);

- new economic relationships characterising the telecommunications "filière", representing the matrix of economic relationships among manufacturing firms, and between suppliers, the operator and customers. The traditional oligopolistic rules which have historically governed manufacturing firms and their linkages with public operators have been substituted in the last decades for more competitive rules, by low national protective barriers and by greater competitive threats coming from firms belonging to previously separated sectors (section 5).

Seen from these perspectives, the transition process from telecommunications to computer networks is far from being a simple development trajectory and is fraught with many difficulties, inevitably posing important questions on the implications this transformation can have for the future development of the sector.

The aim of the present paper is to offer a more detailed mapping of the transition phase in the telecommunications sector, through the definition of reasons and implications of changes, which is crucial to develop some policy recommendations (section 6) to face these structural changes and to allow a high development rate for the sector.

2. Technological Dynamics

It is undoubtedly true that a radical technological process is governing the telecommunications sector. From the analysis of this dynamics some crucial and basic features of this phenomenon emerge, which can be summarised as follows (Capello, 1991):

a) pervasiveness;

b) change in intersectoral barriers;
c) national trajectories of technological development.

The technological changes taking place in the telecommunications sector encompass both the manufacturing and the service sectors. As regards the manufacturing sector, all three main branches of the equipment industry (switching, transmission and customer premises equipments) have been widely influenced by radical technological changes, increasing technological potentialities of products and new innovative output. In this field rather radical innovations are embodied in the transition from analogue to digital switching equipment, or from cables and wires to fibre-optics, or, again, from microwave systems to satellites (Monk, 1989; Tolmie, 1987).

Even more evident appears the host of radical innovations taking place in the service sector, offered on more advanced physical infrastructures and thus capable of transmitting text, voice, image and data.

More interesting than this is the phenomenon of pervasiveness related to the demand side. The diffusion of new information and communication technologies is taking place horizontally in all sectors of the economy, given the strategic importance these technologies represent to pursue a better economic performance.

For mature sectors these new technologies represent a means to achieve economic rejuvenation, as it is the case for the textile and banking systems. Both these sectors exploit product and process innovations through the use of computer networks, despite their high mature output and standardised production processes (Camagni and Rabellotti, 1988; Camagni and Capello, 1990). The importance of new technologies is once more true when we speak of high-tech sectors, highly benefiting from the existence of new technologies both as producers and as users.

Pervasiveness is also characterising the geographical diffusion of these technologies: both core and periphery regions have an interest in developing these technologies. Peripheral regions are supposed to exploit information and capital and thus to need more strategic resources which are not equally distributed over space. By the same token, core areas are interested in infrastructural endowment, even more so if these infrastructures represent the strategic means towards comparative advantages.

Another characteristic of the technological dynamics taking place in the telecommunications sector is its ability of destroying traditional inter-sectoral barriers, and opening up competition between previously separated sectors. The software component in new networks and services has risen to a high percentage, legitimating informatics firms to enter the

telecommunications market. For traditional telecommunications firms the threat towards these new entrants is strenghtened by two factors:

- the lack of technical know-how required to produce new services with high software components;

- the lack of managerial know-how to develop strategic corporate policies in highly competitive markets, originated by years of collusive oligopolistic rules that never stimulated aggressive market policies.

National responses to these pressures and changes have varied a lot, reflecting in part differences in national market characteristics, and to a large extent differences in the market structure (monopolistic versus competitive markets).

Technological trajectories have thus followed national development patterns. Table 1 represents a summary of the development of digital networks in most developed countries, Italy and Spain representing less advanced countries in terms of new technologies development.

These national differences become crucial once countries foresee a possible liberalisation of the sector, which would not prevent local industries from international competition. Internationalisation of the telecommunications sector would in fact underline national differences in the telecommunications industry performance, thus devastating internationally less advanced firms.

The existing technological asymmetry in advanced networks and services among countries reflects at least different time trajectories of new investments rather than different intentions in investments. Even in this case, the threat of this asymmetry is that it can turn into a discontinuity in the existence of physical networks, thereby disenfranchise national realities from participation in a networked economy (Williams and Gillespie, 1989; Sciberras and Payne, 1986).

3. Institutional Dynamics

Despite the fact that in Europe no countries have taken drastic steps to alter the telecommunications market structure, the EC recognises the need to provide some common rules to achieve equal institutional trajectories in all EC countries. The EC proposal, expressed in the Green Paper published in 1987, provides an intermediate model with regard to the two previous extreme models. In abstract terms, in fact, the regulatory structure is based on two conflicting regulatory principles:

- on the one hand, the objective of "universal service provision", measured in terms of both quality and quantity; in essence a supply-led concept;

- on the other hand, a differentiated development of services by key customers in high value added, high growth markets; in essence a demand-led concept.

The model suggested by the EC proposes an intermediate position, represented by:

- a competitive structure in customer premises equipments markets;

- a competitive structure in advanced services markets;

- a monopoly structure in basic networks and services.

This model rests on the assumption that the basic telecommunications services have to be thought of as universal services, and that for this reason they have to be provided to everybody at the same price. The protection of monopoly in the area of basic networks and services can guarantee the cross-subsidy mechanism supporting the notion of universal service, where prices do no reflect costs but are artificially deduced through cross-subsidy mechanisms.

The EC recognises, instead, the necessity to create a competitive market in most technologically dynamic areas, such as value added services and customer premises equipments, where the monopoly structure might damage - by its very limited innovative stimulus - the development of more advanced services and equipments (Camagni and Capello, 1989; Capello, 1989).

Despite the first positive impression, even this model provokes some imbalances and generates problems during its implementation (Capello, 1991b):

- first of all, there is the hard decision about which services can be recognised as advanced services (and thus provided by private companies) and which services are still supplied under a monopoly regime;

- secondly, the recognition of private networks in competition with public networks for the provision of value added services opens up the problem of avoiding capacity resale from private companies, which would destroy the income of public monopoly and thus its capacity of providing a universal network-based service.

In the so-called "accompanying measures", the EC provides some rules to avoid these distorsion mechanisms to occur, by imposing:

Table 1 - Number of digital lines installed by geographical areas 1988

	A1	A2	A3	A4
Usa	127.2	45.0	82.2	28.07%
Giappone	51.7	9.0	42.7	14.58%
Francia	25.8	15.6	10.2	3.48%
Uk	23.4	5.5	17.9	6.11%
Germania Ovest	27.0	1.4	25.6	8.74%
Italia	20.0	2.2	17.8	6.08%
Spagna	10.5	0.7	9.8	3.35%
Svezia	6.1	1.8	4.3	1.47%
Ausralia	7.1	1.3	5.8	1.98%
Argentina	3.2	0.2	3.0	1.02%
Brasile	8.8	0.7	8.1	2.77%
Cecoslovacchia	2.1	0.1	2.0	0.68%
Cina	8	0.7	7.3	2.49%
Sudcorea	9.6	1.7	7.9	2.70%
India	3.5	0.3	3.2	1.09%
Indonesia	0.8	0.2	0.6	0.20%
Jugoslavia	3.1	0.2	2.9	0.99%
Malaysia	1.3	0.9	0.4	0.14%
Messico	4.3	0.7	3.6	1.23%
Rdt	1.8	0.2	1.6	0.55%
Taiwan	5.7	0.6	5.1	1.74%
Ungheria	0.8	0.1	0.7	0.24%
Ussr	30.3	0.2	30.1	10.28%
TOTALE	382.1	89.3	292.8	100.0%
Aree Geografiche				
Europa Occident.	142.9	32.3	110.6	31.94%
Nord America	140.6	50.3	90.3	26.08%
America Latina	19.8	2.5	17.3	5.00%
Africa/Medio Or.	9.5	2.7	6.8	1.96%
Asia/Pacifico	93.7	12.6	81.1	23.42%
Europa Orientale	40.9	0.7	40.2	11.61%
Totale	447.4	101.1	346.3	100.0%

Source: Zanfei, 1990

A1: Total lines installed
A2: Total digital lines installed
A3 and A4 : Potential of substitution

- an official list of basic-networks services to be offered under a monopoly regime - telephone, telex and data transmission - leaving again some doubts about what is meant by "data transmission";

- a revision of tariff structures for private networks, which should be calculated on the basis of the volume of transported information - i.e., a tariff should be closer to costs and should not differ from one country to another, as happens at present (Table 2). In this way, the economic interest on which the capacity resale rests, would be completely disrupted;

- an abolishment of cross-subsidy mechanisms between telecommunications and postal services, the second ones having always been heavily subsidised from the first ones, thus limiting financial resources available to be invested again in the public telecommunications domain.

The complex dilemma created by the two contrasting principles is witnessed by the fact that after ten years of intense debate over the best market stucture in the telecommunications sector still no common agreements have been reached, each Country develops its institutional structure following its own policy (see Table 3) and even the EC intervention in this field has left unsolved some critical problems about tariff, cross-subsidy mechanisms and, more important, legitimacy in private companies service provision (Allen, 1990; Bradley and Hausman, 1989; Brock, 1981; Cradall and Flamm, 1989; Foreman-Peck and Mueller, 1988; Evans, 1983; Kahn, 1970; Phillips, 1990; Philips, 1990; Von Weizsaecker and Wieland, 1988).

Despite their still unsure development patterns, these institutional changes have affected the telecommunications supply through two crucial elements, the first represented by the extreme national trajectories of the liberalisation process, despite the EC efforts to ensure a new uniform process, and the second by the different degree of liberalisation in different branches.

The existing differences in the national trajectories will become crucial once liberalisation will be imposed in all countries, when the specific innovative capacities of each single country will be tested. Inevitably, firms which had to face competition for a longer period will have more advantages in terms of marketing policies than those used to operate in an oligopolistic market. Their privileged position will stem from:

- more consolidated market policies, based on their longer experience on the market and their longer contacts with customers;

Table 2 - Telephone charges in the EC in 1986 - Comparison of tariff structure and levels

Country	Connection charge	Standing charge		Local call charge (LC) (3 mins.)	Trunk call charges		Inter-Community calls*	
		Private	Business		Up to 100 km (TC1)	Maximum distance (TC2)	From	To
United Kingdom	150	9.00	14.02	0.21	0.56	0.56	1.94	2.12
Italy	161	4.48	11.54	0.20	1.62	1.72	2.92	2.16
Belgium	116	10.50	10.50	0.14	0.69	0.69	2.22	2.10
Ireland	235	11.20	15.10	0.14	1.26	1.26	2.88	2.30
Luxembourg	58	5.78	5.78	0.12	-	-	1.41	2.10
France	36	5.67	13.82	0.11	0.85	1.59	1.85	2.10
Germany	31	10.80	10.80	0.11	1.00	1.66	1.67	2.13
Denmark	189	9.88	9.88	0.10	0.36	0.36	1.31	2.31
Netherlands	97	9.81	9.81	0.06	0.26	0.36	1.75	2.09
Portugal	66	7.98	7.98	0.05	1.19	1.19	2.88	2.40
Greece	199	2.23	2.23	0.03	1.15	1.15	2.73	2.33
Spain	83	6.66	7.03	0.03	0.60	1.07	3.15	3.15

* In ECUs including VAT. in Germany, Ireland, the Netherlands and Luxembourg no VAT is charged on telephone bills.
[b]Average charges from one member country to the other EC countries and vice versa.
[c]Ratio of trunk calls (TC1 or TC2) to local calls (LC).
Source: Telefónica, Revista T., No. 16. October 1987.

Source: Mueller, 1991

Table 3 - Institutional situation in most developed countries - 30/4/91

Countries	Italy	U.K.	France	Germany	USA	Japan
Relation between post and telecom services	Separated/ PTT	Separated	Separated	Separated	Separated	Separated
Basic-service network						
a) local	Monopoly	Duopoly BT/Mercury	Monopoly	Monopoly	Limited competition among private companies	Limited competition between private company and public op.
b) interurban	Monopoly	Duopoly BT/Mercury	Monopoly	Monopoly	Limited competition among private companies	Limited competition between private company and public op.
c) international and intercontinental	Monopoly	Duopoly BT/Mercury	Monopoly	Monopoly	Limited competition among private companies	Limited competition between private company and public op.
Customer premises equipments						
1^Telephone	Monopoly	PO and Priv. Comp.	PO and Priv. Comp.	Monopoly	PO and Priv. Comp.	PO and Priv. Comp.
Pabx	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.
Cellular radio	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.
Modem	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.	PO and Priv. Comp.
Telex machine	Monopolio	PO and Priv. Comp.	PO and Priv.Comp.	Private Companies	PO and Priv. Comp.	PO and Priv. Comp.
Teletex machine	PO and Priv.Comp.	Private Companies	PO and Priv.Comp.	Private Companies	PO and Priv.Comp.	PO and Priv.Comp.
videotex machine	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.
Fax machine	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.	PO and Priv.Comp.

PO = Public Operator

Priv. Comp. = Private Company

Source: Capello, 1991b

- more consolidated product innovation policies, based on greater technological, scientific and organisational know-how.

New strategic behaviours for these firms are in this respect a possible solution, i.e. the development of strategic agreements with more advanced international firms. These corporate strategies would have two important feedbacks:

- to acquire technical, managerial and organisational know-how, destroyed during years of monopoly and oligopoly market structures, in a limited time period;

- to keep market shares, though divided with a previously selected partner, instead of risking to lose their market share.

The cooperation agreement between the Italian manufacturing firm Italtel and the American AT&T represents an example of this kind of corporate strategy. Italtel gained technical know-how from the American partner in the switching equipment's branch giving the possibility to AT&T to enter the Italian market.

Corporate external growth allows the decrease of technical and managerial gaps between advanced and backward firms, avoiding for the last firms the negative effects coming from liberalised systems. A rather recent example of such devastated effects of liberalisation on backward firms can be found in Great Britain, where in front of Mercury competition, British Telecom changed its purchasing policies favouring Japanese and American technologically more advanced customers premises equipments, rather than national firms' products, thus destroying British manufacturing firms (Charles et al., 1989).

Another asymmetry in the institutional process stems from the difference in the degree of penetration of liberalisation in different branches. This different degree of liberalisation helps in understanding the present corporate strategies put in place in different branches.

The customer premises equipments market is nowadays governed by competitive rules, such as a high rate of product innovation and "price war". Cooperation agreements represent the best corporate strategies followed by these firms, especially by technologically backward firms, trying to obtain more advanced know-how, exchanging it with market shares.

A different situation characterises the switching and transmission equipment markets. Also in these branches the attempt is to achieve competitive rules. Through the liberalisation of public purchases the level of competition seems to increase. Nevertheless, the high requirements in technical know-how and in R&D expenditures limit the entry possibilities in the market which are still very low. The level of competition has

Table 4 - Manufacturing firms in the telecommunications market

	*1980**		*1985*		*1986*		*1987*		*1988*	
1	AT&T	26.80%	AT&T	20.14%	AT&T	16.66%	AT&T	13.81	AT&T	13.11%
2	ITT	12.40%	ITT	7.57%	Alcatel NV	11.97%	Alcatel NV	8.68%	Alcatel NV	10.27%
3	Siemens	6.90%	Northern Telecom	7.05%	Northern Telecom	6.74%	Siemens	7.88%	Siemens	8.67%
4	Ericsson	5.50%	NEC	7.76%	NEC	6.74%	NEC	6.85%	NEC	7.19%
5	GTE	5.10%	Siemens	5.00%	Siemens	4.76%	Northern Telecom	6.07%	Northern Telecom	6.21%
6	Northern Telecom	4.20%	Motorola	4.53%	Motorola	4.70%	Motorola	3.80%	Ericsson	4.30%
7	NEC	3.00%	Ericsonn	4.42%	Ericsson	4.31%	Ericsson	3.57%	Motorola	3.47%
8	Philips	2.80%	GTE	3.37%	GTE	3.09%	IBM	3.13%	IBM	2.30%
9	Cit-Alcatel	2.40%	Cit-Alcatel	2.72%	IBM	3.08%	Fujitsu	2.94%	Fujitsu	2.87%
10	Thomson	2.30%	IBM	2.65%	Philips	2.31%	GTE	1.97%	GTE	2.10%
	Altri	28.60%	Altri	34.79%	Altri	35.65%	Altri	41.33%	Altri	39.50%

Source: Zanfei, 1990

in fact increased but at the international level in the last 10 years firms operating in this branch have remained the same (apart from ITT leaving the market in 1986) (see Table 4). The strategy followed by these firms to face greater competition is represented by product specialisation with a consequent more simple division of the market.

In such a fragmented institutional framework, the results obtained in a recent analysis on the characteristics of cooperation agreements in the telecommunications sector are not surprising (Zanfei, 1990). In the customer premises equipments market, the first characteristic of cooperation agreements is represented by the number of cooperation agreements developed among firms. On the contrary, the same inquiry has pointed out that in the switching equipments market the most prominent characteristic is the intensity of exchanged resources. These human, technological, scientific and managerial resources are shared among different firms in order to face the high costs and risks associated with the high innovative rate and with the high R&D resources required to achieve a critical mass and a break-even point in the investments required by the technological development.

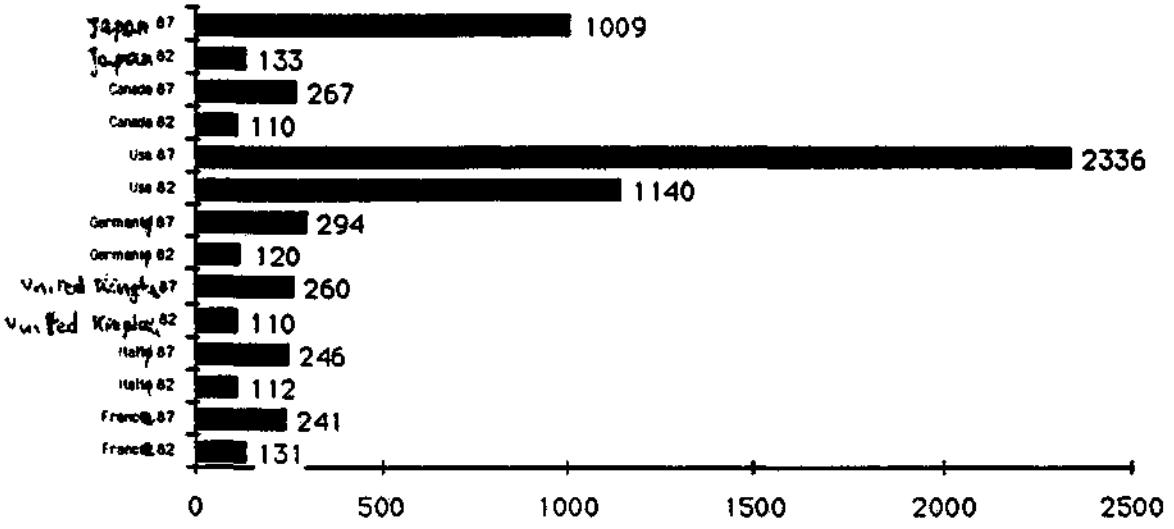
4. Market Dynamics

Through the development and use of private networks, users have recently acquired a steadily growing awareness of the strategic relevance of these infrastructures for their day-to-day activities, as is witnessed by the growing number of data transmission subscribers in the last decade (Table 5). They have developed over time the capacities for using these new and technologically complicated communications systems and, moreover, the capacities of specifying their needs on the basis of previous applications, personal experiences and personal learning processes.

The consequence of this growing awareness of the strategic relevance of these infrastructures is represented by the active role the demand plays in the diffusion of these new technologies. Demand can facilitate the diffusion of these technologies through the development of the following incentives (Camagni and Capello, 1991):

- learning processes of technical systems characteristics;
- learning processes of possible applications of these technologies to solve corporate strategy problems;
- learning processes of possible integrations of new technologies in an existing organisational structure.

Table 5 - Data transmission: implementation in 6 European Countries



Source: Scarpinato, 1991

Moreover, through such learning processes some users can even become "technological gatekeepers", being able to choose appropriately among a multiplicity of innovations (Gambardella, 1985). Thus, a corporate strategy oriented towards bridging between supply and demand turns out to be the most appropriate policy in periods of rapid technological changes.

Through this bridging, cross learning processes between supply and demand can be put in place, providing great advantages for both demand and supply. It is clear, in fact, that cross-learning processes can be crucial for suppliers to produce communications services and computer networks tailored to each adopters' needs, thus satisfying at the same time the demand communications needs and the supply market penetration necessity.

Such successful and efficient communications systems can easily become a reference model for imitative adoption processes, these processes forming the basis of rapid cumulative penetration rates of these technologies.

5. New Economic Relationships

Both the technological and institutional changes underlying the telecommunications sector have raised considerably the level of competition in the last decade and this change had some deep supply implications.

The collapse of inter-sectoral barriers generated by technological changes has given the possibility to informatics firms to enter the telecommunications market, providing technical know-how in the production of value added services and switching equipments software (see Camagni et al., 1991).

In the sphere of value added services, the high technical requirements concerning software have implicitly given a great possibility to informatics firms to enter the market. However, value added services represent a sphere of activity where both telecommunications manufacturing firms and public operators have little to lose. For manufacturing firms value added services represent a very small business area, where they could easily provide hardware (i.e., customer services equipment) to support these services, but where manufacturing firms would never be interested in directly producing these services.

A different perspective characterises the public operator's position. For public operators the entrance of informatics firms in the telecommunications market by providing value added services leads to:

- a direct competition, in the provision of the same value added services on the network;

- an indirect competition, through the common - though sometimes illegal - phenomenon of capacity resale.

The first kind of competition is in reality limited to a very small portion of the market for public operators. Moreover, the presence of informatics firms providing value added services can turn out to have positive outcomes for public providers. Direct competition is created by the implementation of private networks, with the sole scope of supplying value added services on it.

By the extent to which these value added services are provided on a public network, their provision stimulates traffic on public lines, thus increasing income for public operators.

However, two considerations need to be made to explain the public operators' perspective:

- the first remark concerns the small dimension this market represents for public operators' business. In the extreme case of complete loss of market shares, only a small percentage of income (around 10%) would represent its loss (Capello, 1991b);

- the second comment is related to the idea that the existence of value added resellers may turn out to have positive outcomes for public operators. To the extent to which these private networks are leased circuits - or depend for their geographical extension on "bridges" to public infrastructures - the provision of value added services on private networks generates inevitably traffic on public networks, thus increasing the public operators' business.

A major threat is instead presented to public operators by what is called "indirect competition", at least in European monopolistic markets. The implementation of private networks through leased circuits can in fact lead to the illegal provision of network-based services on these networks, thus decreasing traffic on public infrastructures and generating economic losses to the legally protected network-based services market of public operators.

The concern about this phenomenon is related to both its highly geographical and quantitative diffusion and the non-existence of control mechanisms to avoid it. Although all European countries have witnessed the growing phenomenon of capacity resale on private networks, none of them has provided a legal efficient mechanism to keep the phenomenon under control. The most effective proposal to avoid this problem is concerned with the change of the present tariff structure of private leased circuits, based on leasing contracts. This tariff structure should turn out to be based on the volume of transported information, thus destroying economic advantages on which

capacity resale rests. Objections to these changes are presented by business users, arguing that this solution would completely inhibit the use of private circuits, upon which the development of a networked economy is predicated.

The second source for structural changes in the telecommunications supply is concerned with institutional changes imposed by the EC. These changes can be summarised as:

- internationalisation of the telecommunications market;
- new corporate strategic behaviour.

Starting from the most generalised phenomenon in all European countries, competition in customer premises equipments increases international competition among manufacturing firms operating in this market, with severe implications for the present supply structure. Some considerations can be schetched here:

- firstly, a major threat for all European firms is not represented by European competition itself, but by American and Japanese firms legally entering the European market. These firms represent a high potential threat in terms of more advanced technical products and more ad-hoc marketing policies developed through years of experience in competitive markets (especially for the American case);

- secondly, even at a European level, competition will favour countries with stronger supply structure, created through years of extremely favourable telecommunications public policy. This is, for instance, the case in France, with a historically strong supporting public policy devoted to the creation of "national champions". The other extreme case is represented by Italy, w hich has always denied resources to develop strong national telecommunications supply, and has favoured other sectors of public policy.

The effects of internationalisation of customer premises equipments are profound, once radical technological differences among products exist. For "weaker firms" this means the development of some appropriate policies in order to face competition and protect market shares. The most appropriate policies are concerned with cooperation agreements with foreign advanced firms, such as joint ventures and other equity agreements. In this way, weaker firms would achieve:

- from one side, more advanced technological know-how in more restricted time, imposed by radical institutional changes taking place in the sector;

- from the other side, the protection of markets, shared with a partner chosen on the basis of some delineated and precise agreements.

Even in the liberalised provision of advanced services, some changes are expected to follow. In this case, competition increases between firms belonging to previously separated sectors. While informatics firms are legitimated to offer their technical know-how in the provision of value added services, with a high software component, traditional manufacturing firms are often excluded from the provision of these services because of the lack of technological know-how required.

The most appropriate corporate strategies for both informatics and telecommunications manufacturing firms are, once again, cooperation agreements, this time with the unique aim of achieving technical complementary assets.

Liberalisation in the domain of public purchases would destroy the historical division of labour characterising the relationship between telecommunications manufacturing firms and public operators in most European Countries.

Thus, the extremely high R&D expenditures and investments required especially in the switching equipments market will act as entry barriers in this market, and liberalisation of public purchases will push firms towards product specialisation in order to keep market shares under control and to achieve a "natural" division of labour in the market.

Still minor structural changes will affect, on the contrary, the domain of public operators. The EC, in fact, clearly protects monopoly in the most profitable market area for public operators, namely the provision of network-based services.

Moreover, liberalisation of customer premises equipments could turn out to have positive effects on public operators business. By stimulating the use of services through low-pricing terminal equipments, traffic on public networks is consequently positively affected. This has been the case for the Italian videotex service, increasing considerably the number of subscribers after the abolishment of a monopoly on the too expensive terminal equipment. Liberalisation of advanced services, once protected public operators by the public capacity resale, generates once again positive economic effects to public operators. These value added services stimulate traffic on public networks while - more important - their diffusion generates a "telematics culture" among subscribers, representing a first step towards a rapid adoption process.

Finally, the EC resolution to impose an "Open Network Provision", i.e. to implement networks with common transportation standards, guarantees the intercommunications between private and public networks, having positive effects, once again, for public operators. On the one hand, in fact, the interconnection of all modern networks at an international level guarantees an increase

of traffic on the public national network. On the other, the provision of value added services on "compatible" private networks infrastructures is ensured; public infrastructures can thus act as "bridges" between private networks, or can ensure a geographical extension in case of insufficient spatial diffusion of private networks.

6. Policy Recommendations

The interpretation of new characteristics governing the telecommunications sector raises some crucial concerns about the most "appropriate policies" to be put in place.

The notion of "appropriate policy" is concerned with the idea that the telecommunications sector, and more in general the ICT sector, is increasingly regarded as an effective way to increase competitiveness of firms and comparative advantages for regions. Thus, appropriate policies are oriented towards:

- the rapid diffusion of modern infrastructures and advanced services over time and space;
- the minimisation of territorial (regional, national, international) asymmetries in the infrastructure endowment;
- the minimisation of discontinuities, in terms of "missing networks";
- the exploitation of new infrastructures and applications for innovative uses, thus trying to achieve product and process innovations, and enhanced competitive advantages for firms, cities and regions;
- the stimulation of competitive capacities of national suppliers.

The previous arguments suggest that "appropriate policies" regard different areas of application. The first and more general area is concerned with public policy, the second regards demand policy and, finally, the third is related to appropriate corporate strategies of telecommunications suppliers.

6.1. Public policies

The technological complexity and difficulty in the use of modern technologies suggest that the development of new communications technologies is a difficult process in which its diffusion over time and space requires "public policy" stimuli.

The relatively limited diffusion of computer networks is demonstrated by both official sources and empirical data.

In the U.K., for example, OFTEL (Office of Telecommunications) publications indicate the limited use of private circuits, central to computer networks, achieving only 10% of British Telecom revenues in 1988. Further, that 90% of private circuits are analogue and that these circuits represent 75% of private circuits revenues, 25% is derived from digital circuits. Moreover, 75% of all private circuits are within the same exchange area and that the City of London is the main geographic market.

The relatively limited diffusion of computer networks is also demonstrated by a recent survey of organisations (1). Whilst 40% of respondents used a computer network, and over 65% of these organisations had installed their computer networks since 1985, the broad diffusion of computer networks into the functional structure of organisations has remained relatively undeveloped (Table 6) (Capello and Williams, 1991).

The pattern of use of these computer networks suggests that the development trajectory of new technology is still in its first stage.

Thus, inevitably, public policy support should create a pressure on those mechanisms that in diffusion processes generate accumulation rates through spin-off effects.

Public policy should thus encourage computer networks development in areas with high potential demand density, i.e. central regions, where mechanisms such as network externalities could generate positive cumulative effects and, thus, where a critical mass could be achieved in shorter time.

Positive network externalities, in fact, arise because the total number of subscribers has an important effect on the user-value of each additional subscriber, and each additional connection has important effects on the user-value of the network of existing subscribers (Allen, 1989; Antonelli, 1989; Hayashi, 1991). This mechanism is more efficient when applied in central areas, where the user-value of the network of subscribers is higher.

Related to this idea is the assumption that most economically developed areas are legitimated to be "networked" first, in order to develop a cumulative process. A top-down public policy is thus suitable, implementing "information highways" between metropolitan areas. A bottom-up development policy, focusing on network development in local areas, runs the risk to generate a development model with few possible inter-linkages among "islands of networks" and thus presenting a high risk of failure because of its local characteristic.

For instance, Italy witnesses the inadequacy of "bottom-up" policies in telecommunications sector, with respect to many local projects stimulating geagraphically restricted advanced

Table 6 - Use of Computer Networked Appliances in Selected Functions

Selected Applications	Finance	Marketing	Production	Purchasing	Distrib.
Data Processing	85%	47%	53%	54%	40%
Relational Data Base	30%	25%	21%	14%	12%
Electronic Mail	22%	16%	16%	9%	9%
Diarying	10%	9%	9%	5%	3%

Source: Taylor J. and Williams H., Pict Survey, 1989

telecommunications networks. It is the case of the Sprint project in Prato (Tuscany) (Zanfei, 1986), or "Lombardia Cablata" in Lombardy, just to quote two of them, where local advanced networks were implemented and modern services offered, resulting in a complete failure in their use (Camagni and Capello, 1990; Capello, 1988). Their failure is in part contingent upon the local development of these networks, which can rather be interpreted as "white elephants" instead of efficient projects generating real interest from the demand side.

A top-down approach is in this respect a more appropriate public policy to generate cumulative adoption processes. Nevertheless, to be efficient, these policies have to consider the geographical asymmetry in networks, which are created by following a top-down approach, only as a timing difference in investments among regions. These asymmetries must not turn into discontinuity, reflecting different investment intentions. In this case, in fact, discontinuity would become a structural difference between central and peripheral regions, the last ones being penalised by the lack of modern infrastructures, losing the possibility of achieving advantages typical of central locations, i.e. agglomeration economies, and thus the possibility of overcoming limits of a peripheral area.

By the same token, public policy should be concerned with

the existence of "missing networks" at an international level. This concern should go far beyond the simple physical infrastructure, and should take into consideration a series of concerns, as a recent study for the Round Table of Industrialists has pointed out (see Maggi et al., 1991; Nijkamp and Vleugel, 1991):

- hard ware (physical infrastructure)
- soft ware (logistics and informatics)
- org ware (institutional and organisational settings)
- fin ware (financial arrangements fundings)
- eco ware (environmental and safety effects)

In the above study it was concluded that the telecommunications sector could perform much better. To improve the current situation in European telecommunications the following suggestions were made:

- the introduction of a base European telecom network including standard facilities, uniform rules and tariffs, and services;

- a separation of responsibility between regulators (government, policy) and operators implementation (org ware) is needed;

- avoidable barriers to entry should be minimised (org ware); the existence of monopoly should be avoided;

- since deliverable technologies are changing too fast, a sustainable basis for regulation is missing. Improving competition should then be the keyword (org ware);

- telecommunications prices should be cost-related (org ware);

- the outcome of current ENS-applications (e.g. the European Nervous-system) should be used in transportation, banking, environmental protection, health care, education (org ware, hard ware, soft ware, eco ware and fin ware) to develop European-wide applications.

These suggestions reflect a demand-side oriented policy, neglecting monopoly as a useful market structure in highly technologically dynamic sectors, and interpreting competition as a key force for rapid diffusion processes in an era of a networked economy.

6.2. Demand policy

As already been said, the innovative use of advanced technologies provides major opportunities for users to achieve the highest economic benefits and advantages from these new technologies.

However, the simple adoption of these technologies does not provide an immediate positive effect on corporate performances (Tolmie, 1987). The rather complex and relatively new technological possibilities embodied in computer networks have drastic implications for potential users, imposing profound changes on the organisational structure of a firm. Because of their capacity to support the transactional structure of a firm, these networks are inevitably able to reshape inter- and intra-corporate information flows with profound effects on the organisation (Bar et al., 1989; Ciborra, 1989; Williams, 1987).

To achieve higher economic performances through the use of computer networks, corporate users have to adjust their organisational structure to the new "routines" and organisational rules (Nelson and Winter, 1982).

The development of modern networks is thus related to the capacity of firms to change their organisational routines, and to link the technological trajectories to organisational changes. It is very much the case that a high rigidity of attitudes and behaviour exists, which hampers an adjustment to new conditions and the exploitation of technologies to achieve higher economic performances.

The best way for the demand to adopt these technologies rests on the assumption that technology and organisation are two intrinsically interwoven variables and that changes in one of the two inevitably provoke changes in the other.

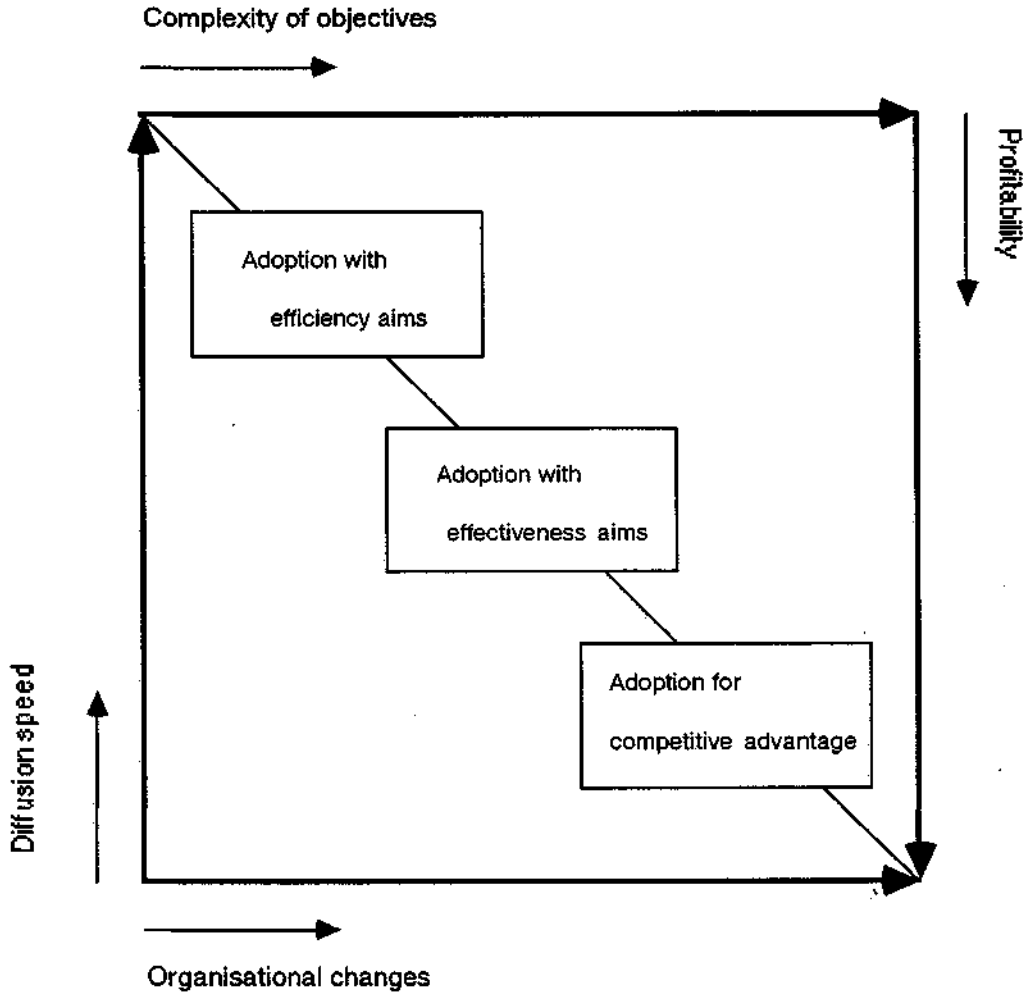
A trade-off exists between the speed of technological development, the profitability obtained by the exploitation of new and advanced technologies, the organisational costs required to use them and the complexity of economic objectives achieved through the adoption of computer networks (Table 7).

The complexity of technological systems reflects high economic objectives and requires profound organisational adjustments changes to new technologies and a long penetration speed. Consequently, we can expect a lower speed of diffusion for technologies implied to achieve more complex objectives, such as higher efficiency and effectiveness and, moreover, competitive advantages. These last objectives imply, in fact, a relevant capacity to use these systems to achieve innovative products and to adapt the organisation to new technology.

The best way for users to handle the complex interrelation between technology and organisation is the development of learning processes regarding the following issues (Camagni and Capello, 1991):

- technological potentialities of the new technologies;

Table 7- Trade-off between objectives, organisational costs, adoption speed and profitability of new technologies



Source: Camagni and Capello, 1991a

- possible applications of these new technologies to solve corporate problems;

- possible integration of these technologies in the organisational structure.

These learning processes are the mechanisms to develop among users adoption processes of these new technologies, overcoming the rigidity of attitudes and behaviour associated with a transition phase, which hampers an adjustment to new conditions.

6.3. Supply policies

Also at the supply level some policy considerations can be offered, regarding two aspects:

- policies related to corporate strategies to enter the market, in essence marketing policies;

- policies related to best corporate strategies to face increasing competition from other maunfacturing telecommunications firms, in essence strategic market policies.

The need for a strong interaction between technology and organisation brings into focus the changing nature of computer network markets. The distinction between products and systems markets is important for developing strategic policies by ICTs suppliers. Product markets, i.e. traditional services and equipments markets, are relatively homogeneous and characterised by standardised and mass produced outputs and the achievement of economies of scale playing an important role in defining competitiveness of individual firms. Technological knowledge required to produce such output is linked to the traditional background of telecommunications producers and suppliers. Thus competition can be based on traditional mass advertising and marketing policies designed to separate an individual producer's output from its competitors.

With respect to computer networks and their applications the characteristics of their market are different to those of traditional telecommunications product markets, thus obliging suppliers to put in place different competitive strategies. Because the adoption of computer networks is dependent upon an interaction of organisation and technology, the marketing strategies need to be tailored to individual users, so that these technologies are essentially customised products.

The adoption process becomes a "bricolage" process, where new technological opportunities have to be linked to an efficient organisational structure in order to achieve a new "business idea" (Camagni and Capello, 1991; Capello and Williams, 1991).

This "bricolage" process allows intermediaries to integrate technological possibilities with the needs of users, generating larger markets for computer networks and their applications. This "bricolage" process can also be developed by manufacturing telecommunications suppliers through strategies of cooperation agreements with:

- some large organisational experts,
- some large firms users, strong in their learning processes;
- some experts in the field of software and integrated systems;
- some value added resellers, or experts in telematics applications.

In this way, complementary technological, organisational and strategic know-how can be exploited and most appropriate marketing policies developed.

Moreover, the development of new technologies is strictly linked to the structure of power in which these technologies are implemented. Because of their direct impact on transactional structure and, thus, on power relationships, computer networks are easier to be installed in hierarchical structures where the "division of power" is not disrupted. On the contrary, their development is particularly difficult when a transaction of bargaining relationships is involved. The case of the Sprint project in Prato is significant in this respect: here an attempt was made to replace the traditional informal network of interpersonal relationships within the "local district" by a new telematics network, but different strategic intentions have not coalesced into a common purpose and unsolved power relationships among participants generated the failure of the project (Camagni, 1987; Camagni et al., 1990; Capello and Williams, 1991).

Another perspective is related to strategic policies, namely the strategic policies suppliers have to follow to face increasing competition in the market.

This problem has already been discussed in section 5. A brief summary is reported here, stressing again the importance of strategic cooperation agreements for suppliers in this area. These cooperation agreements, such as joint ventures and all kinds of equity agreements, should be developed between:

- telecommunications manufacturing suppliers. Firms supplying technologically backward products should develop agreements with advanced firms, in order to achieve two different purposes

  - to achieve better technical know-how in more restricted time
  - to share the market with a previously selected partner.

- telecommunications manufacturing firms and informatics firms, in the area of value added services, for the exploitation of

complementary know-how;

- telecommunications manufacturing firms and experts in organisations, in the area of computer networks, for the exploitation of complementary know-how, necessary for supplying customised products.

7. Conclusions: The EC Policy for ICTs Development

The present paper was stimulated by the interest in defining the nature, features and characteristics of a sector in profound transition, changing the economic, institutional and technological rules governing its development trajectories.

Moreover, the interest in understanding this sector and its diffusion over time and space stems from the importance that this sector is increasingly playing in generating competitiveness of firms and comparative advantages for regions. In the so called "Information Economy", new information and communications technologies are the strategic means to achieve better economic performances for economic agents.

The importance of telecommunications for the development of competitive economies is also witnessed by a great number of studies undertaken by the EC, which is developing an intense series of programmes oriented towards the diffusion of advanced networks and services, such as Integrated Services Digital Networks (ISDN) and Integrated Broadband Communications (IBC).

At the European Community level it is evident that the policy stance adopted by the Commission with regard to telecommunications is critical to the broader debate over the completion of an internal market by the end of 1992. In fact, the telecommunications sector is in the vanguard of the establishment of an internal market. Voorhoede

Furthermore, the proposed European framework for reform of the telecommunications sector is providing a structure within which most of the member states are developing their own responses to an uncertain and turbulent telecommunications environment.

The EC has pursued a two track policy initiative in oder to realise the full advantage of an integrated European market. In the first (and earlier) instance the concern has been with the development of technology through collaborative pre-competitive research projects and the development of new standards. Two key policy initiatives stand out, namely ESPRIT and RACE. The second track has been focused upon the service sector and has sought, through a range of measures, to influence and shape the development of new regulatory structures.

In June 1984 the Council of Ministers approved an action programme for the telecommunications sector. This action plan has sought to develop initiatives in five key areas (Capello et al., 1989):

1 - Coordination of future development of telecommunications: through the adoption of different recommendations the EC tried to coordinate the introduction of ISDN (with common standard, tariffs and services); digital mobile telephone; EDI (standardisation, promotion); future broadband 'telecommunications highway' network (based on fibre-optic and satellite links);

2 - Creation of a common market for terminals and equipment: cooperation agreements were concluded between EC and both CEPT (European Conference of Postal and Telecommunications Administrations) and CEN-Cenelec (responsible for standardisation);

3 - Development of joint research: a major resaerch effort is required to develop the technology of the year 2000. The Community's RACE programme is intended to enable the necessary technology and standard to be perfected for the future broadband integrated network: high-speed and high-complexity integrated circuits, integrated opto-electronics, broadband switching, passive optical components, high bit-rate links, concepts for system development and integration, etc. The RACE programme is based on cooperation between industrial laboratories and universities all over Europe. Other Community programmes also encompass certain aspects of telecommunications: ESPRIT II (information technology), AIM (Advanced Informatics in Medicine), DELTA (Developing European Learning Through Technological Advance) and DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe);

4 - Promotion of modern telecommunications services and networks in less-favoured regions of the Community: Modernisation of telecommunications could and should contribute to strengthening the cohesion of the Community and to developing its peripheral regions. Between 1987 and 1991 the Community finances the STAR programme, which operates in Greece, Ireland, Portugal and certain regions of Italy, Spain, France and Britain, for the development of advanced telecommunications networks in the less-favoured regions (LFRs) of the Community. This programme is focusing attention on an amelioration of structural economic disparities with respect to these regions throught an improvement of the telecommunications system.

Based on various studies in LFRs it was concluded that (see Nijkamp et al., 1990):

- telecommunications is generally less mature in all regions examined, comparing both LFRs and core regions within a Country

and the position of LFRs in relation to core regions of Europe;

- the introduction and location of new equipment and services tends to be oriented towards the core regions;

- the use of telecommunications is an increasingly important part of most industries, and is particularly associated with the high growth, information-oriented service sector and technology sector. Restriction in the supply of, and demand for, telecommunications in LFRs means that there is a danger that the rapid expansion of information technology and telecommunications will accentuate the backwardness of the LFRs;

- particular concern is expressed for the position of small and medium sized enterprises which may be deprived of the benefits which modern telecommunications can bring, and which are less likely than large organisations to be aware of potential services and their uses.

The STAR programme seeks to improve this situation by stimulating the development of modern infrastructures and services provision in LFRs.

5 - Adoption of common positions on the international scene: the Community is a driving force in discussions with the United States, Japan, etc.. on future standards for high-definition television as well as in GATT negotiations, which for the first time are now to cover trade in services.

The result of this action plan for the telecommunications sector necessarily was to force a debate on the nature of telecommunications and on its future development trajectories. In essence the debate should focus on time and spatial trajectories of new technologies appropriate to deliver the benefits of technological change to an enlarged internal European market in the era of the "networked society".

Notes

(*) This paper is a result of a telecommunications project in the framework of the URBINNO network, which was commissioned by the FAST programme of EC. Though the paper is the result of a common work of the two authors, R. Capello has written sections 3, 5 and 6, while the remaining sections have been jointly written. A more extensive version is available from the authors upon request.

(1) The project was financed by the ESRC and developed by a research team at the Centre for Urban and Regional Development Studies of the University of Newcastle in 1989.

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