

**Telecommunications and economic development – The 20th century: the building
of an evidence base**

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Abstract

The literature on the relation between telecommunications and economic development published during the 20th century has been reviewed. It all began in 1963 with the publication of the Jipp curve. Over the twenty years that followed, there was hardly any noteworthy, at least academic, contribution. Already in the eighties, the debate was still focused towards the role of telecommunications in the integration of developing countries into the world economy. In the last decade of the century, subsequent research broadened the scope –the lack of an adequate telecommunication infrastructure is a serious drawback for any country–, and also made a qualitative and quantitative jump forward.

Keywords

telecommunications; economic development; growth; developing countries; basic infrastructure; telephone services

1. Introduction

On December 1976, a new academic journal came to light. The first article of the first number of *Telecommunications Policy* had the appealing title of “*Social implications of computer/telecoms systems*” (Parker, 1976). In those days, the economic impact of telecommunications was still a virtually uncharted terrain for research as Parker’s article made it clear: “*the fundamental economic shift to the Information Society raises new questions concerning the approach to traditional economic issues*”. The first and main of these questions was at the time to determine the role of telecommunications in the new socioeconomic paradigm or, more precisely, to confirm whether the investment in telecommunications would yield the dividends in terms of economic progress that were expected.

Over these more than forty years, the contributions of many researchers have enabled more and more evidence to be identified and understood. This article attempts to put a bit of order in this story whose beginning can be dated some ten years previously, more precisely in 1963 when August Jipp published a paper containing his later on famous *law*. Given the breadth of the topic, the literature review undertaken in this article is restricted to the 20th century. A decision was taken about considering as *papers from the 20th century* those published in or

before 1999. The year 2000 witnessed a number of important events for the telecommunications industry (the start of the dotcom bubble collapse, the biggest 3G spectrum auctions) such as to choose it –better than 2001– for dating the onset of a new phase in the analysis.

It is necessary to clarify that the focus is primarily on academic achievements. Throughout the period considered, but especially in the 1970s and 1980s, there is a body of empirical and analytical work done by finance, development, regional, and sector agencies, and also by manufacturing companies with operating interests and government operating enterprises, which found its way primarily to policy and investment financing decisions and guidelines rather than academic publications. Those works, occasionally cited by other contemporary documents, face two major issues. First, the usual criticism levelled at such contributions cannot be ignored: they did not go through a proper external verification of their quality and objectivity (funding sources may have had spurious interests). Second, and more important, they are difficult, if not impossible, to be located at present. Having said that, there are some noteworthy exceptions that have stood the test of time.

A further clarification should be made. The bibliographical review is limited to those studies devoted to understanding the measurable –or at least observable– influence of solely telecommunications on economic growth. It goes without saying that their full impact is much greater as they are at the core of the vaster concept of information and communication technology (ICT). Nowadays, telecommunications are the linchpin for knowledge dissemination and its access as an input (Antonelli, 2017). But also in the 20th century, a myriad of innovations and breakthroughs were possible only thanks to an appropriate layer of telecommunications. While fully recognising this, induced effects, as well as those not clearly delimited (for instance, works related to the ICT sector as a whole), remain outside the scope of this article.

The field is mapped chronologically. Three stages have been identified. The first one spans over the twenty *infancy years* that followed the paper by Jipp. The second one goes from 1983, the World Communications Year, to 1990, and it includes those works that tried to give an answer to a raising political interest: telecommunications were gaining ground in programmes and agendas as their economic impact was universally perceived, even if not systematically demonstrated. The response of the scientific community, however, lacked consistency. It was not until the nineties, the third stage, that the research became much more solid. Each of these stages is covered in the following three sections. Conclusions close the article.

2. The initial stage – From the Jipp’s work to the World Communications Year

In 1963, a research that studied the relationship between per capita income and telephone density, using data from different countries, appeared in the July number of a journal published by the International Telecommunication Union (Jipp, 1963). A positive correlation was found. This groundbreaking work rewarded his author with the honour of attaching his name to his findings. Even now, we still talk of the Jipp curve or Jipp’s law. In more detail, Siemens engineer August Jipp showed the existence of a strong correlation between the level of development of telecommunications infrastructure in a given country and its economic wealth. Telecommunications infrastructure was measured by teledensity –that is, the number of main fixed lines per 100 inhabitants. National per capita income was intended to serve to measure economic wealth. However, data on income was not reliable due mainly to the lack of stable exchange rates in a number of countries at that time, so Jipp also developed another measure of wealth that accounted for the number of cars in use, electricity production and consumption, the number of letters, steel consumption and so on.

This contribution came to such an early time that it took a long time to be further developed. During the ensuing decade, no contributions from the academia were produced and, overall, hardly any progress was made beyond some internal documents carried on by the International Telephone and Telegraph Consultative Committee (CCITT) of the International Telecommunication Union. Wellenius (1972) provides a list of those documents, almost impossible to locate today. Wellenius himself hits the nail on the head by explaining that “*all these studies show that there seems to be, in general, some relation between investment in the telecommunication sector and the development of other sectors of national economies; they are, therefore, expressions of prevailing policies. Unfortunately they tell us nothing on the cause-effect relationships between telecommunications and other sectors and, consequently, they do not allow any inference to be made on what is the optimum level of investment in telecommunications*”. He goes on by stating that the foundation for establishing optimal growth strategies in the telecommunications sector is “*the quantitative evaluation of the effects of the telecommunication services on the consumer units*” and suggests that this were carried out within a frame of reference based on “*current theories of national development and on development strategies, on one side, and concepts on communication on the other*”.

In the following years, Bebee and Gilling (1976) is the only –at least published– quantitative academic paper. Their research –that owes much to the work of Jipp– used data of 29 countries at different stages of development for the year 1970, showing a strong positive relationship between an index of economic performance and telephone use and availability. Other works from those years followed a qualitative –narrative– approach. Marsh (1976), who

limited his research to Latin America, gives a very comprehensive list of “qualitative telecommunication factors in development”, classifying them in “economic” (impacting the finance, business, manufacturing, power, and transportation areas) and “social” (education, health, pollution control, and crime prevention factors). Shapiro (1976) puts emphasis on industrial development, talking of a sort of chicken-and-egg problem: the lack of telecommunication infrastructure hampers industrial development, while a less advanced stage of industrial development produces a serious shortage of capital and trained manpower which inhibits expansion of telecommunication facilities. In a broadly similar vein, Saunders and Dickenson (1979) analyse differences in investment patterns in telecommunications between developed and developing countries.

The decade of the 1980s began with the important contribution from Hardy for the U.S. Agency for International Development (Hardy, 1980a). The very same year, a reduced version of the report was published as an academic article (Hardy, 1980b). The author uses cross-sectional time series data for 60 nations over 13 years to determine how the telephone might make its contribution to economic development. Path analysis and cross-lagged correlation techniques indicate that the telephone does contribute to economic development. This contribution “*appears to be made not in the transfer of information about production techniques, but through information flows which have impact on the way in which economic activity is organized*”.

It is not a surprise that the research was commissioned by the U.S. Agency for International Development. Since the early seventies, development policies were, so to speak, in vogue. The end of colonialism, the establishment of new trade policies, and technological and industrial progresses were major forces of change in a Cold War scenario where the United States and its allies sought to prevent developing countries (‘the Third World’) from drifting towards communism. On such a context, telecommunications were struggling to find their place in those policies. National development agencies and particularly international organisations were becoming convinced of the importance of telecommunications. The mere intuition, however, needed scientific underpinning.

This lack of supporting evidence was underlined on the Resolution on Telecommunication Infrastructure and Socio-Economic Development¹ agreed within the International Telecommunication Union on 1982. The considerandum part of the Resolution

¹ Plenipotentiary Conference of the International Telecommunication Union. International Telecommunication Convention, Nairobi (Kenya), 28 September - 6 November 1982. Resolution No. 24. *Telecommunication Infrastructure and Socio-Economic Development*. Available at http://www.itu.int/dms_pub/itu-s/oth/02/09/s020900000b5201pdfe.pdf (pp. 264-267).

opens saying that “*telecommunication facilities and services are not only the outcome of economic growth, but a precondition of overall development (...) the development of telecommunication infrastructure is an essential part of the national and international development process*” and talks about “*the important supporting role played by telecommunications in the development of agriculture, health, education, transport, industry, human settlement, trade, transfer of information for social welfare and in the general economic and social progress of developing countries*”. However, it further notes that “*research carried out so far on the benefits to be derived from telecommunications has generally revolved around analysis of input-output tables and correlation of GNP, telephone density and other variables without, however, explaining the causation*”. Consequently, the resolution recognises “*the necessity of providing governments, administrations, decision-makers, economists, financial and other institutions and organizations concerned with development work with the results of comprehensive studies on the direct and indirect benefits of investment in telecommunication infrastructure and the relationship between the growth of telecommunication services and socio-economic development in general, so as to enable developing countries to better assess their own development priorities and give the necessary priority to telecommunications*” and decides that the Union should continue to organise and carry out such studies.

The resolution also requested the ITU Secretary-General to bring the Resolution “*to the attention of the United Nations General Assembly and to provide the Assembly with regular reports on the progress and results of the research on this matter*”. The General Assembly of the United Nations was by that time fully aware of the “*the fundamental importance of communications infrastructures as an essential element in the economic and social development of all countries*”. In November 1981, recognising this fact, it had proclaimed 1983 as the World Communications Year adding the tag line ‘Development of Communications Infrastructures’². Twenty years had passed since the work of Jipp and, in spite of further reflections such as those contained in a book published in 1982 (Hudson, 1982; Karunaratne, 1982; Saunders, 1982), research about the economic impact of telecommunications was yet in the launching pad.

² General Assembly of the United Nations – 64th plenary meeting (19 November 1981). Resolution A/RES/36/40 *World Communications Year: Development of Communications Infrastructures*. Available at <http://www.un.org/documents/ga/res/36/a36r040.htm>

3. Second stage – From the World Communications Year to the first strategies for the national information infrastructures

Possibly to celebrate the Communications Infrastructures Year, in 1983 the World Bank published a book that represented for many years one of the standard references on the field (Saunders, Warford and Wellenius, 1983). Authors made a review of available empirical studies (including many of those non-academic studies whose track is lost at present) in the attempt to establish baseline estimates of telecommunications' impact, both direct and indirect –i.e., cost savings in energy or transportation, and improved information–, and, subsequently, to demonstrate that the positive benefits of investments in the telecommunications sector accrue widely to users as well as strengthen economic performance. In spite of their great effort, as one of the numerous book reviewers stated: “*as one might anticipate, the book raises far more questions than it answers*” (Anders, 1985).

This lack of clear answers kept undermining confidence in telecommunications as a leverage for economic growth. It was not probably the only reason why telecommunications were still far from being given preference in development plans and policies³. At the start of the eighties, the new scenario was marked by the energy crises and, as a consequence, the lending boom that had helped to keep global growth going had come to a halt. The discourse reflected this fact: “*The policy issues surrounding telecommunications investment as an instrument of economic growth are complex. The evidence in favour of increased investment is mounting, but many factors must all be in place before there is a consensus between lender and borrower that priority should be given to telecommunications investment over other promising alternative uses of scarce capital investment funds. Communications may benefit everyone but be no one's first priority*” (Parker, 1984). Moreover, it should be recalled that the telephone service had traditionally been seen as a luxury good (an added convenience for the upper classes) in most, even developed, countries; probably this view remained being an obstacle: “*Investment in telecommunications is not very fashionable. Development planners tend to view it as socially less important than investment in rural development, education, public health or urban rehabilitation*” (Jéquier, 1984).

Against this background, Jéquier (1984) himself tried to collect and build evidence on the role of telecommunication services in development. In his paper, he makes a review of the

³ In turn, not having the higher priority among international financial organisations was not the only reason –not even the main reason– why investment in developing countries remained below levels needed to meet demand. Other factors include capital and foreign currency shortages in the public sector, many competing demands, government appropriation of telecommunications operating surpluses to the detriment of reinvestment within the sector, and limited or no access of the operating enterprises to other sources of capital.

findings of the ITU projects (addressed to rural telecommunications) and concludes that, although evidence accumulated “may be sketchy”, it shows clearly the enormous benefits of investments in rural telecommunications at the micro-economic level: “*one may simply reflect upon the importance of the telephone for calling in a doctor or a veterinarian, keeping track of epidemics, ordering spare parts for agricultural machinery, finding out the prices of agricultural products in the nearest town, or simply keeping in touch with one's family and relatives*”. Leff (1984a) provides a much more theoretically sound approach to the welfare consequences of telecommunications expansion. He points to an increase in the efficiency both of markets and of administrative organisation through lower transaction costs and reduced uncertainty, and to public-good effects, notably in enhancing a country's capacity for responding to new problems and opportunities. Therefore, he criticises the way in which the World Bank allocated funds to telecommunication projects: the SBCA⁴, that the Bank advocated as the standard procedure for investment choice, was not used in the area of telecommunications; therefore, the externalities telecommunications projects may provide were simply excluded from the analysis (Leff, 1984b). An externality is, in fact, that half of production and more than 40% of employment generated by the investment in telecommunication made by Deutsche Bundespost in 1980 were outside the telecommunication and electronics industries. These are the results of the report by DIW (1984), which claimed that “*telecommunication generated significantly more employment than railways, motorways and power stations*”. Despite all these advances and discourses, Wellenius (1984) thought that the problem laid elsewhere: “*more of the same will do little to help promote accelerated telecommunications investment in developing countries as needed. Rather, the efforts should now mainly concentrate on conveying existing sector knowledge to governments and international agencies*”.

The years that followed until the end of the decade provided little in the way of new results. Just a couple of academic papers can be cited. Chen and Kuo (1985), through a simultaneous equation model –in which economic growth and telephone availability and use are treated as endogenous variables, and development support and telephone affordability and demand are exogenous variables–, conclude that the hypothesis of the reciprocal relationship between economic development and telephone availability and use was supported by the Singapore data. Carr (1989) performs a cross-sectional regression using telephones installed per 1,000 population and GDP per capita of about 90 countries as aggregate data variables; again, high correlations were obtained.

⁴ *Social benefit-cost analysis* was a technique for optimal investment choice in developing countries sponsored in the 1980s by the World Bank itself and other international agencies.

Indeed, the most important change that happened during those years concerned the narrative instead of the empirical research. The discourse about the role of telecommunications for economic growth started to be widened. Strover (1989) pointed out this detour when talking of an “incipient rhetoric” among policymakers and stakeholders: “*long a subject of scrutiny among developing countries trying to maximize their investments in critical infrastructural areas, economic development is now a popular phrase among businesses in industrialized democracies searching for new corporate strategies*”. In this vein, Pye and Lauder (1987), considering the “*lack of prior European studies of the economic potential or impact of particular telecommunication investment projects*”, made a review of some earlier –mainly non-European– studies to justify European-funded aid to address the disadvantages in the supply and use of telecommunications faced by the *less favoured regions of the Community*. A very similar approach is the one taken by Hudson and Parker (1990) when making a list of “indirect benefits” of telecommunications in order to ask for policies targeted to the *rural America*.

Just at the end of the decade, another work worth citing is Hansen et al. (1990): they found that, in six European rural areas, the impact on employment of the investment in telecommunications was between 2.2 and 5.2 times greater during the first year than at the time of the original investment.

4. Third stage – From the early nineties to the end of the century

With the decade change, the “incipient rhetoric” of which Strover (1989) had talked became definitely a “new rhetoric”. The lack of an –universal– adequate telecommunication infrastructure was then seen as a major drawback for any country, whereas only a few years before it was mainly considered as a factor hindering the development of developing countries. This shift in the focus of attention had much to do with changes in market structure. From the late 1970s and early 1980s, the industry scenario had begun to radically change. The extraordinary transformation process in the telecommunications service industry was fed by a series of factors that were not only economic and technological but also political (Gómez-Barroso and Feijóo, 2010). At that time, most state monopolies, in developed as well as developing countries, were being privatised, competition was becoming the norm, and governments were moving from ownership and operation to regulation and closing market gaps. The effort to close down market gaps clearly shows that pervasive telecommunication networks were becoming to be perceived as a necessity and not just a choice. The 1991 US National Information Infrastructure initiative evidenced those “new times”. A couple of years later, the European Commission’s (so-called) *Delors White Paper* stressed the importance and urgency of

developing a pan-European information infrastructure *to help revive European economic growth and competitiveness*. Many other countries followed these examples.

The academia assisted this process as research broadened the focus and, more important, made a qualitative –and quantitative– jump forward. The pioneer works lacked of methodological soundness. Relationship between telecommunications investment and economic development had been demonstrated but problems of reverse causality and spurious correlation, that did potentially exist, had not been addressed. In doing more solid and complex works, the *Cronin team* (Francis J. Cronin, always appearing as the first author, accompanied by other colleagues, frequently Edwin Parker, Elisabeth Colleran, and Mark Gold) significantly contributed to pushing the boundaries of the field. They published a bunch of important papers along the decade of the nineties. The most important, just by the fact of being the first one as well as by the number of citations later received, was published (as most of others) in *Telecommunications Policy* (Cronin et al., 1991). They took as a starting point the previously reviewed work of Hardy (1980), in which they found a “potential diminishing returns problem”: as telecommunications investment was measured using the number of telephones per capita, the size of its effect was inversely related to the prior level of telecommunications development; in other words, this was the reason why the largest effect of telecommunications investment on GDP was found in least-developed countries. Then, they tested the causal direction of the relationship between telecommunications investment and each of two economic variables (the sum of the output of 432 industries representing the total US economy, and the annual gross national product) using 31 years of US data (1958-1988). They concluded, first, that the level of US economic activity was a reliable predictor (‘cause’, inverted commas are yours) of the amount of US telecommunications investment at a later point in time, and, second, that, inversely, the amount of US telecommunications investment was a reliable predictor (‘cause’) of the later level of US economic activity. Soon after, they repeated the same approach for state and sub-state level (Pennsylvania and two counties within Pennsylvania), and for two specific sub-categories of telecommunications infrastructure investment (central office equipment, and cable and wire) reaching similar conclusions (Cronin et al., 1993a). The based-on-too-often-unchallenged-assumptions rhetoric started to find a more solid support.

Equally important is the work of those who tried to found different ways for finding links between telecommunications investment and GDP evolution. Cronin et al. (1993b) also investigated new paths: they empirically found (using multifactor productivity measures for the US economy over a 33-year interval from 1958 to 1990) that investment in telecommunications infrastructure is causally related to the total factor productivity and that “*contributions to aggregate and sectoral productivity growth rates from telecommunications advancements are both quantifiable and substantial*”. Their work was slightly preceded –at least considering the

time of publication— by those of Seth Norton and Cristiano Antonelli. Norton (1992) expanded previous research on the macroeconomic determinants of growth including telecommunications and concluded that telecommunications increase growth by reducing macroeconomic uncertainty; in particular, telecommunications lower the cost of capital markets and “*perhaps the efficiency generated by lower capital costs is more important than the investment ratio [total income devoted to capital formation] per se*”. Antonelli (1993) tested empirically (in 19 OECD countries and 5 ‘newly’ industrialised countries for the period 1979-1986) whether the growth of labour productivity had been influenced not only by the general level of investment intensity but also, and more specifically, by the investment intensity in telecommunications; he concluded that the variable gross investment in telecommunications appears “*to be better able to capture the dynamics of technological change, increasing returns and externalities than generic investment*”.

Contrasting investment in telecommunications with other types of investments is also the goal of the paper by Dholakia and Harlam (1994). They made a multiple regression analysis concluding that the impact of telecommunications in development is relevant not only when it is viewed as the only developmental input (as previous research had already demonstrated), but as well when it is compared with other inputs such as education, energy and physical infrastructure; they used US data for the years 1985 and 1990. That same year, 1994, the second edition of the book sponsored by the World Bank was published (Saunders, Warford and Wellenius, 1994). As a new feature, they presented some microeconomic (project specific) benefits of telecommunications in developing countries, considering cost-benefit analysis and opportunity costs techniques.

In the following years, other works broke new ground in the effort to further demonstrate the impact of telecommunication infrastructure on economic activity. Greenstein and Spiller (1995) made a study involving different sectors and concluded that modernisation of the telephone network is associated with more fire, insurance and real estate activity at a local level, while this is not the case for the manufacturing sector (as typically employs less modern telecommunication services). Cronin et al. (1995) broke down the (rural and urban) employment gains in Pennsylvania into several industry groups; in 1991 Pennsylvania employed over 70 000 more people than it would have been the case if constrained to 1975 telecommunications technology. Antonelli (1996)’s results confirmed that the increase in the usage of communication services is strongly associated with the growth of output, and that the marginal productivity of communication services, as a strategic intermediary input, is very high. Cronin, Colleran and Gold (1997) concluded that the substitution of telecommunications for other factor inputs produced substantial economy-wide resource savings –given the quite high elasticity of substitution of telecommunications with respect to capital and the sharply fall of its real price.

Madden and Savage (1998)'s findings indicated that telecommunication investment, especially when measured by main telephone lines, is related to economic growth. Finally, Flores de Frutos et al. (1999) also found significant effects of the investment in telecommunications infrastructure on aggregate output, employment and investment which extended for several years.

In contrast to all the other findings, Capello and Nijkamp (1996) and Crandall (1997) represent a dissenting voice. In the later work, a set of economic variables is related to three measures of telecommunications infrastructure concluding that there is *at best* no relationship between subsequent growth in output and employment, and initial telecommunications infrastructure. However, Crandall qualifies his conclusion by saying that "*these results hardly reflect the potential impact of the large number of new technologies just beginning to be adopted*". In a similar manner, Capello and Nijkamp (1996) introduce a nuance to their main statement: mere accessibility to advanced telecommunications infrastructures and services does not necessarily lead to a better corporate and regional performance but this is not true when "micro-conditions" allowing firms to exploit network externalities are present.

On a second level, those works that did not empirically contribute to the *advance of the evidence*, but instead presented and discussed theoretically the economic impact of telecommunications, can be cited following a chronological approach. In the early years of the decade, some identified "the potential that telecommunications holds for community development in rural areas": Wilson (1992), and later Read and Youtie (1996), for US rural regions; Martin y McKeown (1993) for the rural Europe; or Cornford and Gillespie (1993) taking the example of cable in the UK. Zhao and Liu (1994) provided some data taken from here and there, and mentioned a model "made by Chinese experts" in which it was calculated that an additional investment of 100 million yuan in the post and telecommunications industry would increase national income by 1.38 billion yuan after 10 years. Gensollen and Laubie (1995) maintained that, from the point of view of endogenous growth, "*telecommunications taken as a whole can explain economic growth just as expenditure on education can*". Graham, Cornford and Marvin (1996) made a complete review of the socio-economic benefits provided by a universal telephone network; among the economic ones, they cite network externalities, lowering transaction costs, and lowering social costs (the economic costs of social service providers, health service providers, the probation service, voluntary organisations and emergency services). Riaz (1997) alerted that historical contexts and conjunctures "have serious bearings" on the role of telecommunications in the process of economic transformation.

5. Conclusions

One of the most basic analysis made by Gómez-Barroso et al. (2018) when text-mining the whole corpus of papers published in the first forty years of *Telecommunications Policy* –and indirectly the evolution of the telecommunications policy agenda– is word relative frequency. “Development” (or derivatives of the term) is the fourth most frequent word in article titles, abstracts and keywords, only after “telecommunications”, “policy” and “services”, and preceding words such as “regulation”, “market” or “competition”. The same analysis was conducted in periods of five years and “development” was placed at no. 4 in the 1976-1980 period, no. 2 in 1981-1985, no. 4 in 1986-1990, no. 5 in 1991-1995 and no. 10 in 1996-2000. That means that the relationship between telecommunications and economic development was a topic that came up once and again during the last quarter of the twentieth century.

This article has backed up this assertion by making a review of the papers from the 20th century that dealt with the topic. Even if today there is not a shadow of a doubt about that relationship, the analysis demonstrates that this has not always been the case. Indeed, the story is far from being that simple. Table 1 shows the absolute dearth of empirical academic contributions in the twenty-five years following the pioneering work of Jipp. The way things stood, at least in terms of scholarly-quality research, it was difficult to convince planners to give telecommunications preference over other investments. The advent of an information society, built upon a foundation of telecommunication networks, was still more promise than reality.

As seen above, the situation changed during the 1990s. Research became more methodologically sound and empirically ground. In previous years, regression analyses had been the standard procedure for estimating the relationship between telecommunications and a rate of output growth (usually GDP). Those basic tools gave way to more sophisticated models such as causality tests and production function equations or particular models of growth where telecommunication-related variables were included. The importance of these works cannot be adequately assessed without considering progress in research over the next years (see xxx paper). What then seemed to be occasional works, later became departure points for further research.

Regarding geographic scope, in the last decade of the 20th century the emphasis was no longer on developing countries. At that time, assistance programmes of the international community had changed their focus from direct investment to support for the implementation of market reforms. Those same market reforms were underway in developed countries. Anyway, the reorientation in the way in which the relationship between telecommunications and economic growth was seen was not only a matter of global or sectoral policies. It was becoming ever clearer that telecommunications has a key role to play in fuelling any economy.

At the end of the decade, the first plans for the development of an information society were launched. The two abovementioned facts –an increasing presence of telecommunications on day-to-day economic activities and a larger body of research– reinforced the discourse and somehow legitimised it.

Having said that, to legitimise is one thing, to influence political decision-making is quite another. Whether and in what contexts academic research really contributes to the design of policies is always a very difficult question to answer. Anyway, from the review conducted, it seems quite clear that, for a long while, academic literature –the particular academic literature analysed here, conclusions may be different for other topics– was running behind the facts and behind what would have been probably needed by decision-making centres. Only at the final stage were researchers starting to give a more timely and thorough response to the challenges. This, though, was probably not enough. Supporting reports attached to action plans and policy programmes significantly lacked academic references.

In conclusion, while it can be said that, when entering the new century, the impact of telecommunications on economic development was unanimously acknowledged, in terms of scientific proof there was still a long way to go. In the present century, the story is developing further.

Table 1. Quantitative research on the relation between telecommunications and economic growth 1963–1999

Reference	Results	Model / Methodology	Data (geographical area)	Data (period)
Jipp (1963)	Positive correlation between GDP per capita and telephone density	Correlation	Global (48 countries)	1953-1959
Bebee and Gilling (1976)	Positive relationship between telephone use and availability, and an index of economic performance	Ad hoc regression	Global (29 countries)	1970
Hardy (1980)	Telephones per capita significantly impacts the GDP	Ad hoc regression	Global (60 countries)	1960-1973
Chen and Kuo (1985)	Reciprocal relationship between telephone growth and economic development	Simultaneous equation model	Singapore	1964-1982
Carr (1989)	Telecommunications investment is linked to GDP per capita	Ad hoc regression	Global (89 countries)	1960-1985
Cronin et al. (1991)	Increases in GNP lead to increases in investment in telecommunications. The converse is true: increases in telecommunications investment stimulate economic growth	Causality tests (Granger, Sims, modified Sims)	United States	1958-1988
Norton (1992)	Increases in telecommunications infrastructure lower transaction costs and increases output, doing so via the capital market efficiency/investment channel	<i>Kormendi/Meguire</i> growth equation	Global (47 countries)	1957-1977
Antonelli (1993)	The telecommunications investment correlation to the growth of labour productivity exhibits a higher value of the Pearson coefficient than the non-telecommunications investment	Modified <i>Scott</i> growth equation	Global (24 countries)	1979-1986
Cronin et al. (1993a)	Same as Cronin et al. (1991)	Causality tests (Granger, modified Sims)	Pennsylvania (state and county level)	1965-1991
Cronin et al. (1993b)	Investment in telecommunications infrastructure is causally related to the nation's total factor productivity. Telecommunications advancements contribute to aggregate and sectoral productivity growth rates	Causality tests (Granger, modified Sims)	United States	1958-1990
Dholakia and Harlam (1994)	Influence of telecommunications in economic development is very strong when it is viewed as the only developmental input as well as when it is compared with other inputs	Ad hoc regressions (one of them including lagged variables)	United States (state level)	1985 and 1990
Cronin et al. (1995)	Reductions in business costs following from telecommunications modernisation generate employment gains	Three different ad hoc models (including input substitution and interindustry models)	Pennsylvania	1975-1991
Greenstein and Spiller (1995)	Modernisation of a telecommunications network has an economically important influence on the amount of high tech white collar activity, while it is less important for manufacturing activity	Investment adjusted model	United States (state level)	1986-1993
Antonelli (1996)	Increase in the usage of communication services is strongly associated with the growth of output. More, the marginal productivity of communication services is very high	Modified Cobb-Douglas production function (estimation of the residuals across sectors)	Italy	1985 and 1988
Capello and Nijkamp (1996)	The simple adoption of telecommunications services as such has no effects on the performance of firms	Correlation (between a connectivity index and a performance index which represents labour productivity)	Italy	1991

Reference	Results	Model / Methodology	Data (geographical area)	Data (period)
Crandall (1997)	The evidence on the effect of new telecommunications infrastructure on economic growth is too weak to conclude that it has already created large externalities	Ad hoc regression	United States	1989-1994
Cronin, Colleran and Gold (1997)	The substitution of telecommunications for other factor inputs produces substantial economy-wide resource savings	Input-output analysis	United States	1963-1991
Madden and Savage (1998)	Strong and positive relationship between telecommunications investment and economic growth	<i>Kormedi/Meguire</i> growth equation extended to the sectoral level	Central and Eastern Europe	1991-1993
Flores de Frutos et al. (1999)	Effects of the investment in telecommunications infrastructure on aggregate output and employment are significant	Dynamic simultaneous equation model	Spain	1964-1993

Source: author's elaboration

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