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The evolution of the telecommunications policy agenda: Forty years of articles in *Telecommunications Policy*

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ABSTRACT

This paper investigates the evolution of the telecommunications policy agenda by means of text mining forty years—from 1976 to 2016—of papers in the journal *Telecommunications Policy*. Text mining techniques help identify the key topics, the dominant combinations of concepts and the main areas of research within this multidisciplinary—technical, economic, social, policy—discipline. In addition they depict an evolution of the policy agenda more nuanced than the conventional public service, pre-competition and post-liberalisation stages typical of telecommunications. Also, in combination with bibliometric information, the results display the relationships between areas of research and methodologies, countries and authors' background, all together providing a deeper understanding of the past, present and future avenues for research in telecommunications policy.

1. Introduction

Unlike most academic journals, *Telecommunications Policy* has two salient features: (1) it was founded with a clear and definite aim that has not changed over the years, and (2) its title accurately reflects this aim. Lawrence H. Day, first *General Editor* of *Telecommunications Policy*, wrote on the first Editorial comment published on December 1976 (Day, 1976), that the journal *will present a continuing discussion on telecommunications futures and policy options [...] in a manner that is most useful to decision makers and policy analysts in government and industry*, whilst acknowledging that *a considerable amount of the material published in the journal is expected to come from academic and national and international policy-research organisations*.

The way in which the sought dialogue between academia and stakeholders has developed is twofold. First, decision makers from here and there have undoubtedly taken advantage of the progresses and ideas published in the journal. Unhappily, the extent and manner in which this has happened is impossible to elucidate in the framework of this paper. Conversely, policy agendas have oriented, or even constrained, research agendas and, consequently, the subjects covered in the articles published in the journal.

This on-going link between hot policy and regulatory issues on the one hand, and publications on the other, serves a specific purpose. When reached a certain level of maturity, every discipline looks back to analyse what has been its own evolution. Usually, this requires a considerable effort of gathering and organising facts and documents, often scattered among a wide array of sources. In the case of

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telecommunications policy –as a discipline–, the existence of the privileged outlet that is *Telecommunications Policy* –as a journal– brings a substantial simplification of this task. Without obviously denying that many interesting works can be found elsewhere, *Telecommunications Policy* has held –and holds– the lead position as the reference in the sector. What has happened in telecom-related markets has had a reflection on the pages of the journal; what has been discussed in the articles that have deserved publication has frequently arrived to the offices of regulatory authorities and decision makers.

With this in mind, this article intends to make a review of the evolution of the agenda of the telecommunications sector –this is, which are the most relevant items in this agenda and how they have evolved over time–, looking at it through the glasses of the articles published in *Telecommunications Policy*. For that, a number of techniques from multivariate (big) data analysis specifically aimed at text mining have been employed. The aim when making use of these methods is twofold: these are the most adequate tools to identify prominent items in a set of text documents such as journal papers, while, from the perspective of authors, their usage provides an illustration on the possibilities of textual analysis in the domain of ICT research, an increasingly popular methodology across many industries and research fields but seldom applied in the ICT domain. In addition to the text mining analysis, but always departing from it, bibliometric information has been added to explore the links between main dimensions of research –main topics in the policy agenda– and other variables such as methodological approach or geographical distribution.

The article is structured as follows: after this introduction, the next section briefly discusses the links between academic publications and policy-making to put in context the findings of this paper. Next, the section on methodology explains the collection of data, the pre-processing, the text mining techniques and the software employed. The ensuing section presents and discusses the results with a particular focus on cluster analysis. Last, the conclusions section closes the article.

2. The role of academic journals outside the academic world

The usefulness of scholarly journals is always measured in academic terms. Journal rankings and ratings serve as criteria for evaluating journals performance. Without denying the importance of those indicators, they do not reflect the wider impact that they may have. Scientific research has no sense by itself but understood as an effort to help society progress.

How to assess an impact that transcends academic journals' foremost *playing field* is a pending challenge – an extraordinarily daunting challenge, indeed. For those journals in the technological fields, their significance could be measured by tracing the transfer of knowledge derived from academic articles to marketable products. For instance, a ranking system that considers the number of citations in patents as a proxy for measuring the *technological value of journals* has been proposed (Liaw, Chan, Fan, & Chiang, 2014). For other kinds of journals, and particularly for policy journals, it is hardly to be expected that such a similar ranking would be available.

However, this does not mean that there is no reflection on how to best use –in real-world conditions– the knowledge enclosed in scholarly works with policy implications. Almost as old as *Telecommunications Policy* are two contributions that even today continue to underpin any further work. The “two-communities theory” (Caplan, 1979), which has largely dominated the ensuing debate, claims that the problem of under/non-utilization of research in the policy process lies on the fact that policy makers and academics form two separate and poorly connected communities that operate under different rules, speak different languages, and are motivated by different rewards systems. With a more positive approach, the “enlightenment function of social research” (Weiss, 1977) states that decision makers tend to use research indirectly, as “a source of ideas, information, and orientation to the world (...) although the process is not easily discernible, over time it may have profound effects on policy”.

Over the last 40 years, further contributions have fine-tuned but not replaced these theories. There is a number of sensible middle way approaches that have nuanced the more extreme positions. As a summary, it can be stated that there is not a simple dichotomy between use and non-use of research by decision makers; rather, the relationship occurs along a spectrum of interaction, with some public servants engaging more closely with academic research than others (Newman, Cherney, & Head, 2016).

In spite of all the endeavours towards gaining a deeper understanding of how this interaction takes place, the overall evidence is somehow discouraging: “apart from some biographical accounts and case studies, surprisingly little is known at a more general level about how policy-makers do actually engage with academic research and expertise” (Talbot & Talbot, 2015). The conclusion, therefore, is that, in the particular case of *Telecommunications Policy*, it has influenced, no doubt, telecommunications policy, though in ways that it is impossible to determine or measure.

But equally evident is that telecommunications policy has influenced *Telecommunications Policy*. This reverse link between policy activity and academic research has never been explored before. Although may not always be as appealing as the direct relationship is, it is instrumental in raising some other issues, the most outstanding of these being the analysis of the historical evolution of a particular field.

This is the case for this journal and this area of knowledge. The filing in 1974 by the United States Department of Justice of an antitrust lawsuit against AT&T can be considered the milestone that marks the start of the modern era of telecommunications policy. *Telecommunications Policy* witnessed the settlement of this long process, as well as any other landmark event that had happened since then. In its pages, current affairs at the time have been dissected, analysed, discussed and challenged; issues that were going to play a key role even in the long term have been foreseen before reaching the market; authors have drawn up proposals and offered recommendations. Academic or practitioner, anyone who had had anything to say has sent his/her work in the first place to *Telecommunications Policy*. To untangle the lines of the past of *Telecommunications Policy* is to understand the history and agenda of telecommunications policy.

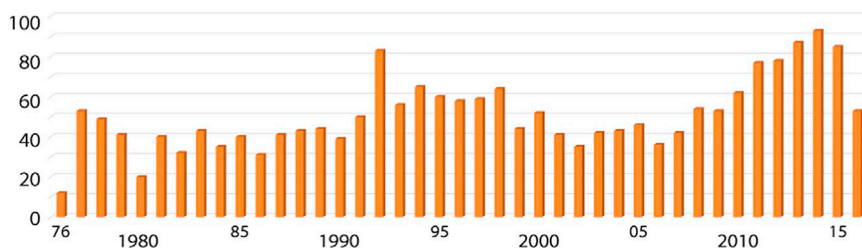


Exhibit 1. Distribution of *Telecommunications Policy* papers per year. Note: Only one issue published in 1976; data from 2016 until June issue. Source: own calculations from Elsevier data.

3. Methodology

An active area of research for more than two decades now, text mining –or text analytics– is a broad umbrella term describing a range of technologies for analysing and processing semi-structured and unstructured text data. In a manner analogous to data mining, text mining seeks to extract useful information from data sources through the identification and exploration of interesting regularities, patterns, trends or associations. In the case of text mining, however, the data sources are natural language document collections, and interesting patterns are found not among formalized database records but in the unstructured textual data in the documents in these collections (Feldman & Sanger, 2007). Inspired by data mining, text mining relies on pre-processing routines, pattern-discovery algorithms, pattern classification and presentation-layer elements such as visualization tools (Weiss, Indurkha, Zhang, & Damerou, 2005).

Text mining can comprise a number of interrelated objectives: search and information retrieval, document clustering, document classification, information extraction, natural language processing and concept extraction. Among them, this article focuses on clustering –finding papers related to each other–, classification –which are the basis for arranging similar papers in a specific category–, and concept extraction –the telecom agenda.

3.1. Text gathering

This paper analyses the information published in the journal *Telecommunications Policy* since its initial number published in December 1976 until the last available issue at the time of drafting the present work (June 2016). There are 272 issues in the lot, comprising a total number of 2,216 papers. From these only 2,121 have been examined, leaving out 76 editorials and 19 notes that have not enough information for data analysis. This is, using text mining terminology, the “corpus” of documents for analysis.

The average page length of papers is 11.8 (median 12 and mode 11) with a standard deviation of 5.95. Exhibit 1 shows the annual distribution of papers where four main periods can be distinguished: (i) a relatively flat number of papers from 1976 to 1991; (ii) an increase in the count of papers from 1992 to 1998; (iii) again a relatively flat and reduced figure from 1999 to 2007; (iv) an increasing trend in the number of papers from 2008 to 2016 with an absolute peak in 2014.

For each paper, title, abstract, keywords, background affiliation and country of authors, and number of citations were collected. Full text was not considered for two main reasons: it is assumed that the abstract is a good representation of the main contents of the paper, and full text examination would have taken too much time and resources not providing a different illustration on how these data analysis techniques can be used in the ICT research domain.

3.2. Text pre-processing

Before conducting the analysis, the paper followed the usual workflow for text mining. First, all the words are converted to lower case; then, non-letter characters as well as common English stop-words are deleted. After this initial stage, the corpus of text is ready to be tokenized and passed on to the next stage, which is called stemming. The basic stemming process consists of reducing and/or grouping words (such as the plural form of nouns) usually by deleting characters until a common root is found. These tasks have been made with the Porter stemmer in its newest version (Snowball).

Next step in the pre-processing is merging the three different text fields: title, abstract and keywords. Although there are authors who prefer to avoid keywords (Delen & Crossland, 2008), or even titles (Miner et al., 2012), with the argument of the possibility of introducing bias because they may be the terms the authors would like to associate their document to and not the real descriptors of the article, this article has preferred to equally weight and combine the three text fields assuming that most authors –with the help of a high-quality review process such as *Telecommunications Policy*’s– will describe correctly the article in both their title and keywords, and that this combination will be a better weighting of key terms that other possible approaches.¹

¹ According to Ramampiaro and Li (2011), boosting title, abstract or specific sentences or terms can improve the quality of text mining results. In particular, they suggest weighting the title field twice as much as the abstract. There are more sophisticated approaches that weight sentences by the number of keywords, and title words they contain, or even the position of the paragraph containing the sentence in a segment, and the position of the sentence in the containing paragraph (Tseng, 2007).

The overall result is 6,348 root terms, reduced to 4,333 after pruning out verbs, adjectives and adverbs.

3.3. Data analysis

The first step in the text mining workflow is building the term frequency-inverse document frequency (tf-idf). This is a statistic to measure the relevance of a word in a document from a corpus. It increases with the frequency of apparition of a word in the document but it is corrected by the frequency of the word in the whole corpus, thus allowing for the fact that some words are more frequent in general but not necessarily so significant.

Next, the paper has opted for an exploratory factor analysis with the objective of finding underlying patterns and relationships between concepts in the text, and as a first attempt to condense the information available in the corpus of papers in a smaller set of key factors. The result of this part of the analysis is a set of words highly interrelated, known as factors, components or dimensions, which are assumed to represent conceptual relationships. In the case of text mining, singular value decomposition (SVD) is the recommended practical technique to extract these conceptual relationships due to the sparse nature of the matrix of documents vs. terms (Miner et al., 2012). SVD is commonly used in statistical natural language processing to identify “latent dimensions of meaning” that organize the documents in the corpus. The information grouped this way contains all the original information but in less variables. Thus, it is a form of feature extraction, eliminating the usual redundancies in a text. Technically SVD transforms a high-dimensional matrix (“space”) of documents by terms into a much lower dimensional space of dimensions defined as linear combinations of row or column values, which extract the most important information from the original matrix.

SVD is a usual first step in the direction of identifying clusters of terms, that is, words that usually go together, which is precisely the next stage in the text mining process followed in this article. Through cluster analysis, terms are grouped into sets or categories so that words belonging to the same cluster are more similar/related to one another than they are to terms in other clusters (Hair, Black, Babin, & Anderson, 2010). Cluster analysis is used with two main objectives: the formation of a taxonomy of papers –an empirical based classification of terms–, and the discovery of relationships between the terms that are not possible at individual word level. It is important to note that while SVD shares the second objective, the first is specific of cluster analysis, thus allowing to include each paper in one particular thematic cluster.

Measuring term similarity is the fundamental element of cluster analysis within text mining. Although it is widely acknowledged that the cosine distance performs better than the Euclidean distance for text data (Pons-Porrata, Berlanga-Llavori, & Ruiz-Shulclopfer, 2007), the latter was selected as measure of similarity since both are equivalent for text vectors of normalized length –which is the case as only title, abstract and keywords are used. Once the measure of similarity is specified, the next step is the classification of the corpus into different categories. There are several clustering algorithms that provide this function. The paper has used k-means as clustering algorithm since the size of the data set avoids the use of hierarchical methods. This algorithm works by portioning the data into a user-specified number of clusters and then iteratively reassigning terms to cluster until the distance between terms within a cluster is minimized and distance between clusters is maximized (Hair et al., 2010). To compensate for the aprioristic user-specification of the number of clusters a full range of them has been explored together with some measures on the optimum number of clusters, in particular the x-means algorithm (Pelleg & Moore, 2000) and the Davies-Bouldin index (Kovács, Legány, & Babos, 2005). The x-means algorithm is an extension of the classic k-means algorithm that finds automatically the optimal number of clusters; it proceeds recursively by running k-means for a given k and deciding whether to split or not each of the k clusters according to Bayesian information criterion. The Davies-Bouldin index measures the average of similarity between each possible cluster and its most similar one. As the clusters have to be compact and separated, the lower Davies–Bouldin index means better cluster configuration.

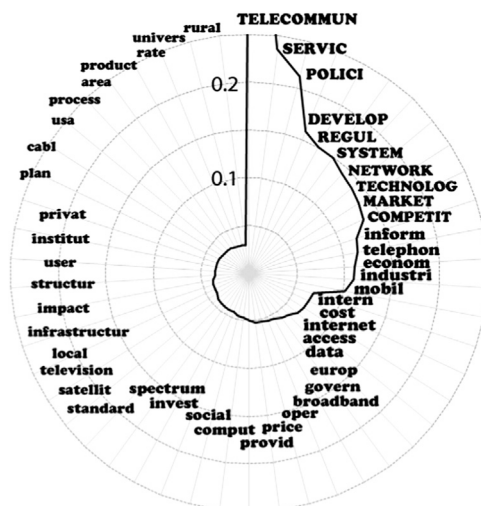


Exhibit 2. 50 most frequent words 1976–2016.

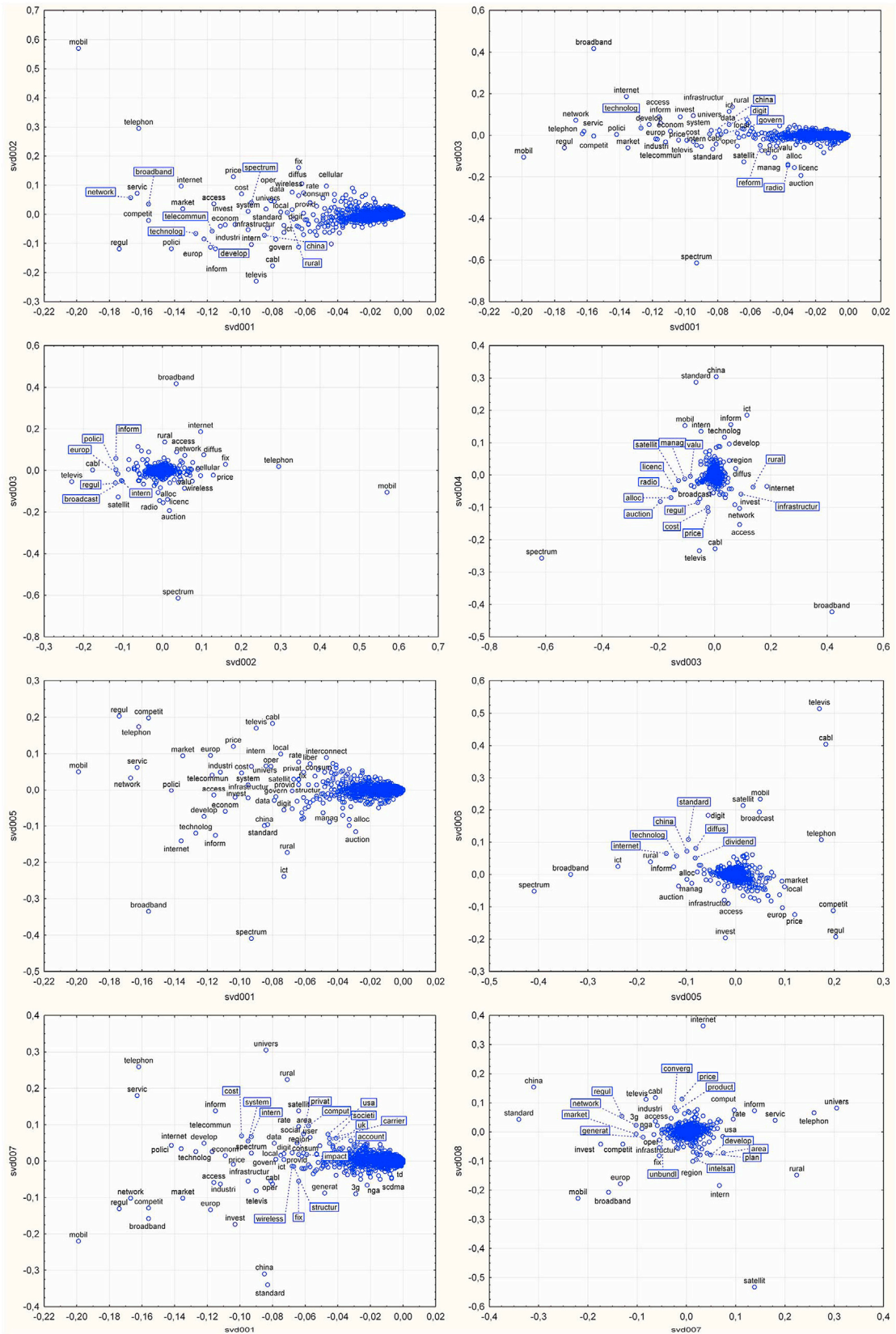


Exhibit 3. Scatterplots of SVD components for corpus 1976–2016.

Table 1
Interpretation of relevant SVD dimensions in each five-year period.

Period	1st Component	2nd Component	3rd Component	4th Component
1976–1980	telecom vs. computing	local/country-specific vs. international	information	(then) new services vs. traditional services
1981–1985	television	satellite	cable	conference
1986–1990	deregulation	satellite	conference	local vs. international
1991–1995	competition / regulation	cable / television	universal service / telephony	EU vs. Asia
1996–2000	competition / regulation / market	internet / telephony vs. television	universal	international
2001–2005	mobile	spectrum	rural access	regulated vs. non-regulated services
2006–2010	regulation / competition / access	broadband vs. mobile	supply vs. demand	standardization
2011–2016	mobile	standardization	spectrum	broadband

Source: own interpretation from SVD analysis.

Table 2
20 more relevant words for eleven-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
	<i>Satellite</i>	<i>Regulation Competition</i>	<i>Fixed telephony</i>	<i>Television</i>	<i>Asia</i>	<i>Standards</i>	<i>Mobile</i>	<i>Info society Development</i>	<i>Broadband</i>	<i>Spectrum</i>	<i>International ITU</i>
1	satellit	invest	telephon	televis	china	standard	mobil	inform	broadband	spectrum	intern
2	intelsat	regul	univers	cabl	reform	china	telephon	polic	internet	auktion	itu
3	db	access	price	broadcast	liber	patent	cellular	technolog	access	alloc	confer
4	orbit	network	servic	digit	japan	technolog	fix	develop	network	licenc	trade
5	broadcast	nga	competit	regul	privat	td	network	telecommun	rural	radio	plenipotentiari
6	system	infrastructur	cost	market	industri	mobil	diffus	ict	area	manag	annual
7	intern	competit	local	pay	competit	scdma	market	internet	diffus	frequenc	pacif
8	warc	unbundl	rate	video	regul	catch	consum	servic	infrastructur	valu	develop
9	inmarsat	europ	carrier	polic	institut	intern	servic	regul	polic	fee	assist
10	spectrum	generat	regul	competit	polic	innov	oper	social	competit	wireless	institut
11	mobil	cost	interconnect	content	ntt	global	custom	europ	deploy	effici	telecommun
12	rural	fibr	network	uk	telecommun	3g	competit	network	develop	mobil	data
13	direct	separ	account	satellit	govern	process	internet	industri	servic	band	europ
14	develop	incent	market	network	market	wireless	wireless	econom	invest	secondari	cooper
15	space	price	charg	channel	develop	technic	data	govern	econom	market	comput
16	global	market	traffic	system	compani	set	handset	comput	speed	india	hungari
17	station	deploy	internet	industri	econom	develop	subscrib	region	penetr	right	union
18	telecommun	oper	exchang	integr	polit	industri	system	market	data	cost	tdf
19	radio	entri	polic	europ	europ	system	technolog	product	technolog	space	servic
20	link	local	distanc	programm	servic	ict	substitut	system	provid	mhz	regul

Source: own calculations

3.4. Complementary techniques

To complete the pure text mining procedure explained above, the paper conducts a number of additional analyses.

The first of them consists of studying the research methodology used in the paper. For this we have downloaded the full text² of 300 papers –about 14% of the total number of papers for analysis– and manually classify them as qualitative or quantitative. We have used this to train a support vector machine (SVM) learner algorithm (Chih-Chung & Chih-Jen, 2011) that was able to correctly assign 77% of papers.

The second complementary analysis uses bibliometric techniques after compiling the affiliation information of authors. Unlike typical bibliometric studies, which are based in simple statistical analysis of bibliometric parameters, –viz., number of publications, citations, types of article, authors affiliation, etc; for a review in Information Science, see Nagarkar and Kumbhar (2015)–, bibliometric information is added to the results of the text mining analysis in order to give these results a wider scope.

3.5. Software

Rapidminer was chosen as the software to carry out most of the analysis because of its ease of use yet powerful and modular approach. Rapidminer is written in Java and uses XML configuration files that are easy to exchange and parse. It has a very intuitive graphical interface and its learning curve allows someone not used to programming languages to extract valuable information almost immediately. Besides, it can be extended and connected to more advanced languages or platforms like R or Python. It is also free software in its “community” edition. Rapidminer was complemented with other statistical, scientific and visualization software, such as Gephi, Octave, PAWS and Statistica.

² The information in the title, abstract and keywords was not enough to distinguish between the two types of research methodologies within the papers.

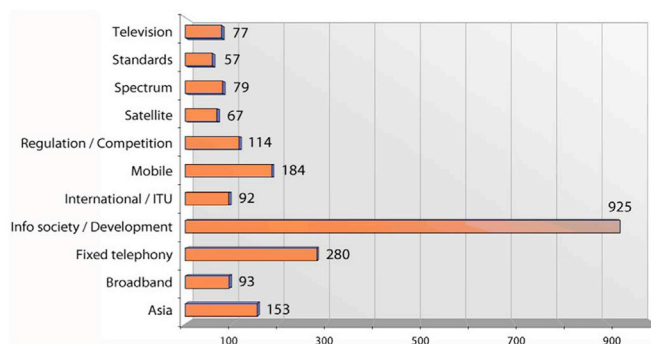


Exhibit 4. Distribution of papers for the eleven-cluster taxonomy for corpus 1976–2016.

Table 3

20 more relevant words for three-subcluster analysis of the category “info society / development” in the 1976–2016 corpus.

Order	C8-1 <i>Information / Internet</i>	C8-2 <i>Policy / Regulation / Development</i>	C8-3 <i>Regional / Rural</i>
1	inform	telecommun	ict
2	internet	polici	region
3	technolog	regul	rural
4	comput	develop	inform
5	media	europ	develop
6	social	industri	technolog
7	polici	competit	product
8	privaci	deregul	econom
9	network	servic	digit
10	develop	market	plan
11	servic	privat	structur
12	electron	govern	communiti
13	societi	network	europ
14	data	usa	infrastructur
15	system	econom	economi
16	user	effici	knowledg
17	govern	uk	societi
18	digit	product	remot
19	econom	isdn	area
20	innov	intern	africa

Source: own calculations.

4. Results and discussion

4.1. Preliminary analysis

The most basic analysis is word relative frequency. Filtering out verbs and other non-relevant terms and consolidating similar terms with the help of the stemmer, Exhibit 2 shows which are the most frequent words in article titles, abstracts and keywords. As expected, “telecommunications” is the most frequent word appearing in more than half of the papers and “policy” ranks number 3, with “services” placed in between. The ranking of other relevant topics is “development” at no. 4, “regulation” at no. 5, “market” at no. 9, and “competition” at no. 10. They are followed by “access” at no. 19, “govern” at no. 22, “social” at no. 28, and “universal” at no. 44. On the technology side, “telephony” is placed at no. 12 proving the weight of historical relevance, “mobile” at no. 15, “internet” at no. 18, “broadband” at no. 23, “spectrum” at no. 30, “standards” at no. 31, “satellite” at no. 32, “television” at no. 33, and “cable” at no. 42. From a regional perspective, “Europe” appears at no. 24, “USA” at no. 43 and China at no. 51.

The same analysis has been conducted in periods of five years, see Exhibit 11 in the Annex. The most interesting differences with the overall picture are highlighted in the following:

In 1976–1980, “computer” was no. 7 while “social” was no. 10.

In 1981–1985 “social” is yet down at no. 24, but “development” was no. 2, and legacy technologies acquired a bigger role from the previous period: “satellite” at no. 8, “telephony” at no. 9, “television” at no. 11, “computer” at no. 14, and “cable” at no. 18.

The evolution of the domain is fast and in 1986–1990 these technologies were losing some positions –but still in the top 20– with “telephony” at no. 14 and “satellite” at no. 15. Interestingly in this period there is also “competition” at no. 16, “Europe” at no. 17, “UK” at no. 18 and “USA” at no. 20 signalling the shake-up of markets about to come.

In 1991–1995 this change is more mature and “competition” is at no. 4, “regulation” at no. 7 and “market” at no. 8, while

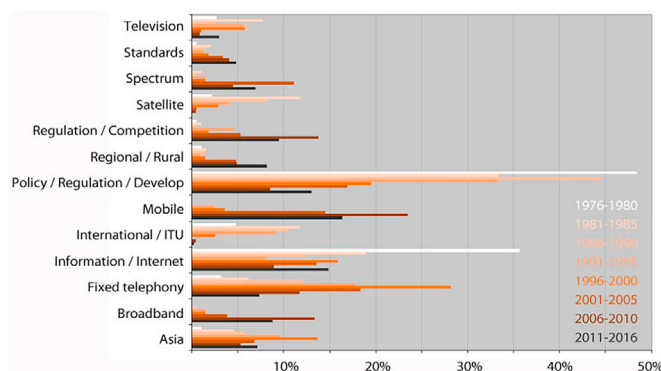


Exhibit 5. Evolution of the relative weight of the number of papers in 13-clusters taxonomy in 5-years periods for corpus 1976–2016.

“telephony” is still at no. 9.

In 1996–2000 this is even more pronounced with “regulation” at no. 4, “competition” at no. 5 and “market” at no. 6, while at the same time “telephony” is again no. 9; “internet” appears for the first time at no. 15.

In 2001–2005 “regulation” and “competition” are in the top-10, “internet” has gone up to no. 9, “mobile” appears for the first time in the top 10 at no. 6 as well as “spectrum” at no. 14, while “telephony” is still no. 12 and “development” is no. 15; also “access” appears for the first time at no. 16.

In 2006–2010 “mobile” is no. 3 and “broadband” enters at no. 10.

Finally in 2011–2016 we still have “mobile” at no. 3, “broadband” at no. 9 and “spectrum” at no. 20, also “market”, “regulation” and “internet” make for the top 10, and last but not least “China” turns up at no. 21.

4.2. Exploratory factor analysis

Applying the SVD technique to the corpus, the first practical question is how many dimensions –linear combination of terms– to retain. A visual criterion called the scree test finds the dimension from where the smooth decrease of singular values appears to level off to the right of the plot. According to this criterion the paper retains eight dimensions for analysis, in line with practical recommendations for text mining to keep between five and 20 dimensions (Miner et al., 2012).

In order to interpret the dimensions and assign some meaning to them, the authors have followed a process consisting of reviewing the scatterplot of terms against the dimensions, as seen in Exhibit 3. This is a mostly subjective procedure and as such subject to some discussion but still useful and frequently employed (Miner et al., 2012). Using this method, first dimension varies from what can be called “market” –as terms such as service, competition and regulation stand out– to “social” –where there is rural, government, local and universal. The second component looks mostly as different “technologies” from mobile through telephony and broadband –closer to market– to cable and television. The third component varies from broadband and internet through radio and mobile to spectrum, therefore could be interpreted as “fixed to mobile”. The fourth is somewhat more difficult to interpret but in authors’ view can be assumed as issues related –and unrelated– with “standardization” –where China is particularly relevant. Following a similar logic, dimension no. 5 can be associated with “spectrum” issues and dimension no. 6 linked to items where “television / media” is (un)relevant. Finally, the 7th dimension confronts “universal / rural / telephony / service” to the rest of concepts, with China and standardization again relevant, and dimension no. 8 displays “internet” vs. “satellite” and related concepts.

These scatterplots provide also useful insights into terms that usually go together. They are a blueprint of clusters of words that are located close together in the space defined by the SVD-derived latent dimensions of meaning. Thus, clusters of terms in relatively close proximity may suggest that the respective terms are associated with similar meaning and underlying dimensions. Main examples of interest are: “mobile–broadband”, “internet–price–access”, “service–network”, “competition–market–country”, “telecommunication–policy–development–regulation”, “ict–china–standard”, “investment–local–infrastructure”, and “allocation–licence–radio–spectrum–auction”.

Next the paper examined SVD in each period of five years. This was just conducted for the first four components for simplicity and only the most interesting results in the view of authors are highlighted. The results are summarized in Table 1. Looking at the first –and main in terms of explanatory power– dimension, the themes have moved from a pre-convergent dichotomy between telecoms and computing, initially to television and then to (de)regulation introducing at sequential stages competition, market and access, with two separate times –2001 to 2005 and 2011 to 2016– where mobile has been dominant. Interestingly the second dimension has been mostly related with technology, subsequently advancing from satellite to cable, then to internet and finally into broadband. The third component has also brought topics with a relevant evolution over time: universal service, rural access, and spectrum. Shared between the third and the fourth dimension, the role of international conferences is underlined in 1981–1985 and 1986–1990. Finally the fourth dimension insists at key periods in the differences between different types of services –1976 to 1980 and 2001 to 2005– and different geographic areas –1986 to 1990, 1991 to 1995–, lately highlighting standardization and broadband.

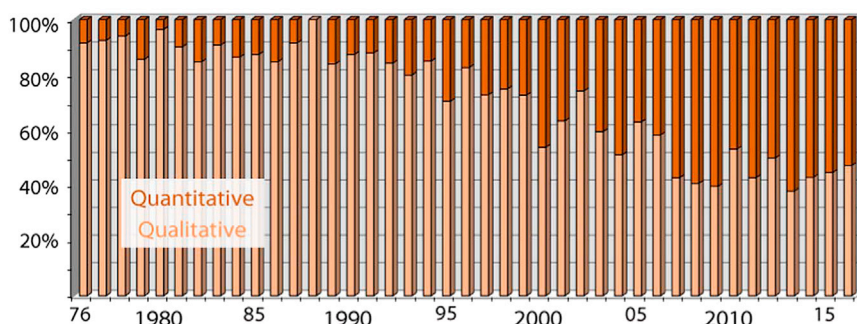


Exhibit 6. Evolution of qualitative vs. quantitative papers (1976–2016).

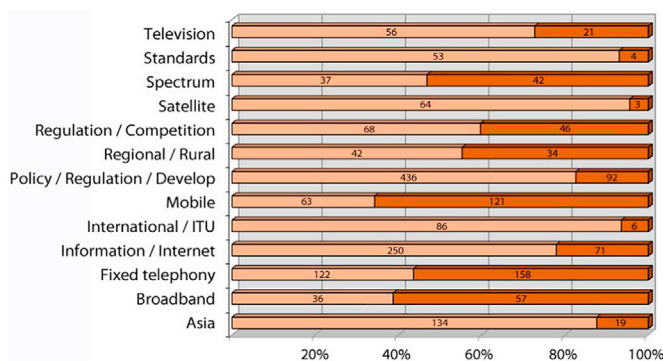


Exhibit 7. Qualitative vs. quantitative papers for 13-cluster analysis (1976–2016).

4.3. Cluster analysis

The next step in the analysis is classifying the corpus into different categories or clusters. Since k-means requires knowing the number of clusters in advance, and as explained in the methodology section, the paper has followed an ordered approach to elucidate the appropriate number of clusters. First the x-means algorithm with cosine distance provides a recommended number of four clusters. The Davies-Bouldin index with Euclidean distance has several minimums at four, seven, eleven, thirteen and eighteen clusters. Using these figures on the number of clusters as a departing point, the paper examines the results of the cluster analysis from five to twelve number of clusters to select –from authors’ perspective– the most meaningful combinations as explained in the following. This supervised approach is rather usual in non-hierarchical cluster analysis.³

When the number of clusters selected is five, authors’ summary interpretation of the themes of the clusters is: “telephony (both fixed and mobile)”, “broadband, television, rural, access”, “standards”, “spectrum” and “regulation / competition”. Moving on to six clusters adds a new theme on “international telecom” and separates “broadband, investment, access” from “television, development” that now go together with “standards”. Here “universal, rural” belongs to the cluster on “regulation / competition”. Advancing to seven clusters brings themes on “development / information society” and pinpoints “rural”. In this clustering “regulation” blends with “television”. Eight clusters analysis separates “television” from “regulation / competition” and joins “internet” and “information society”. Nine clusters raise a specific theme for papers on “European regulation” and complements “international” with “development, itu, conferences”. Ten clusters analysis brings up particular themes on “Asia - China market” and “satellite” and a rather general area on “telecommunications, internet, services”. Eleven clusters is precisely a combination of all of the themes above, with the addition of separating “fixed telephony” from “mobile” for the first time. Finally, twelve clusters analysis extends to a theme on “liberalisation, global trade” but at the expense of reintroducing the rather general area on “telecommunications, internet, services”.

Considering all the above, the eleven-cluster looks as a pertinent summary of the cluster analysis, and therefore, this is the chosen number of clusters. Table 2 gives a descriptive title to every cluster, and shows the 20 more relevant words in every box. Tables 6–12 in the Annex do the same for the other options (five to twelve clusters).

The themes that define the eleven clusters are all strong candidates for a taxonomy of *Telecommunications Policy* papers. Exhibit 4 shows the distribution of the *Telecommunications Policy* papers across this eleven-cluster taxonomy.

³ According to Hair et al. (2010), cluster solutions ultimately require external validation. It is also suggested that the researcher uses several optimization rules for the number of clusters and look for a consensus cluster solution. It is recommended, for the final analysis, to compute a number of different cluster solutions and decide among them using practical judgement.

Table 4
Ranking of countries contributing to *Telecommunications Policy* 1976–2016.

Country	No. papers	No. citations	Share papers (%)	Share citations (%)	Average citations per paper
USA	755	7606	34.47%	38.62%	10.07
UK	295	2351	13.47%	11.94%	7.97
Germany	116	1057	5.30%	5.37%	9.11
China	109	992	4.98%	5.04%	9.10
Canada	77	408	3.52%	2.07%	5.30
Australia	75	615	3.42%	3.12%	8.20
South Korea	75	1045	3.42%	5.31%	13.93
Italy	58	535	2.65%	2.72%	9.22
Netherlands	57	689	2.60%	3.50%	12.09
France	55	258	2.51%	1.31%	4.69
Japan	54	440	2.47%	2.23%	8.15
Spain	51	435	2.33%	2.21%	8.53
Belgium	38	257	1.74%	1.31%	6.76
Greece	31	223	1.42%	1.13%	7.19
Finland	26	419	1.19%	2.13%	16.12
Sweden	23	93	1.05%	0.47%	4.04
India	21	191	0.96%	0.97%	9.10
Denmark	20	175	0.91%	0.89%	8.75
Portugal	19	122	0.87%	0.62%	6.42
Ireland	16	87	0.73%	0.44%	5.44
Singapore	16	143	0.73%	0.73%	8.94
South Africa	16	122	0.73%	0.62%	7.63
Switzerland	16	144	0.73%	0.73%	9.00
Austria	15	75	0.68%	0.38%	5.00
Turkey	14	70	0.64%	0.36%	5.00
Israel	12	127	0.55%	0.64%	10.58
New Zealand	12	85	0.55%	0.43%	7.08
Norway	10	80	0.46%	0.41%	8.00
Mexico	9	250	0.41%	1.27%	27.78
Argentina	8	54	0.37%	0.27%	6.75
Thailand	8	37	0.37%	0.19%	4.63
Chile	7	18	0.32%	0.09%	2.57
Iran	7	90	0.32%	0.46%	12.86
Peru	6	41	0.27%	0.21%	6.83
Brazil	5	17	0.23%	0.09%	3.40
Luxembourg	5	52	0.23%	0.26%	10.40
Bolivia	4	9	0.18%	0.05%	2.25
Hungary	4	12	0.18%	0.06%	3.00
Indonesia	4	25	0.18%	0.13%	6.25
Colombia	3	27	0.14%	0.14%	9.00
Fiji	3	4	0.14%	0.02%	1.33
Macedonia	3	23	0.14%	0.12%	7.67
Malaysia	3	8	0.14%	0.04%	2.67
Poland	3	7	0.14%	0.04%	2.33
Slovenia	3	31	0.14%	0.16%	10.33
Czech Rep.	2	13	0.09%	0.07%	6.50
Ghana	2	28	0.09%	0.14%	14.00
Philippines	2	5	0.09%	0.03%	2.50
Russia	2	3	0.09%	0.02%	1.50
Saudi Arabia	2	24	0.09%	0.12%	12.00
Uganda	2	15	0.09%	0.08%	7.50
Bhutan	1	3	0.05%	0.02%	3.00
UAE	1	19	0.05%	0.10%	19.00
Guatemala	1	15	0.05%	0.08%	15.00
Kenya	1	6	0.05%	0.03%	6.00
Lithuania	1	1	0.05%	0.01%	1.00
Nigeria	1	1	0.05%	0.01%	1.00
Pakistan	1	1	0.05%	0.01%	1.00
Paraguay	1	6	0.05%	0.03%	6.00
Romania	1	0	0.05%	0.00%	0.00
Serbia	1	3	0.05%	0.02%	3.00
Ukraine	1	0	0.05%	0.00%	0.00

Source: own estimations. Data for citations from Scopus database.

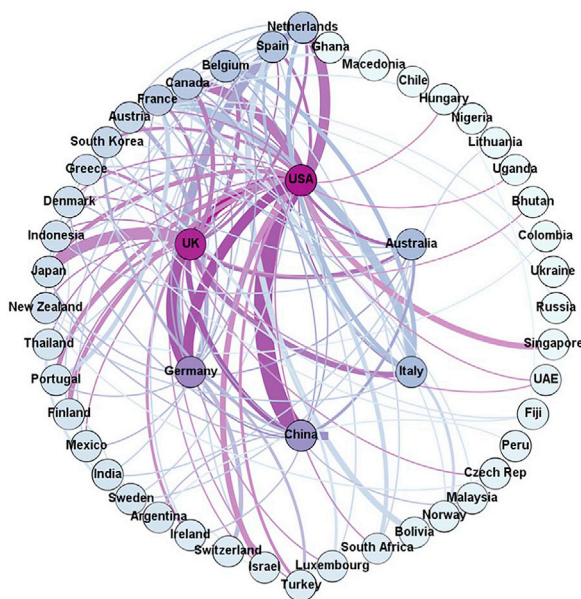


Exhibit 8. Network of collaborations for Telecommunications Policy 1976–2016. Source: own elaboration.

As seen in Exhibit 4, the category related with “information, policy, technology, development, telecom” (C8 in Table 2) has the highest number of papers, well above the rest. Therefore, a specific (sub)cluster analysis on it was carried out. Table 3 presents the results of the cluster analysis for “info society / development”. The Davies-Bouldin index suggest three (sub)clusters for this category. The first subcluster refers to “information, internet, media, social” (321 papers), the second can be labelled more appropriately as “policy, regulation, development” (528 papers) and the third relates mostly with “regional / rural development” (76 papers).

Next stage in the analysis is the evolution of the total 13 clusters (10 clusters +3 subclusters) during the 40-year life span of Telecommunications Policy. Exhibit 5 displays this evolution, grouped in 5-years periods for simplicity. The graph exposes that some of the clusters have had a remarkable change along the 1976–2016 period, in particular: “fixed telephony” had a maximum in the period around the liberalisation of telecoms in 1996–2000; the cluster on “information, internet” slowly gains weight across the total period while the contrary happens with the relationship between “policy, regulation, development”; interestingly “regional / rural development” although more relevant in the first period of five years 1976–1980, since then has maintained a similar relative relevance in the total number of papers; the cluster on “standards” had an early significance during 1981–1985, in the period where industry was looking to initial standards such as GSM and then has regained importance in the last three periods since 2001; “spectrum” is an interesting case as it comes and goes with peaks in 2001–2005 and 2011–2016 in concordance with very active periods for auctions; “satellite” and

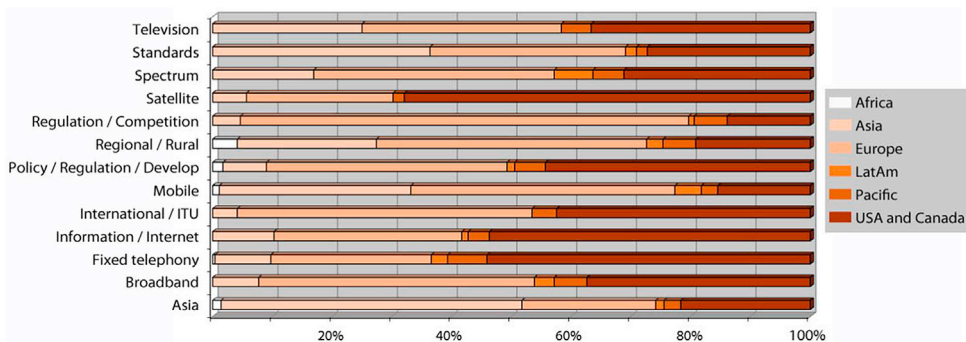


Exhibit 9. Regions of papers for 13-cluster analysis (1976–2016).

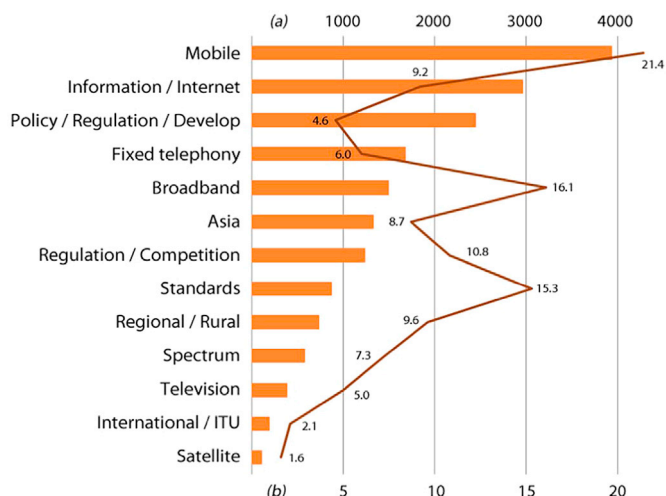


Exhibit 10. Citations of papers for 13-cluster analysis (1976–2016): a) absolute figures; b) relative to the number of papers in the cluster.

“conferences / itu” were key components of *Telecommunications Policy* papers in the early periods, specially during 1981–1985, but since about 2000 they have almost disappeared; “mobile” appeared in the early 1990s gaining momentum since then with a very high share of papers in the period 2006–2010; issues around the triangle “investment, regulation, competition” have been increasingly central since the start of the liberalisation stage in the early 1990s; “Asia” as a cluster on particular regulatory schemes has been approximately constant across the period with a maximum in 1996–2000; finally “television” and “broadband” have followed opposite paths with the former decreasing from 2000, precisely when the latter arrived with relevance.

4.4. Complementary analysis

In connection with the previous analysis, the paper carries out a number of complementary investigations. The first of them refers to the type of research methodology used in each of the papers. Two very simple types have been chosen: qualitative vs. quantitative. Exhibit 6 displays the yearly evolution of both methodologies in the 1976–2016 period. It is evident the evolution from an ample majority of qualitative papers in the first half of the period, through a phase of slight predominance of quantitative papers to a recent and approximate balance between the two types.

Next it is the relationship between methodologies and clusters. Exhibit 7 portrays the two methodologies with regard to the 13-cluster analysis for the whole period 1976–2016. There are strong relationships between this taxonomy of papers and methodologies with three main groups: those where qualitative is dominant (“television”, “Asia”, “conferences / itu”, “satellite”, “standards”, “information, internet” and “policy, regulation, development”); those where quantitative methodologies lead (“broadband” and “mobile”); and those where there is a relative balance (“investment, regulation, competition”, “spectrum”, “regional / rural development” and “fixed telephony”). The paper hypothesizes that there are specific connections between methodologies and clusters, but that

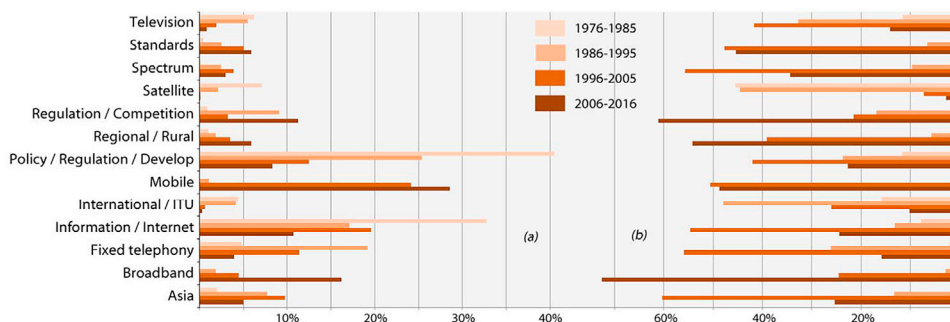


Exhibit 11. Citations of papers per decade for 13-cluster analysis (1976–2016): a) weight of clusters in decades; b) weight of decades in clusters.

Table 5
Main themes in telecommunications policy 1976–2016.

Theme	Keywords	Dimensions	Relevant periods	Dominant methodology	Influential geographical area	Impact from citations	Proactive vs. reactive
Broadband	broadband – internet – access – network	market vs. social technology competition – regulation	2001–2005 2006–2010 (max.) 2011–2016	Quantitative	Europe & USA / Canada (main)	Medium	Reactive
Asia	China – reform – liberalisation – Japan	EU vs. Asia standardization	1991–1995 1996–2000 (max.)	Qualitative	Asia (main)	Medium	Proactive
Fixed telephony	telephone – universal – price – service	fixed vs. mobile new vs. traditional serv.	1991–1995 1996–2000 (max.) 2001–2005	Qualitative & Quantitative	USA / Canada (main)	Medium	Reactive
Information / Internet	information – internet – technology – computer	Information telecom vs. computing	1976–1980 (max.) 1981–1985 1996–2000 2011–2016	Qualitative	USA / Canada (main)	High	Proactive
International conferences / ITU	international – ITU – conference – trade	local vs. international technology standardization	1981–1985 (max.) 1986–1990	Qualitative	Europe & USA / Canada (main)	Low	Neutral
Mobile	mobile – telephone – cellular – fixed	fixed vs. mobile technology	2001–2005 2006–2010 (max.) 2011–2016	Quantitative	Europe (main) & Asia	High	Reactive
Policy / regulation / development	telecommunications – policy – regulation – development	competition – regulation market vs. social	1976–1980 (max.) 1981–1985 1986–1990 1991–1995	Qualitative	Europe & USA / Canada (main)	High	Proactive
Regional / rural development	ICT – rural – regional – information – development	universal service market vs. social	2011–2016 (max.)	Qualitative & Quantitative	Europe (main) & Asia	Medium	Reactive
Regulation / competition / investment	investment – regulation – access – network	market vs. social supply vs. demand	2006–2010 (max.) 2011–2016	Qualitative & Quantitative	Europe (main)	Medium	Reactive
Satellite	satellite – Intelsat – DBS – orbit	internet vs. satellite technology	1981–1985 (max.) 1986–1990	Qualitative	USA / Canada (main)	Low	Neutral
Spectrum	spectrum – auction – allocation – licence	spectrum fixed vs. mobile	2001–2005 (max.) 2011–2016	Qualitative & Quantitative	Europe & USA / Canada (main)	Low	Proactive
Standards	standard – China – patent – technology	standardization technology	2001–2005 2006–2010 2011–2016 (max.)	Qualitative	Europe & USA / Canada & Asia (main)	Medium	Neutral
Television	television – cable – broadcast – digital	media technology	1981–1985 (max) 1991–1995 1996–2000	Qualitative	Europe & USA / Canada & Asia (main)	Low	Proactive

Source: own findings.

Table 6
20 more relevant words for five-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5
1	mobil	broadband	standard	spectrum	regul
2	telephon	televis	china	auction	polici
3	servic	cabl	patent	radio	competit
4	cellular	ict	technolog	alloc	telecommun
5	price	rural	td	licenc	inform
6	network	digit	mobil	manag	servic
7	fix	internet	scdma	frequenc	intern
8	wireless	technolog	catch	orbit	develop
9	market	access	intern	valu	network
10	consum	network	global	mobil	europ
11	diffus	develop	technic	right	industri
12	competit	infrastructur	process	wireless	market
13	internet	econom	3g	fee	technolog
14	custom	inform	consortia	effici	invest
15	cost	polici	wireless	satellit	econom
16	system	area	set	market	govern
17	oper	broadcast	develop	band	privat
18	rate	servic	system	cr	univers
19	data	competit	innov	space	cost
20	univers	dividend	ict	interfer	comput

Table 7
20 more relevant words for six-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6
1	intern	spectrum	broadband	regul	mobil	inform
2	telecommun	auction	invest	competit	telephon	ict
3	polici	radio	access	telephon	fix	china
4	servic	alloc	network	univers	market	technolog
5	develop	licenc	internet	servic	cellular	televis
6	regul	manag	infrastructur	price	network	develop
7	europ	frequenc	fibr	local	diffus	polici
8	privat	orbit	nga	network	servic	standard
9	internet	valu	deploy	market	consum	rural
10	itu	mobil	regul	liber	oper	digit
11	confer	right	generat	cost	competit	satellit
12	market	wireless	competit	europ	wireless	internet
13	industri	fee	cost	polici	custom	econom
14	competit	effici	price	industri	price	media
15	trade	satellit	area	reform	internet	comput
16	uk	market	rural	telecommun	handset	broadcast
17	data	band	polici	interconnect	system	social
18	deregul	cr	unbundl	cabl	industri	govern
19	govern	space	diffus	infrastructur	standard	cabl
20	network	interfer	econom	law	technolog	industri

Table 8
20 more relevant words for seven-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6	C7
1	mobil	broadband	standard	rural	inform	regul	spectrum
2	telephon	internet	china	area	develop	competit	auction
3	servic	access	patent	remot	technolog	televis	radio
4	price	network	td	communiti	intern	europ	alloc
5	network	infrastructur	mobil	internet	ict	market	licenc
6	rate	diffus	technolog	servic	polici	network	manag
7	cellular	invest	scdma	access	telecommun	cabl	frequenc
8	fix	competit	catch	urban	internet	polici	orbit
9	internet	polici	intern	develop	comput	servic	valu
10	market	area	global	telephon	econom	industri	mobil
11	wireless	deploy	3g	broadband	satellit	invest	right
12	consum	develop	process	dividend	servic	telecommun	wireless
13	diffus	econom	wireless	institut	social	liber	fee
14	cost	speed	technic	project	product	local	effici
15	custom	servic	set	digit	region	access	satellit
16	competit	technolog	develop	inform	data	univers	market
17	oper	cabl	innov	cost	system	privat	band
18	system	penetr	system	center	govern	price	cr
19	data	fix	ict	satellit	media	reform	space
20	penetr	municip	nmt	ict	confer	cost	interfer

there is also a considerable influence of time in the sense of those clusters with an earlier relevance are more prone to use qualitative techniques while, on the contrary, quantitative methodologies are strongly linked to more “modern” clusters.

The second complementary analysis looks into the relationship with geographical areas. Authors’ affiliation⁴ was used to know the major countries contributing to *Telecommunications Policy* research. Table 4 displays the results in terms of published articles and received citations. As for calculating the number of citations, Scopus database has been used.⁵ Table 4 shows that the USA ranks first and has contributed almost 35 per cent (i.e. 755) of the total 2,190 publications for which affiliation is disclosed; similarly, almost 39 per cent (7,606) of the total (19,692) citations are received by papers published from USA. In terms of regions, Europe leads with 42 per cent (i.e. 926 of the total) but with also almost 39 per cent (7,585) of the total citations. It is as well interesting to find that in the top ten countries producing *Telecommunications Policy* papers, there are two countries from Asia (China and South Korea) with Japan at no. 11.

⁴ Just the affiliation of first (main) author was used for this particular analysis.

⁵ Scopus information “CitedBy” has been used. It should be noted that figures previous to 1996 are inaccurate. Citations have been gradually incorporated to databases, though it is yet an unfinished business. See <https://blog.scopus.com/posts/scopus-has-added-5-million-pre-1996-articles-and-over-93-million-references-and-we-re-not-even-half-way/> (November 2015)

Table 9
20 more relevant words for eight-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6	C7	C8
1	spectrum	mobil	broadband	regul	televis	internet	standard	intern
2	auction	telephon	invest	competit	cabl	inform	china	telecommun
3	alloc	fix	access	telephon	broadcast	ict	institut	polic
4	radio	market	network	univers	digit	technolog	3g	develop
5	licenc	network	infrastructur	servic	satellit	rural	patent	satellit
6	manag	servic	fibr	price	regul	develop	technolog	europ
7	frequenc	oper	nga	local	pay	product	industri	privat
8	orbit	competit	deploy	cost	video	comput	develop	govern
9	valu	diffus	regul	market	market	econom	mobil	confer
10	right	cellular	competit	network	db	servic	td	itu
11	wireless	consum	generat	polic	polic	network	scdma	servic
12	mobil	custom	internet	carrier	uk	digit	domest	japan
13	fee	price	cost	europ	competit	polic	foreign	deregul
14	effici	handset	price	rate	content	social	reform	plan
15	satellit	industri	area	interconnect	system	infrastructur	intern	usa
16	band	internet	rural	liber	channel	societi	global	regul
17	market	wireless	unbundl	industri	industri	diffus	process	system
18	cr	substitut	polic	telecommun	network	innov	internet	inform
19	cognit	subscrib	econom	reform	integr	data	catch	competit
20	secondari	termin	diffus	intern	europ	user	telecommun	industri

Table 10
20 more relevant words for nine-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	spectrum	mobil	broadband	regul	televis	europ	internet	standard	intern
2	auction	telephon	invest	telephon	cabl	regul	ict	china	develop
3	alloc	fix	access	competit	broadcast	germani	inform	institut	telecommun
4	radio	network	network	univers	digit	competit	technolog	3g	polic
5	licenc	market	infrastructur	servic	regul	isdn	rural	patent	satellit
6	manag	servic	regul	price	satellit	liber	develop	technolog	privat
7	orbit	oper	fibr	cost	pay	market	product	industri	inform
8	frequenc	diffus	nga	local	video	union	digit	develop	govern
9	valu	custom	competit	carrier	market	commiss	econom	mobil	comput
10	right	cellular	deploy	network	polic	region	diffus	td	servic
11	wireless	competit	generat	rate	competit	telecommun	servic	scdma	technolog
12	mobil	consum	internet	market	uk	polic	polic	domest	confer
13	fee	handset	price	interconnect	content	network	network	intern	itu
14	effici	wireless	cost	polic	channel	infrastructur	infrastructur	foreign	social
15	satellit	substitut	polic	industri	system	communiti	access	reform	system
16	band	internet	unbundl	telecommun	network	framework	innov	process	deregul
17	market	data	area	account	industri	servic	dividend	telecommun	plan
18	secondari	subscrib	econom	charg	integr	west	comput	global	japan
19	space	system	rural	intern	europ	green	industri	internet	data
20	interfer	industri	europ	reform	programm	reform	societi	catch	media

Together, Asian countries have contributed 14.5 per cent of the total literature (318 papers) and they have received about 16 per cent of the total citations (3,093).

Papers published from USA have received an average of 10.07 citations per paper. Analysis of citations received by papers published in the top ten countries shows that papers from USA, Korea and Netherlands have received an average of ten or more citations per paper, although it is the nine papers from Mexico those that receive more citations (27.78 in average).

In a second step, collaborations among countries were checked. Exhibit 8 shows the international collaborations in the *Telecommunications Policy* papers.⁶ Darker internal circles indicate collaboration leaders and width of line the strength of collaboration. USA has the highest collaborations with other countries at 82, followed by the UK at 66, Germany and China at 37, Netherlands at 25, Italy at 24 and then, in the external circle, Spain, Canada, Japan and France at 15 collaborations.

In a third step the relationship between regions and clusters is examined. Exhibit 9 shows papers' region –Europe, USA/Canada, LatAm, Asia, Africa, Pacific– with regard to the 13-cluster analysis for the whole period 1976–2016. The region USA/Canada is

⁶ Countries with no collaborations are not included in the graph.

dominant in connection with “fixed telephony”, “information, internet”, and most notoriously in the “satellite” cluster. Europe leads in “mobile”, “regional / rural” and notably in “regulation, competition, investment”. There is an approximate balance between these two geographical areas in the clusters related with “broadband”, “international / itu”, “policy, regulation, development”, “spectrum”, “standards” and “television”. Asia has a remarkable position in –obviously– the “Asia” cluster, but also in “mobile”, “regional / rural”, “spectrum”, “standards” and “television”. Pacific region is noteworthy in “broadband”, “fixed telephony”, “regional / rural”, “regulation / competition”, “spectrum” and “television”. In the case of LatAm important clusters are “spectrum” and “mobile” followed by “broadband”, “fixed telephony” and “regional / rural”. Finally, Africa focus lies in “regional / rural”.

The last of the complementary analysis uses citations to look into how the knowledge enclosed in *Telecommunications Policy* has been used –at least within the academic world– and how the relevance of the different clusters in terms of their –at least academic– influence has changed over time. To introduce the status of citations, Table 13 in the Annex displays the most cited papers in *Telecommunications Policy* in each decade within the period 1976–2016.

The first decade, up to 1985 is dominated by papers discussing the diffusion and relevance of (then) new technologies and services such as teleconferencing and teletext, together with papers on development and social implications. There is also an early study into competition in telecommunications.

The second decade, 1986–95, has been influential mostly through papers on the relationship between telecommunications and economic growth, although there are also relevant papers on the use of information, spectrum auctions and universal service.

The third decade, 1996–2005, exhibits the maximum absolute value on citations and shifts from supply into demand with authoritative works on customer satisfaction, mobile phone usage, and Internet connectivity. It is also the decade where mobile and data –Internet– comes into the forefront along with examinations of an increasingly complex industry that moves from simple value chains into value networks.

The last decade, 2006–2016, is probably early to be scrutinized globally in terms of citations but hints at papers in 2006–2010 dealing with the triangle investment – regulation – competition, as well as mobile services –and applications–, and broadband –and mobile– rural development.

Ensuing this brief analysis of the status of *Telecommunications Policy* citations, Exhibit 10 shows the number of citations per cluster in absolute value and relative to the number of papers in the cluster. “Mobile” cluster leads both classification, followed by “information, internet” and “policy, regulation, development” in absolute figures, but by “broadband” and “standards” in relative terms.

Next, the evolution of these citations in each of the four decades in the 1976–2016 period appears in Exhibit 11. In terms of decades, works on “policy, regulation, development” lead the first and second decade. Third and fourth decades are commanded by “mobile”, with emerging “broadband” in the latter. From clusters’ perspective, *outmoded* themes seems to be “satellite” (which concentrates its citations in the first two decades), “international / itu” (mainly cited in the second decade), or “television”. The third and fourth decades sees a blooming of citations in all themes. The clusters whose impact is most recent, i.e., those who have received the higher share of citations during the last ten years, are “regulation / competition”, “regional / rural” and notoriously “broadband”. “Standards” and “mobile” have a similar number of citations in the third and fourth decade.

Always classified by decades, Table 13, in the Annex, shows the *Telecommunications Policy* articles that have received more citations along the years. Conversely, Table 14, also in the Annex, shows the documents (articles, books, book chapters, even policy documents)

Table 11
20 more relevant words for ten-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	spectrum	inform	china	standard	mobil	telecommun	broadband	regul	satellit	intern
2	auction	ict	institut	china	telephon	polic	access	competit	db	itu
3	alloc	technolog	industri	patent	cellular	internet	internet	price	intelsat	confer
4	licenc	comput	reform	technolog	servic	privat	network	network	televis	trade
5	radio	media	internet	mobil	fix	develop	rural	invest	broadcast	account
6	manag	social	develop	catch	consum	servic	infrastructur	univers	orbit	rate
7	frequenc	develop	3g	intern	wireless	industri	area	cabl	system	settlement
8	valu	polic	polic	td	network	govern	diffus	local	intern	plenipotentiari
9	fee	societi	regul	scdma	market	regul	competit	cost	inmarsat	develop
10	effici	econom	market	global	diffus	market	polic	servic	direct	pacif
11	mobil	electron	foreign	europ	oper	europ	cabl	access	mobil	telecommun
12	wireless	system	govern	technic	custom	econom	invest	europ	rural	telephon
13	market	servic	competit	process	price	competit	develop	market	develop	annual
14	secondari	rural	mobil	consortia	competit	network	deploy	interconnect	warc	servic
15	band	product	telecommun	wireless	system	deregul	servic	infrastructur	spectrum	regul
16	india	offic	cabl	develop	subscrib	liber	econom	polic	global	assist
17	space	digit	televis	set	data	telephon	speed	telephon	telecommun	data
18	right	impact	domest	3g	internet	plan	fix	televis	station	arrang
19	assign	converg	inform	televis	cost	televis	penetr	entri	polic	call
20	interfer	region	converg	system	handset	usa	technolog	telecommun	link	traffic

Table 12
20 more relevant words for twelve-cluster analysis in the 1976–2016 corpus.

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
1	satellit	inform	televis	china	standard	liber	telecommun	broadband	invest	spectrum	mobil	price
2	orbit	ict	cabl	institut	china	intern	polic	access	regul	auktion	telephon	telephon
3	intelsat	technolog	broadcast	industri	patent	trade	regul	internet	competit	licenc	cellular	rate
4	db	comput	digit	internet	technolog	germani	develop	network	univers	alloc	fix	cost
5	broadcast	develop	regul	reform	td	europ	internet	rural	network	radio	network	servic
6	spectrum	social	pay	converg	mobil	agreement	privat	infrastructur	access	manag	diffus	charg
7	warc	media	video	foreign	scdma	competit	servic	area	local	frequenc	servic	account
8	intern	rural	market	develop	catch	wto	intern	diffus	europ	valu	oper	call
9	system	polic	competit	polic	intern	servic	industri	competit	servic	fee	market	intern
10	inmarsat	societi	polic	inform	technic	regul	govern	polic	infrastructur	effici	consum	settlement
11	geostationari	internet	industri	market	global	telecommun	confer	invest	cost	wireless	custom	regul
12	rural	econom	uk	govern	process	reform	network	develop	market	mobil	competit	traffic
13	develop	privaci	content	3g	3g	market	itu	deploy	interconnect	secondari	wireless	competit
14	direct	servic	channel	manufactur	consortia	polic	uk	servic	polic	band	internet	market
15	mobil	digit	network	telecommun	set	privat	competit	econom	nga	market	subscrib	internet
16	space	product	system	regul	wireless	industri	market	speed	entri	india	technolog	network
17	televis	data	integr	mobil	develop	govern	deregul	penetr	separ	right	system	consum
18	global	system	broadband	cloud	system	west	europ	fix	generat	properti	data	carrier
19	radio	region	europ	technolog	innov	develop	institut	technolog	loop	assign	handset	cap
20	resourc	impact	programm	comput	ict	econom	japan	data	telecommun	regul	satisfact	system

Table 13
Ten most cited *Telecommunications Policy* papers per decade within the 1976–2016 period.

No. citations	Year	Authors	Title
1976–1985			
24	1977	Pye, R. & Williams, E.	Teleconferencing: Is video valuable or is audio adequate?
20	1985	Carey, J. & Moss, M.L.	The diffusion of new telecommunication technologies
19	1983	Kling, R.	Value conflicts in computing developments. Developed and developing countries
18	1982	Kraemer, K.L.	Telecommunications / transportation substitution and energy conservation. Part 1
17	1976	Parker, E.	Social implications of computer/telecoms systems
14	1984	Wellenius, B.	On the role of telecommunications in development
13	1979	Tyler, M.	Videotex, prestel and teletext. The economics and politics of some electronic publishing media
13	1981	Kraemer, K.L. & King, J.L.	Computing policies and problems. A stage theory approach
12	1982	Langdale, J.	Competition in telecommunications
12	1977	Johansen, R.	Social evaluations of teleconferencing
1986–1995			
98	1991	Cronin, F.J.; Parker, E.; Colleran, E.K. & Gold, M.	Telecommunications infrastructure and economic growth. An analysis of causality
69	1988	Allen, D.	New telecommunications services. Network externalities and critical mass
61	1993	Cronin, F.J.; Colleran, E.K.; Herbert, P.L. & Lewitzky, S.	Telecommunications and growth. The contribution of telecommunications infrastructure investment to aggregate and sectoral productivity
57	1989	Braman, S.	Defining information. An approach for policymakers
52	1995	McMillan, J.	Why auction the spectrum?
51	1993	Cronin, F.J.; Parker, E.; Colleran, E.K. & Gold, M.	Telecommunications infrastructure investment and economic development
43	1993	Mueller, M.	Universal service in telephone history. A reconstruction
38	1988	Waterman, D.	World television trade. The economic effects of privatization and new technology
36	1992	Noll, A.M.	Anatomy of a failure: picture phone revisited
1996–2005			
298	2004	Kim, M.-K.; Park, M.C. & Jeong, D.-H.	The effects of customer satisfaction and switching barrier on customer loyalty in Korean mobile telecommunication services
252	2003	Rice, R.E. & Katz, J.E.	Comparing internet and mobile phone usage: Digital divides of usage, adoption, and dropouts
202	2001	Gerpott, T.J.; Rams, W. & Schindler, A.	Customer retention, loyalty, and satisfaction in the German mobile cellular telecommunications market
179	1999	Hargittai, E.	Weaving the Western Web: Explaining differences in Internet connectivity among OECD countries
159	2002	Li, F. & Whalley, J.	Deconstruction of the telecommunications industry: From value chains to value networks
129	1999	Mahler, A. & Rogers, E.M.	The diffusion of interactive communication innovations and the critical mass: The adoption of telecommunications services by German banks
128	2004	Kim, H.-S. & Yoon, C.-H.	Determinants of subscriber churn and customer loyalty in the Korean mobile telephony market
122	2003	Lehr, W. & McKnight, L.W.	Wireless Internet access: 3 G vs. WiFi?
98	2004	Ishii, K.	Internet use via mobile phone in Japan
92	2002	Maitland, C.F.; Bauer, J.M. & Westerveld, R.	The European market for mobile data: Evolving value chains and industry structures
2006–2016			
106	2006	Turel, O. & Serenko, A.	Satisfaction with mobile services in Canada: An empirical investigation
105	2010	West, J. & Mace, M.	Browsing as the killer app: Explaining the rapid success of Apple's iPhone
99	2009	Koutroumpis, P.	The economic impact of broadband on growth: A simultaneous approach
98	2009	Cambini, C. & Jiang, Y.	Broadband investment and regulation: A literature review
98	2006	Cave, M.	Encouraging infrastructure competition via the ladder of investment
88	2006	Rouvinen, P.	Diffusion of digital mobile telephony: Are developing countries different?
82	2007	LaRose, R.; Gregg, J.L.; Strover, S.; Straubhaar, J. & Carpenter, S.	Closing the rural broadband gap: Promoting adoption of the Internet in rural America
81	2006	Ahn, J.-H.; Han, S.-P. & Lee, Y.-S.	Customer churn analysis: Churn determinants and mediation effects of partial defection in the Korean mobile telecommunications service industry
72	2007	Jaeger, P.T.; Shneiderman, B.; Fleischmann, K.R.; Preece, J.; Qu, Y. & Fei Wu, P.	Community response grids: E-government, social networks, and effective emergency management
66	2007	Warren, M.	The digital vicious cycle: Links between social disadvantage and digital exclusion in rural areas

Source: own calculations from Scopus data.

Table 14Ten most cited references by *Telecommunications Policy* articles in a particular decade within the 1976–2016 period.

No. citations	Year	Authors	Title	Source
1976–1985				
8	1977	Pye, R. & Williams, E.	Teleconferencing: Is video valuable or is audio adequate?	<i>Telecommunications Policy</i>
6	1976	Short, J.; Williams, E. & Christie, W.	The social psychology of telecommunications	<i>Book</i>
6	1977	Gehrig, J.	Geostationary orbit-technology and law	<i>Conference paper – In Proceedings of the Nineteenth Colloquium on the Law of Outer Space</i>
5	1971	Jacobson	International institutions for telecommunications: the ITU's role	<i>Book chapter – In E. McWhinney (ed.), The International Law of Communications</i>
5	1975	Rockoff, M.L.	An overview of some technological/health-care system implications of seven exploratory broadband communication experiments	<i>IEEE Transactions on Communications</i>
5	1979	Johansen, R.; Vallée, J. & Spangler, K.	Electronic meetings: Technical alternatives and social choices	<i>Book</i>
5	1980	FCC	Regulatory policies concerning resale and shared use of common services and facilities	<i>Policy document</i>
4	1973	Bell, D.	The coming of the post-industrial society	<i>Book</i>
4	1973	Colino, R.R.	The Intelsat definitive arrangements: Ushering in a new era in satellite communications	<i>Book</i>
4	1973	Noll, R.G.; Peck, M.J. & McGowan, J.J.	Economic aspects of television regulation	<i>Book</i>
4	1975	US Congress	Interim report and recommended courses of action resulting from the hearings on telecommunications research and policy development	<i>Policy document</i>
4	1977	UK Government	Report of the Post Office Review Committee (Carter Report): Analysis and development of policy	<i>Policy document</i>
4	1983	Brock, W.A. & Evans, D.S.	Predation: a critique of the government's case in U.S. vs. AT&T	<i>Book chapter – In D.S. Evans (ed.), Breaking up Bell: Essays on industrial organization and regulation</i>
4	1983	Näslund, R.	ITU Conference in Nairobi: Confrontation or mutual understanding?	<i>Telecommunications Policy</i>
4	1984	Lovell, R. & Fordyce, S.W.	A figure of merit for competing communications satellite designs	<i>Space Communication and Broadcasting</i>
1986–1995				
10	1982	Codding, G.A. & Rutkowski, A.M.	The International Telecommunication Union in a changing world	<i>Book</i>
9	1981	Brock, G.W.	The telecommunications industry: The dynamics of market structure	<i>Book</i>
8	1981	Wihlborg, C.G. & Wijkman, P.M.	Outer space resources in efficient and equitable use new frontiers from old principles	<i>The Journal of Law and Economics</i>
7	1983	MacAvoy, P.W. & Robinson, K.	Winning by losing: the AT&T settlement and its impact on telecommunications	<i>Yale Journal on Regulation</i>
7	1983	Saunders, R.; Warford, J.J. & Wellenius, B.	Telecommunications and economic development	<i>Book</i>
6	1974	Rohlf's, J.	A theory of interdependent demand for a communications service	<i>Bell Journal of Economics and Management Science</i>
6	1980	Hardy, A	The role of the telephone in economic development	<i>Telecommunications Policy</i>
6	1982	Baumol, W.J.; Panzar, J. & Willig, R.	Contestable markets and the theory of industry structure	<i>Book</i>
6	1983	Evans, D.S. & Heckman, J.J.	Multiproduct cost functions estimates and the natural monopoly tests for the Bell system	<i>Book chapter – In D.S. Evans (ed). Breaking up Bell: Essays on industrial organization and regulation</i>
6	1985	Katz, M.L. & Shapiro, C.	Network externalities, competition, and compatibility	<i>American Economic Review</i>
6	1987	Kahn, A.E. & Shew, W.B.	Current issues in telecommunications regulation pricing	<i>Yale Journal on Regulation</i>
6	1987	Noam, E.M.	The public telecommunications network a concept in transition	<i>Journal of Communication</i>
6	1989	Parker, E.B; Hudson, H.E.; Dillman, D.A. & Roscoe, A.D.	Rural America in the Information Age	<i>Book</i>

(continued on next page)

Table 14 (continued)

No. citations	Year	Authors	Title	Source
1996–2005				
9	1994	Armstrong, M., Cowan, S. & Vickers, J.	Regulatory reform: British experience and economic analysis	Book
8	1994	Levy, B. & Spiller, P.T.	The institutional foundations of regulatory commitment: A comparative analysis of telecommunications regulation	<i>Journal of Law, Economics and Organization</i>
7	1996	Levy, B. & Spiller, P.T.	Regulations, institutions, and commitment: Comparative studies of telecommunications	Book
6	1993	Mueller, M.	Universal service in telephone history: A reconstruction	<i>Telecommunications Policy</i>
6	1995	McMillan, J.	Why auction the spectrum?	<i>Telecommunications Policy</i>
6	1996	Noam, E.M.	Beyond liberalisation III: Reforming universal service	<i>Telecommunications Policy</i>
6	1997	European Commission	Green paper on the convergence of the telecommunications, media and information technology sectors, and the implications for regulation	Policy document
6	1997	Mueller, M.	Universal service: Competition, interconnection and monopoly in the making of the American telephone system	Book
6	1998	Mansell, R. & Wehn, U.	Knowledge societies: Information technology for sustainable development	Book
6	2000	Parker, E.B.	Closing the digital divide in rural America	<i>Telecommunications Policy</i>
6	2002	Armstrong, M.	The theory of access pricing and interconnection	Book
2006–2016				
36	2009	Cambini, C. & Jiang, Y.	Broadband investment and regulation: A literature review	<i>Telecommunications Policy</i>
24	2011	Xia, J.	The third-generation-mobile (3 G) policy and deployment in China – Current status, challenges, and prospects	<i>Telecommunications Policy</i>
23	2011	Kshetri, N.; Palvia, P. & Dai, H.	Chinese institutions and standardization: The case of government support to domestic third generation cellular standard	<i>Telecommunications Policy</i>
21	2001	Röller, L. & Waverman, L.	Telecommunications infrastructure and economic development: A simultaneous approach	<i>American Economic Review</i>
21	2003	Cave, M. & Vogelsang, I	How access pricing and entry interact	<i>Telecommunications Policy</i>
20	1985	Katz, M.L. & Shapiro, C	Network externalities, competition, and compatibility	<i>American Economic Review</i>
20	2001	Gruber, H.	Competition and innovation. The diffusion of mobile telecommunications in Central and Eastern Europe	<i>Information Economics and Policy</i>
20	2001	Gruber, H. & Verboven, F.	The diffusion of mobile telecommunications services in the European Union	<i>European Economic Review</i>
20	2006	Cave, M.	Encouraging infrastructure competition via the ladder of investment	<i>Telecommunications Policy</i>
19	1962 ^a	Rogers, E.M.,	Diffusion of innovations	Book
19	2006	Distaso, W.; Lupi, P. & Manenti, F.M.	Platform competition and broadband uptake: Theory and empirical evidence from the European Union	<i>Information Economics and Policy</i>
19	2009	Koutroumpis, P.	The economic impact of broadband on growth: A simultaneous approach	<i>Telecommunications Policy</i>

^a Several editions from 1962 to 2003 (fifth edition).

Source: own calculations from the analysis of the References section of Telecommunications Policy articles. Inaccuracies can occur due to incomplete or poorly-cited references.

that have received more citations by *Telecommunications Policy* articles in every decade. Table 15 establishes a global rank in the documents cited by *Telecommunications Policy*.

5. Conclusions

This paper presents a straightforward approach to text mining in the context of telecommunications policy with the twofold objective of illustrating its possible application in similar settings and contributing to identify the main elements of the telecommunications policy

Table 15Twenty most cited references by *Telecommunications Policy* articles within the 1976–2016 period. Global rank.

No. citations	Year	Authors	Title	Source
36	2009	Cambini, C. & Jiang, Y.	Broadband investment and regulation: A literature review	<i>Telecommunications Policy</i>
31	1985	Katz, M.L. & Shapiro, C.	Network externalities, competition, and compatibility	<i>American Economic Review</i>
24	2001	Gruber, H. & Verboven, F.	The diffusion of mobile telecommunications services in the European Union	<i>European Economic Review,</i>
24	2001	Gruber, H.	Competition and innovation. The diffusion of mobile telecommunications in Central and Eastern Europe	<i>Information Economics and Policy</i>
24	2011	Xia, J.	The third-generation-mobile (3G) policy and deployment in China: Current status, challenges, and prospects	<i>Telecommunications Policy</i>
23	2002	Armstrong, M.	The theory of access pricing and interconnection	<i>Book</i>
23	2011	Kshetri, N.; Palvia, P. & Dai, H.	Chinese institutions and standardization: The case of government support to domestic third generation cellular standard	<i>Telecommunications Policy</i>
22	1980	Hardy, A.	The role of the telephone in economic development	<i>Telecommunications Policy</i>
21	1999	Ahn, H. & Lee, M.	An econometric analysis of the demand for access to mobile telephone networks	<i>Information Economics and Policy</i>
21	2001	Röller, L. & Waverman, L.	Telecommunications infrastructure and economic development: A simultaneous approach	<i>American Economic Review</i>
21	2003	Cave, M. & Vogelsang, I	How access pricing and entry interact	<i>Telecommunications Policy</i>
20	2006	Cave, M.	Encouraging infrastructure competition via the ladder of investment	<i>Telecommunications Policy</i>
19	1962 ^a	Rogers, E.M.,	Diffusion of innovations	<i>Book</i>
19	2006	Distaso, W.; Lupi, P. & Manenti, F.M.	Platform competition and broadband uptake: Theory and empirical evidence from the European Union	<i>Information Economics and Policy</i>
19	2009	Koutroumpis, P.	The economic impact of broadband on growth: A simultaneous approach	<i>Telecommunications Policy</i>
18	1991	Cronin, F.J.; Parker, E.B.; Colleran, E.K. & Gold, M.A.	Telecommunications infrastructure and economic growth: An analysis of causality	<i>Telecommunications Policy</i>
18	1994	Katz, M. & Shapiro, C.	Systems competition and network effects	<i>Journal of Economic Perspectives</i>
18	1998	Laffont, J.J.; Rey, P. & Tirole, J.	Network competition II. Price discrimination	<i>RAND Journal of Economics</i>
18	2012	Xia, J.	Competition and regulation in China's 3G/4G mobile communications industry - Institutions, governance, and telecom SOEs	<i>Telecommunications Policy</i>
17	2003	Rodini, M.; Ward, M.R. & Woroch, G.A.	Going mobile Substitutability between fixed and mobile access	<i>Telecommunications Policy</i>
17	2004	Kim, M.K.; Park, M.C. & Jeong, D.H.	The effects of customer satisfaction and switching barrier on customer loyalty in Korean mobile telecommunication services	<i>Telecommunications Policy</i>
17	2005	Hausman, J. & Sidak, G.	Did mandatory unbundling achieve its purpose? Empirical evidence from five countries	<i>Journal of Competition Law and Economics</i>

^a Several editions from 1962 to 2003 (fifth edition).

Source: own calculations from the analysis of the References section of *Telecommunications Policy* articles. Inaccuracies can occur due to incomplete or poorly-cited references.

agenda from 1976 to 2016 and their evolution in this period as summarized below.

In addition, the results tell about the *Telecommunications Policy* journal. In fact, from this simple analysis, it is ascertained that *Telecommunications Policy* is a well-configured journal with regard to its foundational aims, able to combine economy –markets–, law –regulation–, social theories –policy– and technology in a unique multidisciplinary approach. No keyword from any of these areas seems to preside over the others and most of them are subordinated to telecommunications. Looking specifically into dimensions it seems there is a broad picture with a basic separation of market and social approaches to distinguish between papers and then technology is merged to complete each *Telecommunications Policy* paper investigation into a particular issue.

Regarding the telecommunications policy agenda, and according to the findings in the paper, it has been dominated by a shortlist of about ten to fifteen themes that shape overlapping but meaningful subdomains within the extensive area of telecommunications. The first column in **Table 5** enumerates the thirteen themes selected in this paper for analysis while the second and third columns compile keywords and dimensions respectively. The fourth column highlights the most relevant periods for the particular theme, indicating also

Table 16
Milestones in telecommunications policy 1974–2015.

Year	Event	Geography
1974	AT&T antitrust lawsuit	USA
1980	FCC Second Computer Inquiry final decision	USA
1982	Commission decision condemning BT's abuse of dominant position in the telex market	EU
1984	Breakup of AT&T (Baby Bells)	USA
1984	UK: Privatization of BT / Creation of a duopoly	EU
1985	Japan: Privatization of NTT and creation of new common carriers	Asia / Pacific
1987	Green Paper on the development of the common market for telecommunications services and equipment	EU
1989	Japan's KDD lost monopoly on international communication activities	Asia / Pacific
1989	Television without frontiers Directive	EU
1991	Gore report: National Information Infrastructure	USA
1992	Cable Act	USA
1992	1992 Review of the situation in the telecommunications services sector	EU
1993	Delors' White paper (White paper on growth, competitiveness and employment)	EU
1994	Bangemann report on EU and the Information Society	EU
1994	Start of spectrum auctions	USA
1994	China: First private operator (Unicom)	Asia / Pacific
1995	Remaining FCC prices control over AT&T basic residential services are eliminated	USA
1996	Telecommunications Act	USA
1996	Japan: Major package of deregulation announced and final agreement of restructuring NTT	Asia / Pacific
1997	Green book on convergence between telecoms, information technologies and audiovisual	EU
1998	Complete liberalisation on January 1st ("1998 package")	EU
1998	WTO agreement on basic telecommunications services	Global
1999	FCC adopted rules for gradual deregulation of incumbents' provision of local service for interstate communications	USA
1999	Price regulation of Cable Act expired	USA
1999	Launch of i-mode	Asia / Pacific
1999	1999 Communications Review	EU
1999	Launch of 'eEurope An Information Society for all'	EU
2000	1st generation Information Society plans: eEurope 2002	EU
2000	Biggest 3G spectrum auctions (UK and others)	EU
2000	Dot-com bubble collapse	Global
2001	3G Launch	Asia / Pacific
2001	Japan: e-Japan strategy	Asia / Pacific
2001	China: China enters WTO	Asia / Pacific
2002	2002 Telecoms package review	EU
2002	China: China Telecom is split geographically	Asia / Pacific
2002	Launch of eEurope 2005	EU
2004	Korea: BcN (Broadband convergence network)	Asia / Pacific
2005	Second phase of the World Summit on Information Society (Tunisia)	Global
2005	Launch of i2010	EU
2008	4G standardization	Global
2008	China Antimonopoly law	Asia / Pacific
2009	2009 Telecoms package review	EU
2009	Australia: National Broadband Network	Asia / Pacific
2009	Japan: i-Japan strategy 2015	Asia / Pacific
2010	Digital Agenda for Europe	EU
2010	Connecting America: National Broadband Plan	USA
2012	Regulation on roaming	EU
2012	Korea: Giga Korea project	Asia / Pacific
2015	Open Internet Order (net neutrality)	USA
2015	Digital Single Market strategy	EU

Source: own elaboration.

when there was a maximum. The fifth column shows the dominant methodology for the theme, while the sixth displays the most influential geographical area. The seventh column classifies the themes has high, medium and low number of citations. The eight and last column uses the Table 16 in the Annex with a compilation of milestones in telecommunications policy to establish whether the theme was anticipating the policy decision –proactive– or rather discussing its effects and implications –reactive.⁷

As explained in Section 2, this compilation of themes helps to explore the reverse link between policy activity and academic research, and it is instrumental in the analysis of the historical evolution of telecommunications policy.

Conventionally, see Gómez-Barroso and Feijóo (2010) for a detailed account from a public-private perspective, there have been three main stages for telecommunications policy:

⁷ Readers are invited to modify and complete this table of milestones on telecommunications policy.

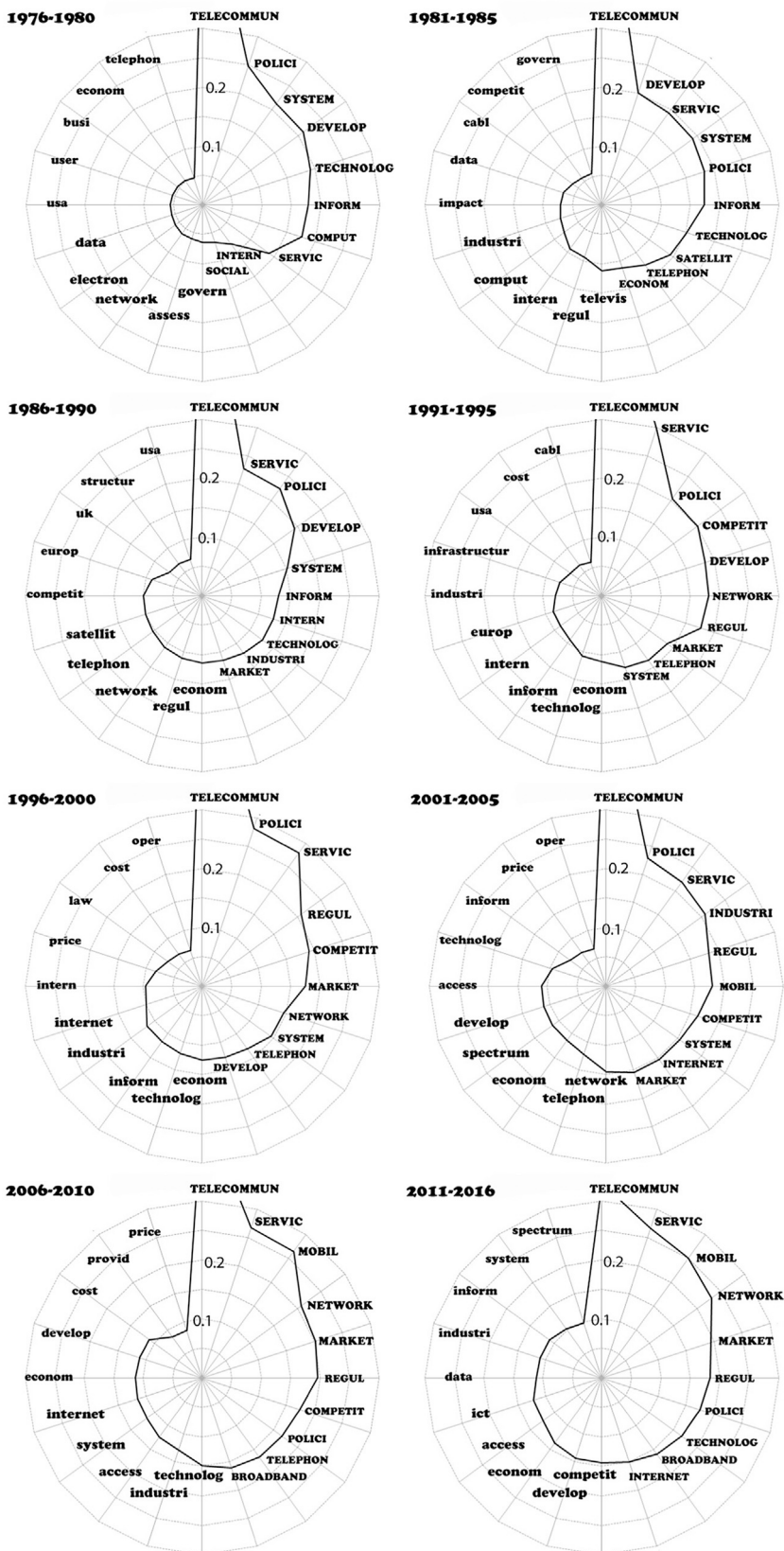


Exhibit 12. Most frequent words by period of five years.

- i) The “monopolistic stage”, from the beginning of network deployment up to the various crises of the seventies, where telecommunications were basically a “public matter”.
- ii) The “liberalisation stage”, from the early 1980s up to the turn of the century, where telecommunications became a matter for private operators, led by a long-running and “guided” re-regulation process.
- iii) The “information society stage”, from the early 2000s until now, characterized by mostly open markets, speeding-up of the technological advances, transnational companies and institutions, economic and geopolitical instability and, especially, a change of economic paradigm: from an industrial age to an information age.

The analysis in this paper, in authors’ view, allows proposing a more nuanced evolution of the stages for telecommunications policy, adding characteristic and notes that complete the above agenda. Precisely, the paper suggests the following (sub)stages⁸:

- i.b)⁹ “Late monopolistic stage”, up to about 1980, where the academic community is concerned with two types of issues that the conventional approach can not address properly: the social changes that the use of new informational and communication services and computers could bring, and the limitations of existing policy and regulation for development and underserved areas.
- ii.a) “Early liberalisation stage”, up to about 1985, where it was considered that international conferences, such as ITU, were appropriate fora to discuss the telecommunications policy agenda and where technologies such as satellite served as instances of early liberalisation and the fall of pre-existing barriers in the telecommunications field. At the same time television in connection with new services, but also with conferences, satellite and new services was an initial example of convergence and the mutual influence between media and telecommunications.
- ii.b) “Mid liberalisation stage”, up to about 1995, where both the topics from previous stages were considered still relevant, but also emerged new topics around the effects of liberalisation on traditional services such as telephony; the difference across world regions started to gain weight in the agenda.
- ii.c) “Late liberalisation stage”, up to about 2000, where regional differences in the approach to liberalisation and the effects of liberalisation on conventional services such as telephony take central stage accompanied by a renewed interest in –now digital– television and the implications of Internet deployment and usage.
- iii.a) “Early information society stage”, up to about 2005, where expectations were laid in spectrum auctions, the promises of new generations of mobile communications, conventional broadband and the effects of standardization in the industry, all with a major supply-side perspective.
- iii.b) “Mid information society stage”, up to about 2010, where the very dominant themes are the triangle regulation – investment – competition, mobile and broadband.
- iii.c) “Late information society stage”, up to present, where the focus is on regional / rural development and standardization, in combination with –supported from– mobile, broadband, spectrum, regulation – investment – competition and Internet themes, and where the themes on demand, usage and consumers are increasingly central.

All in all, the analysis presented in this paper is an evident simplification of the complex reality portrayed in 40 years of papers of *Telecommunications Policy*. However unpretentious, it sheds some light on both the main themes in the last 40 years of telecommunications policy and how they have evolved from 1976 to the present. And, maybe more relevant, the analysis draws a vibrant field for research, multidisciplinary and encompassing by nature, able to adapt –and even anticipate– the changing policy priorities and hopefully influence them for more informed and better decisions, still the valid foundational aim of the area.

Annex¹⁰

See Tables 6–16 and Exhibit 12.

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⁸ The paper just highlights the additional notes. It takes for granted the basic features of the three main stages and does not discuss them.

⁹ There would be previous stages within the monopolistic phase, but they happen before the launch of *Telecommunications Policy* in 1976.

¹⁰ In order to avoid confusion, tables and exhibits numbers are a continuation of those from the main text tables/exhibits.

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