Working paper

Dynamics of global co-patenting networks in ICT: Is China on the way to pass the US?

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Abstract. The purpose of this study is to identify and characterize the structure and dynamics of global R&D networks in ICT by analyzing cross-country co-inventions, with a special focus on the role of China and the US. We employ a Social Network Analysis Perspective (SNA), using information on more than 77 thousand co-patents from 2001-2015. These co-patents are disaggregated by three time periods and four ICT subsectors. Global measures for the network as a whole as well as local measures on the positioning of countries in the networks are interpreted. The empirical results are highly interesting. First, international R&D networks in ICT become larger in magnitude (more countries but also more inter-linkages), less centralized and more densely connected, though with varying degree across ICT subsectors. Second, the powerful position of the US weakens relatively compared to other, increasingly connected countries. While China has already surpassed the US in total patenting in ICT in 2015, China is also catching up from a network perspective shown by its growing central position over the observed time period. However, despite China's first rank in ICT patenting in general, the catching up to the US in terms of networking is still ongoing, though clearly on track.

Keywords

R&D networks, R&D collaboration, R&D internationalization, Co-patents, ICT, Globalization

1 Introduction

In an increasingly globalized world, Research and Development (R&D) networks – defined as sets of organizations interacting with each other in R&D activities – hold enormous potentials and opportunities and have become an essential element for the successful generation of innovation [1, among others]. This is mainly related to the increasing complexity of innovation processes, characterized by a higher variety in the combination of different pieces of knowledge coming from different technological domains, as well as to rapidly changing patterns of global demand [2]. Therefore, innovating actors are forced to increasingly tap into external knowledge sources and integrate them in their own knowledge production processes, usually transferred via R&D collaboration networks [3]. Forms of joint R&D activities are for example joint research projects, joint patents or publications, exchange of R&D-staff and the joint development and usage of R&D-infrastructure. The literature on R&D internationalization [4] tells us that sharing new knowledge as basis for innovation leads to increased cross-border R&D collaboration (see, e.g., [5] and [6] for the European case). However, the development of collaboration links does also relate to the individual economic and political framework conditions of a country.

Especially, for the Information and Communication Technology (ICT) sector – a knowledge-intensive sector shaped by fast innovation and production cycles [7] – extensive networking in R&D is essential and of increasing importance, because external knowledge can be collected and integrated faster and more effectively in the innovation process[1]. Given the generic importance of the ICT sector contributing to change at various levels, not only across economic sectors but also in social and political terms, the global innovation competition has gained tremendous pace over the past decade [8]. In particular, the rise of the Asian countries has been stressed in the literature reflected both by growing R&D expenditures and but also patenting activities [9].

Here, the increasing competitive position of China, challenging the exclusive and traditional leading position of the US, has been highlighted as one of the most important issues defining the future global economic development since innovations in ICT are an important driver for economic growth for various reasons. First, ICT breakthroughs are often radical innovations

[1] The ICT sector is rooted in the radio, telephone and engineering industry in the beginning of the 20th century. Military demand was high during the world war and there was a strong promotion through investments from the public sector. However, there was a big alteration of the sector during the post war time; followed by an evolution of the computer and software industry with a switch from analog to digital and deregulations in the industry. The upcoming internet and internet companies led to the "New Economy Boom" of the 1990s. The dot-com bubble burst in 2001 and since then, consolidation and moderate growth have been defining the ICT industry [29].

paving the way for completely new business models (with the internet being the most prominent one in the closing 20th century, and trends in artificial intelligence the most recent one). Second, ICT as a general-purpose technology is generically important for many other technological fields, and more or less all economic sectors [10]. Therefore, a highly developed ICT sector as well as advanced capabilities to innovate in ICT brings countries strategic competitive advantages, and – in the mid- to long term – a leading position in the global economy [11].

Previous literature provides substantial empirical evidence on the enormous increase of the Chinese innovation potential in ICT per se, as reflected by the increasing global shares in patenting and publication activities related to ICT [9], peaking with China taking the first rank from the US in ICT patent counts in 2015 [12]. However, there are only scarce insights into how the global R&D collaboration networks has developed in ICT, and whether we can also observe the shift of China to a leading role, and in that context also underline the important role of R&D collaboration for emerging countries with different, more closed political systems. One exception is the study of [13] investigating the global ICT R&D network by mapping global R&D locations belonging to multi-national companies. Still, there is no empirical literature yet directly investigating R&D collaboration, also outside multinational companies, in terms of joint knowledge creation, and moreover there is no work telling us something about structure dynamics of these networks across ICT subsectors (with telecommunication probably being considered as the most important one).

This is the gap this study is intended to contribute to, in particular, from the angle of China's catch-up challenging the position of the US in the global ICT industry. The objective is to identify and characterize structure and dynamics of global R&D networks in ICT as a whole, and in four ICT subsectors, with specifically shifting attention to the changing roles of China and US in the network. We are inspired by previous research from [14] for the global pharmaceutical R&D network in terms of our empirical setting and methodological choices. We mobilize a large-scale dataset containing information on cross-country co-patents, i.e. patents that feature inventors from at least two different countries. We use patent applications in ICT from 2001 to 2015 and employ a Social Network Analysis (SNA) perspective to gain an overall perspective of cross-country R&D co-operation, to trace the changing role of China and the US in the network.

The remainder of the paper is organized as follows. Section 2 discusses in some detail the data and methods used for this study. Section 3 presents the empirical results before Section 4 closes with a discussion against the background of the global innovation competition.

2 Data and methods

This study uses co-patents to statistically analyze international R&D collaboration in the ICT sector. Here, we follow several previous empirical works that have used co-patents to investigate structure and dynamics of R&D collaboration networks at different geographical scales, for different technological fields, and or economic sectors (see [15] for an overview). Co-patents are defined as patent applications that feature at least two different *inventors*, and, in this sense, clearly indicate collaborative knowledge production activities between them. When these inventors are located in different countries, co-patents accordingly indicate cross-country R&D collaboration activities. While patents as indicator for innovation per se feature a number of limitations (see [16], among many others), they reflect very well the extent of new knowledge created[2].

While cross-country comparisons can often be inflated by the fact that the patent propensity differs markedly across economic sectors [17], this limitation is minimized in this study since it focuses on ICT per se. Moreover, we consider patent applications applied for under the Patent Cooperation Treaty (PCT), refining to inventions of global relevance applied for via common procedures across countries and by this avoiding bias related to different rules at different national patent offices. In this study, the data used covers co-patents of the ICT sector and sub-classes from the time period 2001 to 2015 and is extracted from the PATSTAT database. The classification of ICT patents is based on the assignment produced by the OECD [18] referring to the 8th edition of the IPC classification. Here, ICT patents are subdivided into the technological fields of *Computers and Office Machinery*, *Consumer Electronics*, *Telecommunications* and *Measurements and Semiconductors*. Next to the technological categorization into these four fields, the study divides the time frame into the periods of 2001 to 2005, 2006 to 2010 and 2011 to 2015 according to the date of the patent application filing, enabling to look at the evolution of the network, in particular the changing positions of countries.

This study lies in the vein of the literature stream that considers a social network perspective as highly useful to study international R&D collaboration (see [15], [20]). Social Network

[2] Since patents directly represent the gain of new knowledge, they are considered suitable indicators for analyzing global innovation structures and dynamics, because they directly result from invention processes [16]. Further advantages are the patent's data availability, easy access and the procedure of acquisition which is regulated by law. What is more, the standardized classification by IPC makes patents suitable as indicator for comparisons of statistical data on a global level. On the other hand, there are limitations to be considered. First, certain technological areas are excluded [19]. Also, it is more economically profitable for companies than for universities to apply for patents, because costs and expenditure of time are high.

Analysis (SNA) has come into fairly wide use for the analysis of social systems, offering a wide range of analytical tools disclosing the structure and dynamics of large social systems [21]. While SNA measures have initially been derived to be interpreted at the individual level of socially interacting persons, it has also come increasingly into use to analyze internationalization trends in R&D networks of countries [22]. This is usually done by aggregating individuals level information (in our case inventors) on collaborations to the country level and shifting attention – away from the traditional variable-centric approach – to a structural-relational angle.

To investigate dynamics of the global ICT network, we first need to formally define our network under consideration, and second, derive some respective – global and local – network analytical measures that characterize structural changes at global scale (the network as a whole), and at local scale (the changing role of specific nodes, in our case countries). Graph theory sets out the basic instrument to formally describe our global R&D collaboration network in ICT. In our case, we define a graph $G = (N, L, V)$ with $N = \{N_1,N_2,\ldots, Ng\}$ being a set of nodes (here countries) which is related through a set of edges $L = \{L_1,L_2,\ldots,L_M\}$ and a set of weights $V = \{V_1,V_2,\ldots,V_M\}$ for each edge, here the number of joint co-patents between two countries. The topology of a graph can be decoded in an n-by-n adjacency or sociomatrix, where n denotes the number of nodes, in our case countries:

$$X_t(i,j)=\begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nn} \end{pmatrix} \; i,j=1, \ldots, n \tag{1}$$

Accordingly, one element of X corresponds to the number of joint co-patents between countries i and j at time t. The total number of neighbors i.e. partner countries of a node is labelled as degree k_i of a node. With the adjacency matrix at hand, we can define a number of global and local network analytical measures for the purpose of this study. In global terms, we want to shed some light on whether the global structure of the ICT network changes, e.g. the connectedness and density of the network or the degree centralization. Here, we define the *mean degree* as an indicator for the connectedness of a network simply as the sum of individual degrees divided by the number of nodes. The *density* is defined as the relation between the actual number of edges and the possible number of edges, while the *degree centralization* characterizes the concentration of links across the nodes, taking a value of 1 if it is fully concentrated on one node (star-like network) and zero if all nodes have the same degree (fully connected graph). In addition, we look at *average path length* and *clustering* in the network. A *path* is the alternating sequence of nodes and links, so that the shortest path (or geodesic distance) is defined as the number of modes to be passed in the shortest possible path from one node to another (i.e. a shorter average path length is conducive for information flow in the network). Clustering is defined using the transitivity concept that is the connection of two nodes via a third node (often referred to as a 'clique'). The more cliquish a network and the smaller the average path length, the more a network shows so-called small world characteristics [23]. The formal definitions of these measures are provided in Wasserman and Faust [24].

However, next to the global view we are interested in the local positioning of individual nodes (countries) in the network. In SNA, this can be captured by using different kinds of network centrality measures, providing information on the prominence of nodes with respect to different qualitative dimensions. Here, we rely on the degree-based centrality, betweenness centrality and eigenvector centrality (see again [24] and [14] for a formal definition). The degree-based centrality is just defined by the degree of a node, i.e. the number of co-patents. It is a measure of connectedness of a single country. Further, the betweenness centrality of is the ratio of the number of all geodetic distances of a graph to the geodetic distances going through that node. That is, the betweenness centrality describes the importance of a country as connector (often referred to as 'gatekeeper' or 'broker') between other countries. The eigenvector centrality is defined as the degree of a node weighted by the degree the node is connected to. Therefore, it is also referred to as prestige centrality since it indicates whether a country is connected to prominent other countries (having a high degree) or to rather less connected countries.

3 Empirical analysis

In our empirical analysis, we have calculated the global and local SNA measures (as described above) for 15 networks; that is, for the whole ICT network and for the four subsectors - each for the three time periods. The total number of co-patens analyzed (2001-2015) equals to around 77,000. Table 1 initially presents the results of the global SNA measures for the three time periods and the four subsectors. Overall, the results confirm the increasing importance of R&D collaborations in the ICT sector as a whole and across the subsectors, but also the increasing connectedness, density and clustering. In total ICT, the number of collaborations almost doubled its value from about 18,000 co-patens in 2001 to 2005 up to 33,700 co-patents in 2011 to 2015. This growth is especially visible in the sub-industries of *Telecommunications* and

Computer, and points to the increased necessity but also openness for actors to engage in ICT R&D collaborations. The density is also increasing by nearly 15% from 0.10 in 2001 to 2005 to 0.13 in 2011 to 2015. Also, the clustering coefficient, that indicates the connectedness of the neighbors of a country, increased considerably from 0.43 (2001-2005) to 0.50 (2011-2015), pointing to a more cliquish structure and closure in the network. The higher connectedness is also underlined by the average path length between two countries that is slightly decreasing, indicating a small-world phenomenon", i.e. the members of a social network being connected via short paths.

Table 1: Global SNA indicators in ICT and ICT- sub-industries (2001-2015)

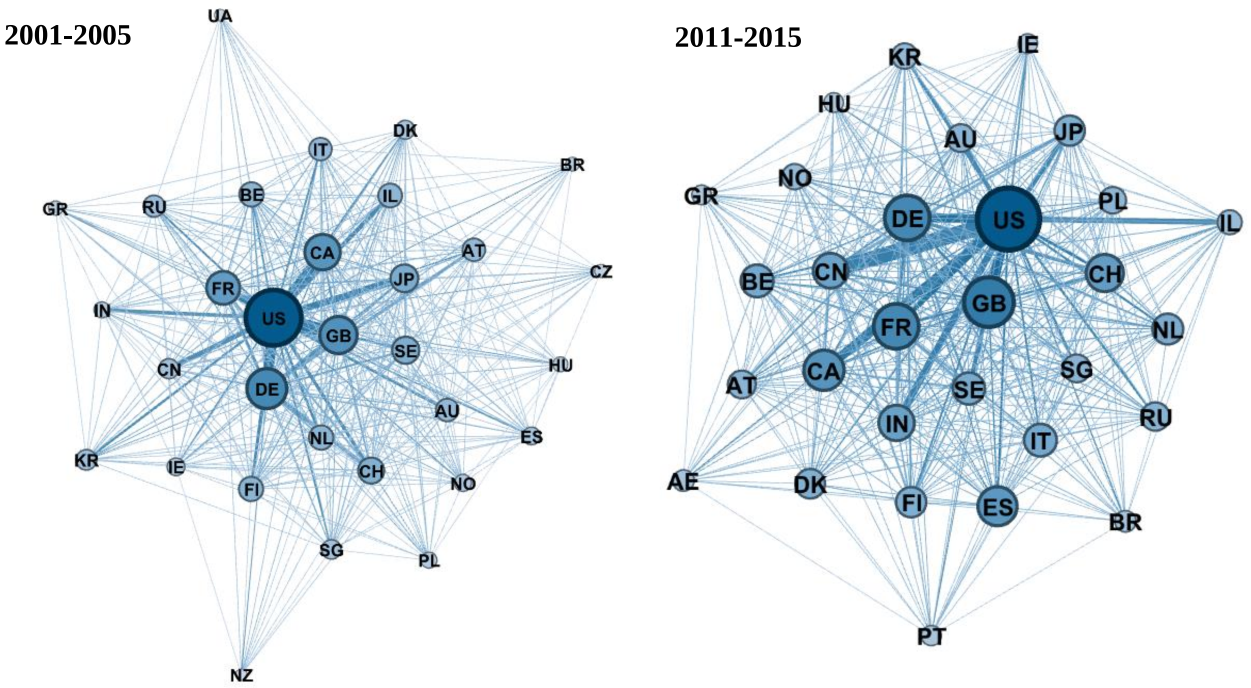
	Total ICT			***Consumer Electronics***			**Tele-communications**			**Computer, Office Machinery**			**Measurements / Semiconductors**		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
# of nodes *n*	123	131	132	55	60	66	93	91	94	95	97	103	109	110	113
# of edges *l*	776	923	1113	203	268	315	431	503	580	452	589	717	592	674	799
# of links (*w*; in thousands)	18.68	25.36	33.66	1.37	1.86	2.31	5.98	9.04	13.01	5.98	7.34	10.43	8.61	9.92	11.62
Density	0.10	0.11	0.13	0.14	0.15	0.15	0.10	0.12	0.13	0.10	0.13	0.14	0.10	0.11	0.13
Clustering coefficient	0.43	0.47	0.50	0.38	0.44	0.45	0.43	0.46	0.47	0.39	0.43	0.48	0.42	0.45	0.47
Average path length	2.10	2.08	2.06	2.07	2.07	2.01	2.17	2.12	2.07	2.13	1.97	2.02	2.11	2.09	2.09
Mean degree	12.62	14.23	16.86	7.38	8.93	9.55	9.27	11.05	12.34	9.51	12.14	13.92	10.86	12.25	14.14
Nodes (%) w. degree higher than mean	4.51	4.22	4.31	9.85	8.58	7.94	6.50	6.16	5.17	6.19	4.75	5.02	5.41	4.75	4.76
Degree centralization	0.68	0.68	0.63	0.66	0.63	0.70	0.62	0.61	0.66	0.66	0.76	0.71	0.68	0.62	0.59

Notes: (1) 2001-2005, (2) 2006-2010, (3) 2011-2015; # denotes "number"

Before we turn to the results of the local SNA analysis, we take a combined look on global and local characteristics by means of network visualization. Here, we follow a force directed approach for network visualization taking the so-called *Yifan Hu* layout-algorithm [25]. This is, countries with a high centrality are located in the center of the networks, and countries with a high intensity in interaction and a similar structure of partnerships are located nearer to each other in the visualization. The size of the nodes is proportional to their degree and the edges are proportional to their weights, i.e. collaboration intensity. In this sense, the visualizations are effective means to illustrate global dynamics but also changing roles of individual countries.

Figure 1 initially presents the total ICT network visualization of the earliest and the latest observed time periods. It can be seen that the networks have a highly connected center with relatively less connected countries in the environment which underlines the relatively high centralization measures (see Table 1), i.e. a few countries, with the US as the main hub, cover most of the links. Overall, there are only moderate changes over time recognizable for total ICT. However, the network becomes less “star-like” with an expanding center, i.e. the centralization is decreasing. The countries of the network are more connected in the latest time period observed, and also, less centralized countries of the outer environment become more connected to each other in the center of the network.

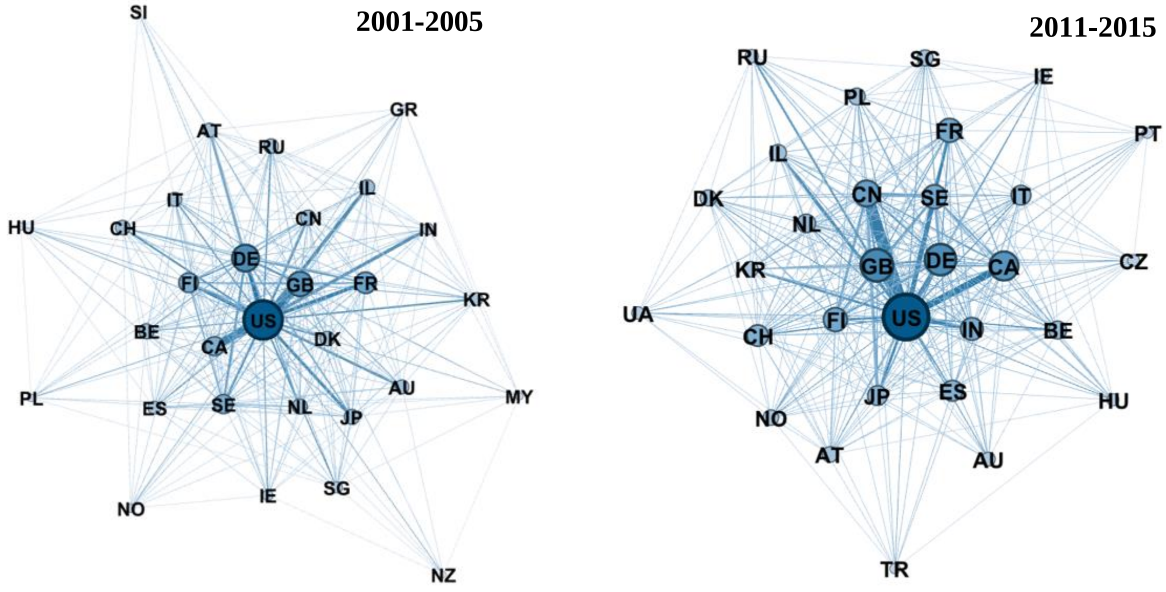
Figure 1: Global R&D collaboration network in ICT



Notes: CN … China; other country codes given in the Appendix

Turning to the subsectors of ICT, we find not only a much higher network density and connectivity over time, but also more structural shifts. We illustrate the *Telecommunications* network in Figure 2 as the one with the most significant changes. Most notably, China is developing to a very central network position and comes much closer to the US as central network player. Also, the UK, Germany, Sweden and Finland have a high centrality in Telecommunications. France is less central and also Canada shows a decreasing centrality.

Figure 2: Global network in Telecommunications



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However, while the network visualizations are very insightful in illustrating the overall increasing importance and density of R&D collaboration, the interpretation of individual countries must be done with caution and hence, needs to be specifically underlined by our local centrality measures. The respective local SNA indicators are presented in Table 2, showing. the ranking of the Top-10 countries by their degree, eigenvector and betweenness centrality as described in the methods section. In general, they underline the impressions from the visualizations. It can be seen that the US is still holding the network position with the highest centrality in all sub-industries over the whole time period observed (2001-2015), but the centrality is decreasing in relative terms, i.e. other countries clearly gain in centrality. This development can be observed especially in the fields of *Telecommunications* and *Measurements and Semiconductors*. In *Consumer Electronics*, however, the US is still holding a strong central network position.

China, on the other hand, is just arising with a very central network position in the global R&D-network in ICT. Reviewing the Top-10 ranking of the total ICT network in 2011 to 2015, China is moving closer to recent big players like the US, Great Britain, Germany and Sweden. It is holding position nine in both, degree and eigenvector centrality, and position ten in betweenness centrality (see Table 2). This is remarkable, given that China has been on rank 18th in the first period, climbing up 9 ranks over the observed period. The rise in betweenness centrality is even more interesting, i.e. China does not only participate and more collaboration in general, but also increasingly acts as knowledge 'gatekeeper' in the networks.

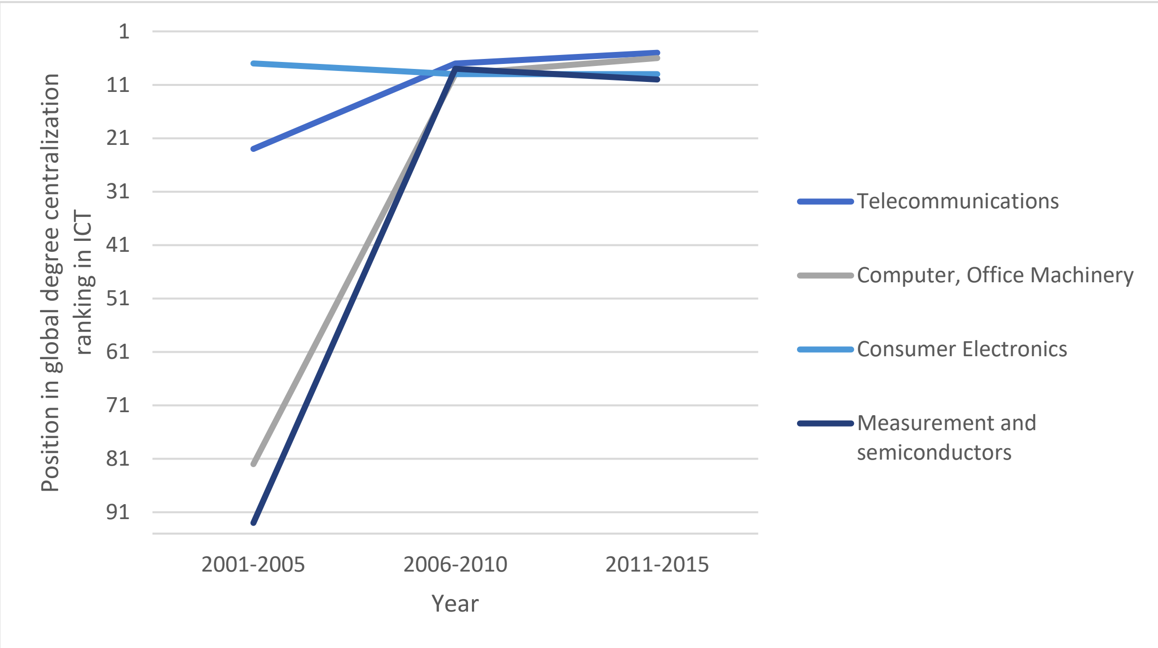
Table 2: Top ten centralities of countries in the global ICT network (2001-2015)

Country	Degree	Country	Eigenvector	Country	Betweenness
2001-2005					
US	**95**	**US**	**1.00**	**US**	**2667.43**
DE	67	DE	0.92	DE	742.50
GB	62	GB	0.89	GB	663.27
CA	59	CA	0.85	CA	655.42
FR	55	FR	0.82	FR	534.53
JP	45	CH	0.77	KR	339.64
SE	44	SE	0.77	SE	248.89
CH	42	JP	0.76	JP	240.45
NL	39	NL	0.75	RU	227.26
FI	39	BE	0.73	BE	204.85
CN (18.)	**31**	**CN (16.)**	**0.64**	**CN (13.)**	**152.14**
2006-2010					
US	**103**	**US**	**1.00**	**US**	**3214.10**
GB	70	DE	0.93	FR	1095.15
DE	70	GB	0.92	DE	713.40
FR	67	FR	0.87	CA	690.72
CA	62	CA	0.83	GB	6.30
SE	48	SE	0.81	DK	278.79
IT	47	CH	0.79	ES	233.80
CH	47	IT	0.79	FI	202.15
ES	46	AT	0.77	BE	195.52
CN	**46**	**CN**	**0.77**	IT	171.20
				CN (12.)	**149.42**
2011-2015					
US	**100**	**US**	**1.00**	**US**	**2399.79**
GB	79	GB	0.96	FR	918.56
FR	71	DE	0.94	GB	862.90
DE	71	FR	0.91	CA	563.87
CA	63	CH	0.87	JP	433.88
ES	61	ES	0.87	DE	404.68
CH	58	CA	0.86	ES	394.04
IN	55	IN	0.84	IN	377.60
CN	**54**	**CN**	**0.81**	RU	315.66
IT	50	BE	0.78	**CN**	**311.47**

Notes: Notes: CN … China; other country codes given in the Appendix

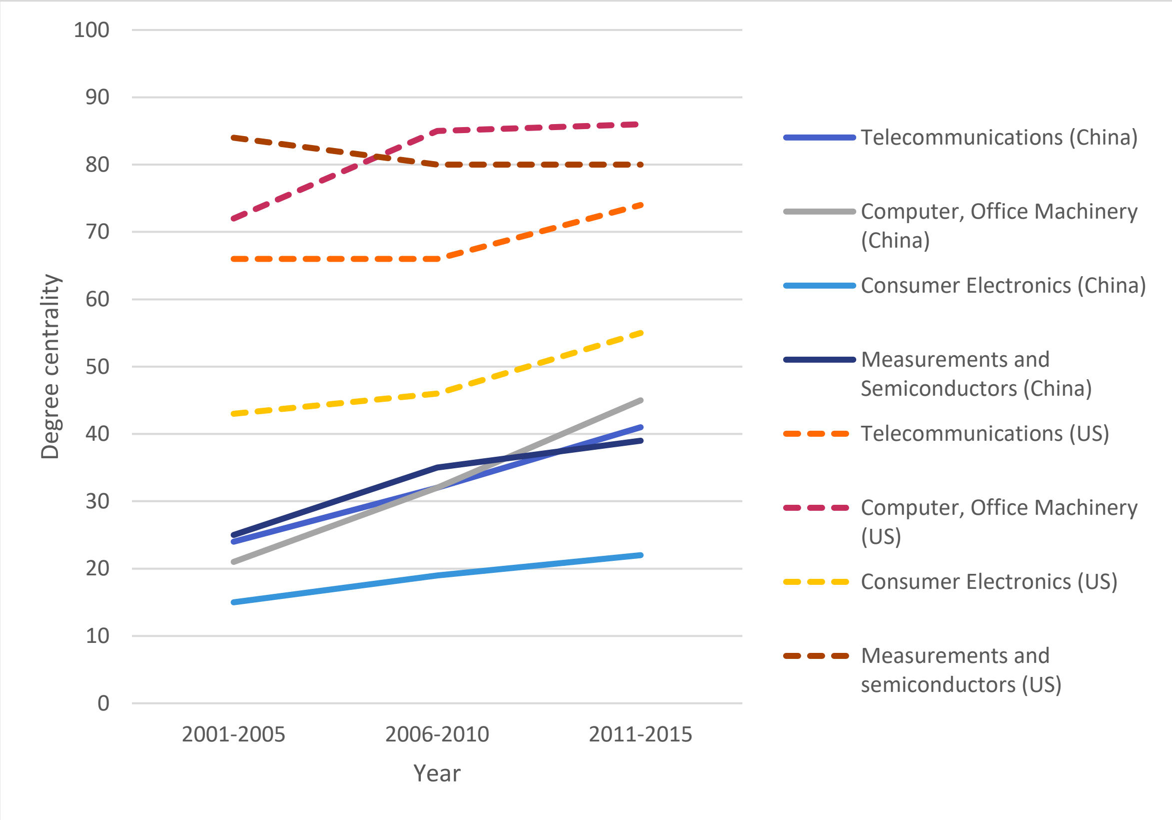
Looking at the sub-sectors, a strong development can be especially observed in *Telecommunications* and *Computer*, *Office Machinery*. Figure 3 illustrates the rise of China in the global ranking of degree centrality from 2001 to 2015 in the sub-industries of ICT. China is already holding a higher position of centrality in Telecommunication in 2001 to 2005 and increasing to position five in all three centralities in period 2011 to 2015. Aside of high rankings in centrality. there is still a bigger difference between the US and China in absolute terms of centralization, though the growth of the centrality measures for China is remarkable (Figure 4). However, *Computer, Office Machinery* is also growing in eigenvector and betweenness centrality and holding position six in all three values of centrality in period 2011 to 2015. China is already starting with a high position seven in degree centralization of *Consumer Electronics* in time period 2001 to 2005, but then moving down to position nine in 2011 to 2015. In *Measurements and Semiconductors* there is a strong development of China's position from period 2001 to 2005 compared to period 2006 to 2010 which is followed by a more moderate growth in period 2011 to 2015 with a ranking position of ten. However, there is a strong difference between position ten in degree centralization and position 103 in eigenvector centrality and position 97 in betweenness centrality in period 2011 to 2015.

Figure 3: China's global ranking of degree centrality in ICT (2001-2015)



To further put these revealing insights into perspective, it is interesting to compare the ICT collaboration intensity of China and the US with their overall patenting intensity. In contrast to the US' number one position in co-patents. China overtook the US in the total number of ICT patents in 2015. The development of China in ICT patents is enormous compared to the US. The US ICT patents grew about 50 percent from 2001 to 2015, while China's more than 8,600 percent from 2001 to 2015 [12]. That is, China has already developed an advanced global position in R&D in ICT, but just rather recently. This explains why China is still just in position five in the *Telecommunications* network. However, it is expected to advance also in this respect when the enormous innovative potential is further manifested in additional collaborations, in particular connecting other emerging countries of the region to the network (e.g. India. Vietnam. etc.).

Figure 4: Degree centrality of US and China in the global ICT network (2001-2015)



4 Discussion

Networks play a central role for the modern ICT sector as adaption to recent trends like globalization and digitalization. The purpose of this study was to identify and characterize the structure and dynamics of global R&D networks in ICT by analyzing cross-country co-inventions. First, the study emphasizes the importance of networks for innovation and states out the significance of the ICT sector for economic growth. Furthermore, it informs about the trend in international R&D cooperation in ICT of growing, less centralized and stronger connected networks. Next, the methodological approach for analyzing the structure and dynamics of the international R&D network is presented. On the one hand, co-patents are used as indicator for cross-country cooperation in R&D in ICT for the time periods 2001 to 2005, 2006 to 2010 and 2011 to 2015. The Social Network Analysis (SNA) perspective, on the other hand, defines different local and global network indicators. For further analysis, the observed networks were visualized. The empirical part of the study analyses network structure and dynamics on a global level, as well as from a local, single country perspective and with a special focus on the USA and China.

The empirical analysis has produced a number of highly interesting insights into the dynamics of global R&D collaboration networks in ICT. These are, international R&D networks in ICT become larger in magnitude (more countries but also more inter-linkages), less centralized and more densely connected. The USA is continuously holding the most central network position, followed by larger European countries and new emerging ones like India, Israel, and in particular China coming closer to the center of the network. However, there are even more remarkable changes when considering the different sub-industries of the ICT-sector. First, the strongest development towards larger, less central and more connected networks can be observed in the *Computer. Office Machinery* and in the *Telecommunications* sub-sectors. Less changes are noticeable in *Measurements and Semiconductors* and the least changing network structure and dynamics shows the sub-sector *Consumer Electronics*. The development of the central network position of the US and China's growing centrality in the international R&D-network in ICT are of special interest and relevance. That is, the powerful, well connected position of the US weakens relatively compared to other, increasingly connected countries. While China has already surpassed the US in total patenting in ICT in 2015, China is also catching up from a network perspective shown by its growing central position over the observed time period. However, despite China's first rank in ICT patenting in general, the catching up to the US in terms of networking is still ongoing, though clearly on track.

In light of these insights, it is interesting to reflect on the determining factors for the rise of China's ICT sector. Firstly, China has put immense emphasis on fostering R&D and strengthening the Chinese innovation system as a whole; in particular a strong development of the higher education sector, with a strong focus on natural sciences and engineering has been supported [26]. This has not only improved the own innovation capability of China, but also increased its adoptive capacity, i.e. the ability to absorb technological knowledge from the many foreign firms investing in China. Secondly, and as a major complementary effect to the first one, China follows a well-directed government-controlled investment plan of economic development with the ambition to build up the global leadership in ICT. China already provides the leading digital marketplace and is home to a third of all unicorn startups – which are startup companies with a current value of more than $1 billion before going public or the investors exit – worldwide [27]. China has in this context also immensely advanced in e.g. KI-based applications like face recognition, blockchain technologies and quantum-computing.

Furthermore, there are many successful, meanwhile large-scale Chinese companies in ICT like Huawei (the currently largest patent applicant in ICT worldwide), Alibaba or Tencent, acting at a global scale [28].

Against the background of the empirical results produced by this study, some ideas for a future research agenda come to mind. First, monitoring the ongoing dynamics in this important, generic industry is crucial, in particular in light of the observed catching-up processes of Asian countries, mainly China. Second, a more systematic investigation of the drivers for the observed network dynamics has a top priority for future research. This needs a move from descriptive to explanatory network analytic approaches, for instance by using exponential random graph or spatial interaction models to estimate country-specific relational factors influencing the dynamics of the ICT R&D collaboration networks.

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Appendix: Country names and Alpha-2 code elements (ISO, 2020)

Country	Alpha-2 code
Algeria	DZ
Australia	AU
Austria	AT
Belgium	BE
Brazil	BR
Canada	CA
China	CN
Czechia	CZ
Denmark	DK
Finland	FI
France	FR
Germany	DE
Greece	GR
Hungary	HU
India	IN
Ireland	IE
Israel	IL
Italy	IT
Japan	JP
Korea, Republic of	KR
Luxembourg	LU
Malaysia	MY
Netherlands	NL
New Zealand	NZ
Norway	NO
Poland	PL
Portugal	PT
Romania	RO
Russian Federation	RU
Singapore	SG
Slovenia	SI
South Africa	ZA
Spain	ES
Sweden	SE
Switzerland	CH
Thailand	TH
Trinidad and Tobago	TT
Turkey	TR
Ukraine	UA
United Arab Emirates	AE
United Kingdom of Great Britain and Northern Ireland	GB
United States of America	US