

THESIS FOR THE DEGREE OF LICENTIATE OF PHILOSOPHY

Radio Spectrum Regulation in the European Union

A three-level context

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Abstract

In the light of the unprecedented growth of mobile broadband services, radio spectrum regulation is undergoing a substantial review in the European Union (EU). The radio spectrum presents a three-level regulatory context. At international level, the International Telecommunications Union (ITU) regulates the allocation of radio spectrum. At regional level, the European Conference of Postal and Telecommunications Administrations (CEPT) promotes cooperation and coordination between European countries. At national level, National Regulatory Authorities (NRAs) are responsible for assigning the radio spectrum. In addition, the EU has also the power to regulate the radio spectrum. The EU regulatory framework for radio spectrum has only recently been set up. Therefore, an exhaustive understanding of the role of the EU in the three-level regulatory context of radio spectrum is still lacking.

Against this background, the purpose of this thesis is to shed light on the implications of the EU regulatory framework for radio spectrum. In other words, this thesis aims to address the following research question: *how does the EU influence the three-level regulatory context of radio spectrum?* In order to answer this research question, three academic papers are written, each focusing on the role of the EU in one regulatory level. Paper 1 focuses on the international level. Theories of international relations are employed to assess the effectiveness of the EU in influencing international negotiations on radio spectrum regulation. Paper 2 explores the regional level. Theories of EU integration provide the tools to understand the issue of competence distribution between EU and EU member states in the policy field of radio spectrum. Paper 3 deals with the national level. Theories on the regulation-innovation relation guide the assessment of a specific national regulatory regime, which has been particularly promoted by the EU. Although radio spectrum assignment is a national responsibility, the EU may indirectly impact on the national context by providing EU member states with ideas on innovative regulatory tools.

A qualitative research strategy is adopted to conduct the research work described in this thesis. In particular, this research work is characterised by an iterative inductive-deductive process between theory and empirical data, whereby purpose, theoretical framework and data collected progressively and mutually shape one another. This thesis is mainly based on secondary data, retrieved from official documents, reports, news articles, academic papers and books. Backward and forward snowballing techniques are used to systematically find relevant secondary sources of data.

This thesis concludes that the EU regulatory framework influences the three regulatory levels of radio spectrum to different extents. Firstly, the EU influences the international level thanks to the presence of the European Commission (EC) in international fora. The EC has the right to attend international negotiations on radio spectrum regulation and can oversee the actions of EU member states. Secondly, the EU impacts on the regional level by promoting harmonised availability of radio spectrum across the EU. To this objective, the EU adopts policy instruments which are legally binding for all EU member states. Furthermore, the EC cooperates with the CEPT in order to build consensus across the EU. Thirdly, the EU's influence on the national regulatory level is confined to general regulatory principles for radio spectrum assignment. Nevertheless, the EU can still leverage on national regulation, by encouraging EU member states to adopt specific regulatory instruments.

Although interesting implications of the EU regulatory framework for radio spectrum are ascertained in this thesis, the influence of the EU on the three-level regulatory context of radio spectrum has not been captured thoroughly. Future research in the form of a more systematic evaluation of the EU's actorness (Bretherton & Vogler, 2006) is necessary to capture the relevance of the EU's influence on both the international and regional regulatory levels. In addition, a detailed analysis of the issue of competence distribution between EU and EU member states is critical for better evaluating the extent to which the EU influences radio spectrum regulation at national level.

Keywords: radio spectrum regulation; European Union; shared competence; allocation; assignment.

List of appended papers

This thesis consists of a collection of three separate academic papers, preceded by a cover essay entitled “Radio Spectrum Regulation in the European Union. A three-level context.” In the cover essay, the integrated nature of the overall research work is shown. The three academic papers are indicated in the thesis as Paper 1, Paper 2 and Paper 3. The author of this thesis is the sole author of Paper 1 and Paper 3. With regard to Paper 2, both authors of the paper were equally involved in the phases of defining purpose, collecting and analysing data, and drawing conclusions. The author of this thesis was responsible for writing Paper 2, while the second author of Paper 2 has been supervising and editing the manuscript during the writing phase. The three academic papers included in the thesis are listed below:

Paper 1. Massaro, M. (2017), *Declining effectiveness of the European Union in the International Telecommunication Union: evidence from recent World Radiocommunication Conferences.*

This paper won the 2017 Yale M. Braunstein Student Prize Award of the Pacific Telecommunications Council (PTC) and was presented at the 2017 PTC Annual Conference, Honolulu, Hawaii, USA, 15-18 January 2017.

Paper 2. Massaro, M. & Bohlin, E. (2017), *EU radio spectrum legislation: four stages of development.*

A previous version of this paper was presented at the 20th Biennial Conference of the International Telecommunications Society (ITS), Rio de Janeiro, Brazil, 30 November-3 December 2014; and at the 2015 Scientific Seminar “Policy challenges in Digital Markets” of the Florence School of Regulation (FSR) - Communications & Media, Florence, Italy, 27-28 March 2015.

Paper 3. Massaro, M. (2016), *Next generation of radio spectrum management: Licensed Shared Access and the trade-off between static and dynamic efficiency.*

This paper has been submitted to Journal of Telecommunications Policy, Special Issue “Optimising Spectrum”, guest editors Martin Cave and Jock Given. A previous version of this paper was co-authored with Professor Gérard Pogorel, Telecoms ParisTech, and Professor Erik Bohlin, Chalmers University of Technology, and presented at the 26th European Regional Conference of the International Telecommunications Society (ITS), San Lorenzo de El Escorial, Spain, 24-27 June 2015; and at the 2015 Regional Conference of the International Telecommunications Society (ITS), Los Angeles, California, USA, 27-28 October 2015.

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In the past three years, my life has been a whirlwind of emotions. I am sitting on my sofa, reflecting upon the persons I have met, the places I have visited, the events I have taken part in. During my PhD studies, I have grown so much as a person and as a researcher that I cannot even remember who I was three years ago. Being a PhD student has made me a better person. My willing to learn has dramatically grown and my curiosity about my research has expanded beyond my imagination. I am just thrilled about what is yet to come. In the meanwhile, I want to express my gratitude to all the persons that have guided me halfway through my PhD studies.

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Post Scriptum. I am sorry if I forgot to mention someone. Even if your name is not written here, you know you have also contributed to this licentiate thesis.

Memento Audere Semper

Maria Massaro

February, 2017

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List of Abbreviations

5G	Fifth Generation
APT	Asia-Pacific Telecommunity
ASMG	Arab Spectrum Management Group
ATU	African Telecommunications Union
BEREC	Body of European Regulators for Electronic Communications
CEPT	European Conference of Postal and Telecommunications Administrations
CITEL	Inter-American Telecommunication Commission
COM	Communication (of the European Commission)
CPG	Conference Preparatory Group
CUS	Collective Use of Spectrum
DSM	Digital Single Market
EC	European Commission
ECP	European Common Proposal
EP	European Parliament
EU	European Union
FCC	Federal Communications Commission
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union-Radiocommunication
LSA	Licensed Shared Access
NRA	National Regulatory Authority
RCC	Regional Commonwealth in the Field of Communications
RR	Radio Regulations
RSC	Radio Spectrum Committee
RSPG	Radio Spectrum Policy Group
RSPP	Radio Spectrum Policy Programme
TEU	Treaty on European Union
TFA	Table of Frequency Allocations
TFEU	Treaty on the Functioning of the European Union
UN	United Nations
WRC	World Radiocommunication Conference

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Radio spectrum regulation in the European Union

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The aim of this cover essay is to provide a comprehensive overview of the research work conducted and document the coherence of this thesis. The cover essay is structured in six sections. Section 1 introduces the research problem addressed in the thesis. Furthermore, purpose and research questions are outlined, as well as the scope of the thesis and its limitations. Section 2 gives a thorough presentation of the theoretical framework used to understand and analyse the research problem. Section 3 presents the research strategy adopted to conduct the research work. Section 4 provides a summary of the appended papers, outlining the theoretical and practical contribution of each paper to the overall purpose. In section 5, comprehensive analysis and discussion of the research problem are provided, based on the three appended papers. Finally, section 6 concludes with final remarks on the contribution of this thesis to existing knowledge and provides recommendations for future research.

1. Introduction

After a brief description of the expected reader of this thesis, this section introduces the reader to the research problem. Firstly, a general overview of the research context is provided. Secondly, purpose and research questions of the research work are outlined. Thirdly, the scope and limitations of the thesis are pointed out.

1.1. The expected reader

This thesis is multidisciplinary and international in scope. It is intended to serve a readership of researchers, industry practitioners and policy makers involved in radio spectrum policy issues, with an interest in gaining a deep understanding of radio spectrum regulation in the European Union (EU). This thesis addresses radio spectrum policy issues from a EU political science perspective. Although the emphasis is on radio spectrum policy, this thesis might provide useful insights for a wider variety of readers, who are curious about the EU integration process, the EU policy-making methods and the role of the EU as an international actor.

1.2. Contextual background

Novel uses of radio spectrum have uncovered an urgent need to review and revise the existing radio spectrum regulatory framework. Currently, the radio spectrum is in the limelight of policy makers and industry practitioners involved in the global race for the provision of 5th generation (5G) mobile broadband services.¹ 5G is expected to bring enormous economic and social benefits worldwide, supporting the digitalisation of a number of industries such as: transport, health, manufacturing, logistics, energy, media and entertainment. Key players from different industries are actively engaged in discussions with policy makers and regulators about creating a regulatory

¹ The acronym 5G is used to indicate the fifth generation of both mobile services and mobile networks. Furthermore, mobile services and networks are indicated with different expressions in various official and unofficial documents. For instance, mobile services are also referred to as mobile broadband services, mobile communications services or wireless communications services. Similarly, mobile networks are also referred to as mobile network technology, mobile communications technology or wireless communications technology. These terms do not have the exact same meaning. However, investigating the difference in meaning between the terms is considered not to be relevant for this thesis.

environment which would encourage investment and innovation in mobile communications (ITU, 2015a; 5G manifesto, 2016; COM(2016) 588; FCC, 2016).

The existing radio spectrum regulatory framework oversees the use of the radio spectrum by regulating two major activities: allocation and assignment of radio spectrum. Radio spectrum allocation is carried out at international level, while radio spectrum assignment is a national responsibility. A frequency band is allocated when a decision is taken on the service(s) that can be provided by using that specific frequency band. Each frequency band and its related service(s) are indicated in the international Table of Frequency Allocations (TFA), which reports all frequency bands and attached services, on a global basis (ITU, 2012a). Once allocated at international level, frequency bands are assigned at national level. A frequency band is assigned when service providers are granted authorisations to deliver their services over that frequency band, on a national basis (ITU, 2012a). As shown in Table 1, radio spectrum regulation at international level is a core responsibility of the International Telecommunication Union (ITU). The ITU is responsible for allocating radio spectrum frequency bands to radio-based services, which are set out in the TFA. National regulatory authorities (NRAs) are in charge of regulating the radio spectrum at national level. NRAs conducts assignment procedures for granting radio spectrum licences to service providers within their national territories. Radio spectrum is largely regulated at national level, the radio spectrum being a national resource (Cave & Webb, 2015).

Table 1. Radio spectrum: international and national regulatory levels

Regulatory Context	Radio Spectrum Activity		Entity
International	Allocation	Designating frequency bands to radio-based services	ITU
National	Assignment	Granting service providers authorisations for using the frequency bands	NRAs

1.2.1. Radio spectrum allocation

At international level, the radio spectrum is regulated by the ITU, a specialised agency of the United Nations (UN).² Every three to four years, the ITU holds a World Radiocommunication Conference (WRC), where ITU member states discuss and revise the so-called Radio Regulations (RR). The RR is the international treaty that regulates the allocation of radio spectrum frequency bands to the various radio-based services, with binding effects on all ITU member states. The ITU counts 193 member states, including all EU member states. Delegations of national governments participate in WRCs and take decisions in the matter of radio spectrum allocation. Each WRC concludes with the adoption of amendments to specific portions of the RR.

In the RR, the globe is conventionally divided into three macro-regions, called ITU Region 1, Region 2 and Region 3. As illustrated in Figure 1, Region 1 includes Europe, Africa, the Middle East, including Iraq, the former Soviet Union and Mongolia. Region 2 covers the Americas, Greenland and some of the eastern Pacific Islands; and Region 3 comprises most of the Asian countries, which were not part of the former Soviet Union, Iran, and most of Oceania (Cave & Webb, 2015).

² Descriptive information contained in this section is retrieved from the websites of the ITU and the CEPT. This information is publicly available.

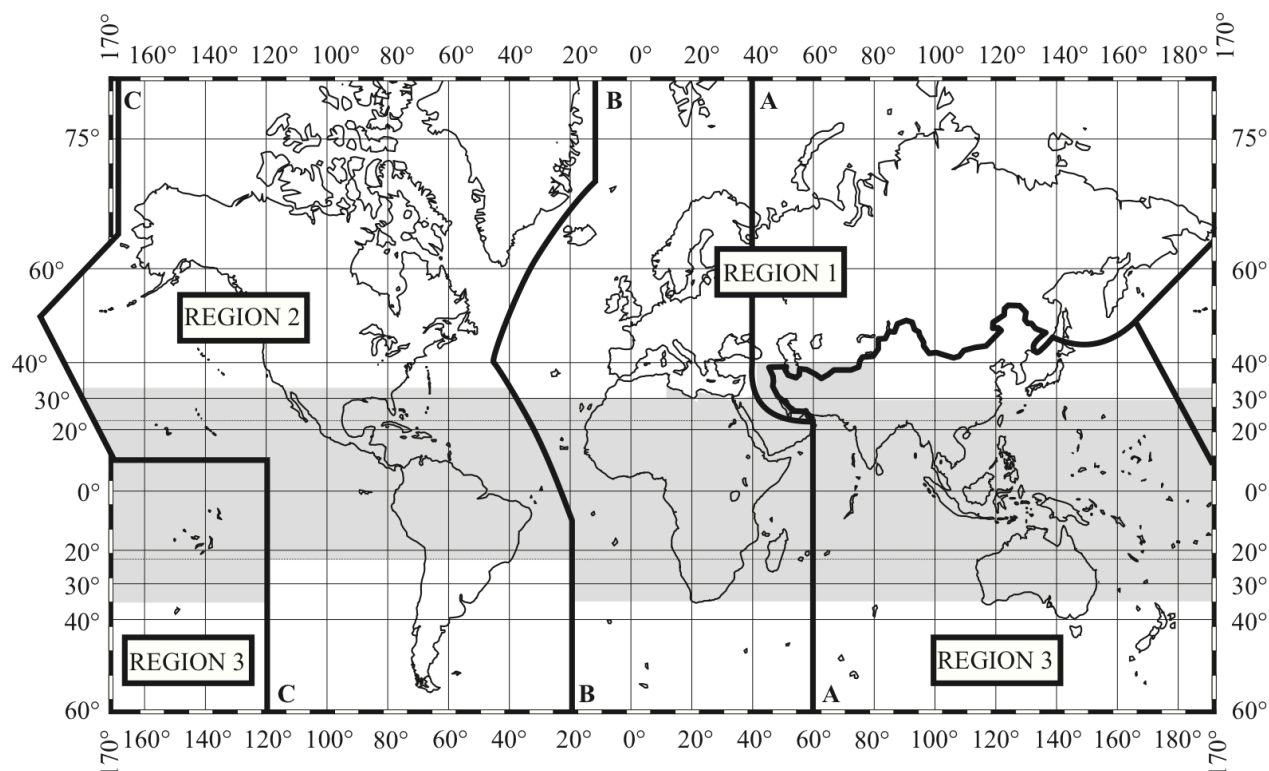


Figure 1. ITU Regions

Source: ITU (2012), Radio Regulations, Vol. 1 Art. 5.

Cross-border coordination of the use of radio spectrum is fundamental in order to avoid the risk of producing harmful interference. In this respect, countries belonging to the same ITU Region have established regional³ organisations to create a forum for discussion and strengthen cooperation. In particular, countries in Region 1 are organised in four regional entities: the European Conference of Postal and Telecommunications Administrations (CEPT), the African Telecommunications Union (ATU), the Arab Spectrum Management Group (ASMG), and the Regional Commonwealth in the Field of Communications (RCC). Countries in Region 2 are all members of the Inter-American Telecommunication Commission (CITEL). Likewise, all countries in Region 3 belong to the Asia-Pacific Telecommunity (APT).

With the establishment of such regional organisations, radio spectrum regulation acquires a three-level regulatory context, adding a regional level to the existing international and national regulatory levels. Table 2 gives an overview of the three-level regulatory context of radio spectrum. The overall aim of regional organisations is to harmonise radio spectrum regulation and promote coordination of radio spectrum, regionally. In particular, regional organisations are responsible for building consensus among countries on common policy objectives and associated priorities with regard to radio spectrum allocation. On behalf of the countries they represent, each regional organisation is responsible for formulating regional proposals to review the RR during the preparatory work of WRCs.⁴ Such regional proposals express the common view of the countries belonging to the same region on the topics that are discussed at WRCs.

³ The term “region” indicates a geographical area which includes a group of countries. The term “Region” refers to the three agglomerates of countries called ITU Region 1, Region 2 and Region 3, as specified in the RR.

⁴ Belonging to a regional organisation does not prevent ITU member states from formulating individual proposals for modification of the RR.

Table 2. Radio spectrum: three-level regulatory context

Regulatory Context	Radio Spectrum Activity		Entity
International	Allocation	Designating frequency bands to radio-based services	ITU
Regional	Allocation	Formulating common proposals to review radio spectrum allocations	CEPT; ATU; ASMG; RCC; CITE; APT
National	Assignment	Granting service providers authorisations for using the frequency bands	NRAs

The EU member states are members of the regional organisation called CEPT, which brings together 48 European countries,⁵ corresponding to almost the entire geographical area of Europe. Within the CEPT, a specialised Conference Preparatory Group (CPG) is set up with the responsibility to prepare the so-called European Common proposals (ECPs) for WRCs. ECPs contain common proposals for amendments to the RR. They are adopted with the support of ten CEPT members and the opposition of not more than six CEPT members. ECPs are then discussed at WRCs, together with other proposals for modification of the RR.

1.2.2. Radio spectrum assignment

NRAs grant service providers access to the radio spectrum on a national level. NRAs can be an independent agency or part of a government ministry. A statute usually specifies NRAs' powers and responsibilities. In some countries, radio spectrum is a shared responsibility between a government ministry and an NRA (Cave & Webb, 2015). NRAs assign radio spectrum rights of use by means of assignment procedures. Assignment procedures can be administrative-based, whereby radio spectrum rights of use are usually assigned free of charge, on a first come-first served basis, or by beauty contests (e.g. Melody & Lemstra, 2011). Beauty contests are comparative administrative procedures, whereby competing applications are assessed and winning applicants are selected on the basis of a set of predefined criteria, including financial resources and network deployment plans (Cave & Webb, 2015). Currently, market-based assignment procedures are generally adopted in the EU. In particular, radio spectrum rights of use are assigned by means of auctions. In an auction, licences are awarded on the basis of bidding among competing applicants. Generally, the bidder who offers the highest monetary sum is granted a licence to use the spectrum (ITU, 2012b). Markets for radio spectrum rights of use have also been established, to allow for a change of ownership by secondary trading (McLean Foster & Co., 2007). Furthermore, access to certain portion of radio spectrum can be granted on a licence-exempt basis. In licence-exempt frequency bands, spectrum users can provide services without holding a licence. However, they are asked to comply with specific technical requirements so that the provision of their services is not likely to cause any harmful interference to other radio spectrum users in the same or adjacent bands. Since radio spectrum users do not acquire a licence, they are not entitled any protection from potential harmful interference caused by other radio spectrum users (Faulhaber & Farber, 2002).

1.2.3. Radio spectrum allocation and assignment: the European Union

The EU's interest in radio spectrum regulation is grounded in the EU's policy priority of creating the so-called EU internal market (EC, 2014). The EU internal market is conceptualised as a unified market with minimum national regulatory barriers, where capital, persons, goods and services can easily circulate across the EU. Both European and national policy-makers, and industry practitioners have acknowledged the desirability of establishing the EU

⁵ Current members of the CEPT are: Albania, Andorra, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, The former Yugoslav Republic of Macedonia, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, San Marino, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and Vatican. This information is publicly available on the CEPT website.

internal market, given the increasingly interdependent nature of national economies (Nugent, 2010). Recently, the European Commission (EC) has formulated a Digital Single Market (DSM) strategy (COM(2015) 192) for the removal of national regulatory barriers, which would prevent the EU from seizing the opportunities offered by digitalisation. In this context, the EC claims that the regulatory framework for radio spectrum currently in place in the EU slows down the creation of the EU DSM because it does not ensure coordinated availability of radio spectrum across EU member states, which is necessary for the development of trans-European networks and the provision of pan-European services (SWD(2016) 313). Coordinated availability of radio spectrum would require both harmonised allocation of frequency bands, including technical measures to limit the risk of harmful interference, as well as coordinated national assignment procedures and harmonised conditions of use, for instance in terms of licence duration and coverage requirements. In this way, radio frequency bands would be available at the same conditions in all EU member states. According to the EC, lack of coordination across the EU has discouraged investment and innovation in advanced networks and services (COM(2013) 627), to the detriment of the EU DSM (EC, 2016a; Ansip, 2016).

The EC is the major EU institution responsible for promoting harmonisation of radio spectrum use across the EU. To perform its duty, the EC is supported by two EU bodies: the Radio Spectrum Policy Group (RSPG) and the Radio Spectrum Committee (RSC). RSPG is a consultative group, whose members are high-level governmental representatives of the EU member states and an official representative of the EC. Similarly, the RSC is composed of representatives of the EU member states and it is chaired by an official representative of the EC. This comitology mechanism was introduced by the 2002 Radio Spectrum Decision of the European Parliament (EP) and the Council of the EU (Council) with the aim to lay down the foundation of the EU legislative framework⁶ for radio spectrum to promote harmonised use of radio spectrum across the EU and further EU interests at international level. In particular, RSPG assists the EC in the formulation of strategic actions, taking account of economic, political, social and other relevant aspects of radio spectrum use. Furthermore, the RSC supports the EC in formulating, developing and implementing technical measures necessary for ensuring coordinated availability of radio spectrum across the EU (Decision 676/2002/EC; Decision 2002/622/EC; Decision 2009/978/EU).

The policy area of radio spectrum is an area of shared competence between EU and EU member states. This means that both EU and national institutions can legislate. For the scope of this thesis, competence is intended as the power to legislate. The distribution of competence between EU and national institutions is regulated by the Treaty on EU (TEU) and the Treaty on the Functioning of the EU (TFEU). These treaties are binding international agreements, whereby EU member states have agreed on conferring EU institutions the power to act, to different extents, in various policy areas. Although both EU and EU member states can legislate in the policy field of radio spectrum, only EU member states can decide how the radio spectrum is to be allocated. The EU does not have the right to participate in the WRC decision-making process. Nevertheless, it is granted the right to attend WRCs as observer and it is involved, in various ways, in the preparatory work prior to WRCs.

The EU's membership in international organisations assumes different degrees of engagement, from pure observer to full member. Being an observer means that the EU can attend meetings of international institutions, but does not have the right to vote. On the contrary, when the EU has full membership, it actively participates in the decision-making processes. Wessel (2011) states that the degree of engagement of the EU in an international organisation depends on two factors: firstly, the rules of the international organisation itself, which might recognise full membership only to nation states, and, secondly, the distribution of competences between EU and

⁶ The terms EU legislative framework and EU regulatory frameworks are used interchangeably in this thesis to indicate the rules set by the EU to control the use of the radio spectrum in the EU.

EU member states, namely, the EU member states' willingness to transfer national sovereignty to the EU. The EU usually has full membership in international organisations engaged in policy areas where it retains exclusive or extensive competences, such as trade, fisheries and some aspects of the internal market. In addition, the willingness of the EU to engage in international negotiations also depends on whether the global issues at stake occupy a relevant position in the EU's agenda. In this regard, radio spectrum use has become one of the main policy priorities of the EU, for the creation of the EU DSM (COM(2015) 192; Ansip, 2016). It is worth mentioning that the role of the EU in international organisations has been, for long time, neglected by international relations literature, because of the belief that external relations activity was mainly a nation state responsibility (e.g. Bretherton & Vogler, 2006). Furthermore, other dominant players in world politics have been struggling to recognise and accept the EU as an international entity, because of little understanding of its multi-level governance structure (e.g. Waele & Kuipers, 2013: 4). With the entry into force of the Lisbon Treaty in 2009 (EU, 2007), the EU has strengthened its role as global actor, often acting as promoter and main supporter of trade negotiations, military interventions, democracy, international development, climate change debates, and reforms of international financial institutions (e.g. Waele & Kuipers, 2013). The EU's increasing participation in global politics has generated a growing interest, in the academic world, to research about the EU as an international actor (e.g. Wunderlich & Bailey, 2011; Jørgensen et al., 2011). In particular, the EU role has been investigated in various international organisations, such as the UN (Brantner & Gowan, 2009; Buonanno & Nugent, 2013); the North Atlantic Treaty Organization (Menon, 2011; Simon, 2012; Varwick & Koops, 2009; Buonanno & Nugent, 2013); the International Monetary Fund (Smaghi, 2009); the International Criminal Court (Groenleer & Schaik, 2007); and the World Trade Organization (Gehring et al., 2013). Continuing this tradition, this thesis looks at the EU as an actor in its own right, participating in international negotiations for radio spectrum regulation, within the ITU framework.

With regard to the relation between EU and national institutions, competence distribution has been a hot topic in European studies since the beginning of the EU integration process (Rosamond, 2000; Pollack, 2000; Henkel, 2002; Henke, 2006; Heidbreder, 2014). Many theories of European integration have been developed over time. These theories examine the EU integration process trying to understand formation and functioning of the EU, as well as to foresee its future developments (Rosamond, 2000). Particular attention has been devoted to scrutinising the exercise of legislative power by the EU institutions in policy areas of shared competence, such as financial services and capital markets (Pelkmans, 2005; Dixon, 2014), labour markets (Pelkmans, 2006), agriculture (Grether, 2008), and environment (Kulovesi et al., 2011). The general aim is to provide motives in support of centralisation of legislative power to EU institutions or decentralisation of legislative power towards national or sub-national institutions. Currently, the distribution of competences between EU and EU member states has become an issue of enormous relevance in the policy field of radio spectrum. Demand for access to the radio spectrum is constantly and rapidly growing, in particular due to the pervasive use of mobile broadband services.

The need to find additional spectrum for mobile broadband services is putting pressure on existing radio spectrum regulation. In the EU, increasing attention is devoted to alternative ways to allocate and assign radio spectrum in order to accommodate emerging spectrum needs, including new forms of radio spectrum sharing, which may play a key role for the provision of 5G (e.g. COM(2012) 478; Mueck et al., 2015; AGCOM, 2016). In particular, the EU promotes two alternative sharing regimes: the licence-exempt approach, also known as the Collective Use of Spectrum (CUS) approach, and the Licence Shared Access (LSA) approach. The main difference between these two approaches regards the type of authorisation granted to service providers. In the CUS approach, service providers do not hold individual licences, but they are granted a general authorisation to access the spectrum. No protection from interference is guaranteed to spectrum users, which are asked to adopt specific technical

measures in order to minimise the risk of producing harmful interference. In the LSA approach, service providers hold individual licences to access certain frequency bands on a shared basis. The LSA approach has only recently been introduced in the EU regulatory framework for radio spectrum and its regulatory architecture is still being discussed by policy-makers (e.g. RSPG, 2013); industry practitioners (e.g. GSMA, 2013) and researchers (e.g. Palola, et al, 2014). Nevertheless, LSA testing has been conducted in a number of EU member states, including Italy, Spain, Finland and France (COM(2012), 478; ETSI, 2013; CEPT, 2014a & 2014b).

In September 2016, the EC launched a new EU legislative proposal, which would significantly reform the existing EU legislative framework for radio spectrum, substantially altering the distribution of competences between EU and EU member states, in particular with regard to radio spectrum assignment (COM(2016) 590). This recent legislative proposal has triggered intensive discussions on the degree of involvement of EU and national institutions in radio spectrum policy. Although both EU and EU member states have recognised that the existing framework is to be revised (e.g. COM(2013) 627; ComReg, 2016), there is large disagreement on how competences should be distributed between EU and national institutions. The EC claims that the existing framework does not ensure coordinated availability of radio spectrum across the EU, which is needed for the EU to be successful in the 5G race (5G manifesto, 2016; COM(2016) 588). Therefore, the EC proposes to adopt EU-wide regulatory criteria to guarantee higher harmonisation of radio spectrum allocation and radio spectrum assignment procedures. The EU legislative framework for radio spectrum has only recently been set up. Therefore, an exhaustive understanding of the role of the EU in the three-level regulatory context of radio spectrum is still lacking.

1.3. Purpose and research questions

The purpose of the study is to shed light on the implications of the EU regulatory framework for radio spectrum. In other words, this thesis aims to address the following research question:

How does the EU influence the three-level regulatory context of radio spectrum?

In order to address this question, three sub-questions are devised, each focusing on one regulatory level.

Sub-question 1. *To what extent has the EU been effective in influencing WRCs' outcomes?*

Sub-question 1 focuses on the international regulatory context. Paper 1 answers sub-question 1 by providing an assessment of the EU effectiveness in influencing the outcomes of three WRCs. EU effectiveness is intended as the ability of the EU to achieve its objectives in specific multilateral settings (Jørgensen et al., 2011; Wessel, 2011; Schaik, 2013). In order to assess EU effectiveness, a comparison is made between EU's objectives prior to WRCs and WRCs' outcomes. The degree of match between EU's objectives and WRCs' outcomes is taken as explanatory of the EU's capability to fulfil its objectives through international negotiations.

Sub-question 2. *How has competence distribution between EU and EU member states changed overtime in the policy field of radio spectrum?*

Sub-question 2 focuses on the regional regulatory context. Paper 2 answers sub-question 2 by tracing changes of competence distribution between EU and EU member states since the beginning of EU radio spectrum policy, eventually focusing on the most recent EU legislative proposals. Changes of competence distribution are traced by documenting the expansion of EU radio spectrum legislation, paying particular attention to the type of legal instruments adopted by the EU. Content and format of the EU radio spectrum legislation delimits the competence of the EU in the policy field of radio spectrum.

Sub-question 3. *To what extent has the EU been successful in influencing EU member states' radio spectrum regulatory practices?*

Sub-question 3 focuses on the national regulatory context. Paper 3 answers sub-question 3 by examining the LSA regulatory regime, which has been particularly promoted by the EU. Although radio spectrum assignment is a national exclusive competence, the EU may indirectly impact on the national regulatory level by encouraging the adoption of regulatory instruments, such as the LSA, by the EU member states.

1.4. Scope and limitations of the thesis

As stated by Cave & Webb (2015: 3): "Life without the services reliant upon spectrum would be unthinkable". In fact, the radio spectrum is a key public resource for an extensive range of commercial and public services. Public safety and emergency services, defence, public broadcasting, and public transport, are all examples of public services provided over the radio spectrum. Private television broadcasting and mobile broadband services are well-known types of commercial radio-based services. In this context, the scope of investigation of this thesis is narrowed to regulation of the commercial use of radio spectrum, in particular of mobile broadband services, although considerations on the public sector's use of radio spectrum are sometimes necessary. Evidence shows that radio spectrum regulation for mobile broadband services has become the most critical regulatory issue of the present time, due to an exponential growth of mobile data usage. The need to find additional radio spectrum for mobile broadband services has triggered a profound review of existing regulatory framework for radio spectrum, on a global scale.

Although the first research work on radio spectrum regulation can be traced back to 1959, when the seminal work "The Federal Communication Commission" was published by Ronald Coase, no consistent research has been developed, to investigate the three-level regulatory context of radio spectrum. Furthermore, although competence distribution between EU and EU member states has been a hotly debated issue in European studies, since the beginning of the process of EU integration, no research study has investigated this issue in the policy field of radio spectrum. Against this background, this thesis can be considered a pioneering work for two main reasons. Firstly, it delves into a research field, that of radio spectrum regulation, which has been barely explored in political science. Secondly, it focuses on the issue of competence distribution between EU and EU member states in a policy field which has been so far neglected in European studies.

Nevertheless, this thesis is not without limitations. Three major limitations are to be outlined. Firstly, a single study cannot adequately shed light on a phenomenon. Further research is needed to confirm, reject or refine the contribution of this thesis. Secondly, this study does not strive for objectivity. In fact, the researcher's subjectivity is part of the research investigation. Although aware of the fact that existing knowledge and expectations may influence the research process, the author of this thesis cannot assure that her judgement has been free from cognitive biases during the whole research process. Thirdly, data used in this study may represent an additional source of biases. More specifically, most of the data have been collected from official documents published by policy-makers and regulators. Enlarging the scope of investigation, for instance by including the viewpoint of mobile service providers, may contribute to better understand the EU regulatory framework for radio spectrum.

1.5. Terminology

The purpose of this sub-section is to provide the reader with a clear explanation of the relevant terminology used in the thesis. Terms often retain different meanings; therefore, it is important to clearly state how terms are connoted, in order not to disorient the reader. In this regard, definitions of the main terms recurrently employed in this thesis, both in the cover essay and the appended papers, are provided.

Radio Spectrum. Radio spectrum is a term used to indicate a portion of the electromagnetic spectrum. Electromagnetic radiation can be described as a stream of massless particles, called photons, each travelling through space in a wave-like pattern at the speed of light, each photon carrying a certain amount of energy or information (NASA, 2013). The electromagnetic spectrum is conventionally divided into categories, on the basis of propagation properties, such as frequency and wavelength, and amount of energy carried. As shown in Figure 2, these categories are: gamma rays, X rays, ultraviolet, visible light, microwaves and radio waves (NASA, 2013). The radio spectrum is characterised by radiation with the lowest frequency, the longest wavelength and the higher amount of energy

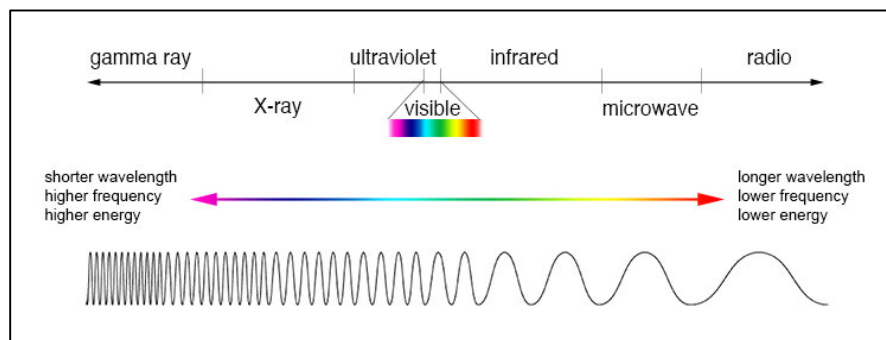


Figure 2. The electromagnetic spectrum

Source: Nasa (2013)

The radio spectrum stands out from amongst natural resources because of its unique properties. The radio spectrum is not homogeneous, meaning that it owns various propagation properties and information carrying capacity, which result valuable for the provision of a wide variety of radio-based services. It is non-exhaustible, which means that it does not run out because of its use, but it is non-storable, thus it cannot be accumulated for later use. The radio spectrum cannot be created or destroyed. Moreover, radio spectrum is considered a scarce resource: at a given time and location, it has limited availability. In fact, the radio spectrum is subject to congestion: the provision of services using the same or adjoining radio frequency bands, at the same time and in the same location, might cause harmful interference, which can reduce or nullify the usability of radio spectrum (Rosston & Steinberg, 1997; Cave, 2002; McLean Foster & Co., 2007; COM(2010) 471). The need to manage the problem of harmful interference is at the very foundation of radio spectrum regulation.

In the RR, the radio spectrum is divided into nine frequency bands, as shown in Table 3. The frequency range goes from 3 kHz to 3000 GHz. The unit for frequency is the hertz (Hz); as a matter of practicality, multiple of Hz are usually used, such as kilohertz (1 kHz = 10^3 Hz); megahertz (1 MHz = 10^6 Hz); gigahertz (1GHz = 10^9 Hz). Each radio spectrum frequency band is allocated to specific services.

Table 3. Radio spectrum: nine frequency bands

Band Name	Symbols	Frequency range
Very low frequency	VLF	3 to 30 kHz
Low frequency	LF	30 to 300 kHz
Medium frequency	MF	300 to 3000 kHz
High frequency	HF	3 to 30 MHz
Very high frequency	VHF	30 to 300 MHz
Ultra high frequency	UHF	300 to 3000 MHz
Super high frequency	SHF	3 to 30 GHz
Extremely high frequency	EHF	30 to 300 GHz
Terahertz (ITU, 2015b)	THz	300 to 3000 GHz

Source: ITU (2012), Radio Regulations Article 2

Allocation. An allocation is the outcome of a binding decision which associates a frequency band to one or more specific services. In other words, a frequency band is allocated when a decision is taken on the service(s) that can be provided by using that specific frequency band. Each frequency band and its related service(s) are reported in the international Table of Frequency Allocations (TFA), which summarises all frequency bands and related services, worldwide (ITU, 2012a). Radio spectrum allocation is decided at international level.

Assignment. An assignment is the outcome of a binding decision which associates a frequency band, allocated to certain services, to a service provider. In other words, a frequency band is assigned when service providers are granted authorisations to deliver their services over that frequency band, on a national basis (ITU, 2012).

Authorisation. An authorisation is the approval that service providers receive from NRAs to access a specific frequency band, for a certain period of time, in a certain geographical area. There exist different kinds of authorisation (or assignment) procedures, depending on whether access to a radio frequency band is exclusive or shared and on whether the authorisation is individual or general. With regard to the commercial use of radio spectrum, service providers are usually granted individual authorisations, also referred to as licences or rights of use, in this thesis. Generally, such individual authorisations guarantee exclusive access to radio spectrum frequency bands. However, new modes of spectrum sharing would allow for individual authorisations to access certain frequency bands on a shared basis.

European Union. The EU is a political and economic system formed by 28 European countries. The functioning of the EU is defined in the Treaties of the EU. The main Treaties currently in force are: the Charter of Fundamental Rights of the EU; the TEU and the TFEU. These treaties set out the fundamental principles and values upon which the EU is based, the institutional structure of the EU and the distribution of competences between EU and EU member states. The EU owns a sui generis institutional structure. In national systems, the distribution of legislative, executive and judicial powers is usually based on the Montesquieu's system of separation of powers, according to which the legislative power belongs to the parliament, the executive power to the government and the judiciary power to an independent court of justice. In the EU, there is no clear-cut separation of power between the EU institutions.

Institutions. The term institution is used in the thesis to refer to EU and national institutions. The main EU institutions mentioned in the thesis are the European Commission, the European Parliament, and the Council of the European Union. National institutions are national regulatory authorities and national governments.

Policy. The term policy does not own a straightforward definition. In the remit of this thesis, policy can be defined as an intended course of action to reach certain goals by using certain identified means and resources. Policy-making can be defined as a conscious choice between alternative policies.

Legislation. A law is an instrument adopted in order to implement a policy. At EU level, a law is the outcome of the EU decision-making process called Community method, which includes ordinary and special legislative procedures. These procedures involve, to various degrees, the EC, the EP and the Council. All EU member states are bound by EU legislation. In addition, each EU member state has its own national laws. EU laws can take the form regulations, decisions or directives.

Regulation. In the context of the EU legislative framework, the term regulation is used to indicate a specific type of EU law. Regulations are directly and generally applicable. Regulations immediately become part of national legal systems, without being transposed into national laws. Furthermore, they apply to any sort of situation objectively determined and are not limited to specific circumstances. Regulations are usually adopted to enhance legal uniformity across the EU.

Decision. In the context of the EU legislative framework, the term decision is used to indicate a specific type of EU law. Decisions are similar to regulations, in the sense that decisions are also directly applicable. However, their content is usually rather specific. Furthermore, a decision can be addressed not only to EU member states, but also to individuals and organisations. Decisions are usually adopted to enhance legal uniformity across the EU.

Directive. In the context of the EU legislative framework, the term directive is used to indicate a specific type of EU law. Directives are not directly applicable. Directives can apply to a single, a group or all EU member states. Contrary to regulations and decisions, directives need to be transposed into national legislation. It is up to each EU member state to decide what type of domestic legal instrument to adopt in order to reach the objectives specified in the directive. Directives are adopted to remove conflicts and contradictions between national legal systems in order for certain conditions to take place in all EU member states, while at the same time, taking account of national legal structures (EU, 2012: art. 288 TFEU; Chalmers et al., 2010; EP, 2016; EU, 2016b).

2. Theoretical Framework

In this section, the reader gets familiar with the theoretical concepts used in the three appended papers to analyse the research problem at hand and contribute to its understanding. Firstly, the overall theoretical framework for this thesis is presented in a comprehensive manner, emphasising the interdependencies between the theories used. Secondly, the relevant theoretical concepts, drawn from these theories, are illustrated in more detail.

2.1. A theoretical overview

This thesis is based on theories of international relations, theories of EU integration and theories on the regulation-innovation relation. At first glance, these theories might seem not to constitute a homogeneous theoretical framework. However, theoretical linkages clearly emerge by looking more closely into the theoretical streams. Theories of international relations arose in the aftermath of the First World War to provide theoretical tools for understanding and analysing international political phenomena (Burchill et al., 2005). The complexity of international politics has given rise to a great proliferation of heterogeneous multidisciplinary theoretical approaches (Andreatta, 2011), which focus on, but are not limited to, historical, economic, and legal aspects of international relations (Jackson & Sørensen, 2016). International relations scholars began to approach the study of the EU since the idea of a “United Europe” arose in the 1950s (Milczarek, 2013), with the aim to theorise about the process of EU integration. Therefore, theories of EU integration can be considered a sub-field of international relations theories (Pollack, 2001). Neo-functionalism, intergovernmentalism, liberal intergovernmentalism and multi-level governance are generally acknowledged theories of EU integration. Between the 1950s and 1960s, international relations scholars are broadly divided between neo-functionalists and intergovernmentalists. Neo-functionalism is a theory of EU integration which places major emphasis on the role of non-state actors, such as supranational interest groups and social movements, in creating pressure for EU integration (Haas, 1958 & 1961; Lindberg & Scheingold, 1970; Schmitter, 2002; Pollack, 2005). On the contrary, intergovernmentalism claims that the process of EU integration is controlled and shaped by national governments, which voluntarily agree on transfer of legislative power to EU institutions (Hoffman, 1966; Pollack, 2005; Moga, 2009). In the 1990s, a variant of intergovernmentalism, called liberal intergovernmentalism, becomes popular (Moravcsik, 1993; Rosamond, 2000; Pollack, 2005; Moga, 2009). Liberal intergovernmentalism emphasises the importance of bargaining power of the EU member states as driver of the process of EU integration. Moravcsik (2005) proposes a three-stage process of EU integration whereby national governments formulate national preferences, then participate in interstate bargaining to negotiate their preferences and eventually sign international agreements delegating national sovereignty to EU institutions. According to liberal intergovernmentalists, state sovereignty is not weakened by the EU integration process; on the contrary, it is strengthened (Moravcsik, 1994). This is because EU member states voluntarily delegate to EU institutions the lowest common level of sovereignty necessary to meet their national interests. Therefore, supranational institutions would exert little influence over policy outcomes as they are the result of interstate bargaining (Moravcsik, 2005; Pollack, 2005). Multi-level governance theory challenges the state-centric approach of liberal intergovernmentalism and claims that state sovereignty is diluted in the EU integration process. The EU integration process is described as a centrifugal process whereby authority is dispersed “away from central government, upwards to the supranational level, downwards to subnational jurisdictions, and sideways to public/private network” (Hooge & Marks, 2001: 4). Multi-level governance has become one of the concepts most widely used to describe the EU system, emphasising the multiplicity of actors at different levels involved in EU activities (Schmitter, 2002; Buonanno & Nugent, 2013; Waele & Kuipers, 2013). Nevertheless, multi-level governance theory has not been stretched over its descriptive

nature, poorly contributing to understand how authority should be distributed between the different levels of governance (Bache, 1998; Benz & Zimmer, 2010).

The issue of distribution of authority between national and EU institutions often interrelates with discussions on the effects of regulation on innovation. The relation between regulation and innovation is generally acknowledged (Prieger, 2002; Bauer, 2010; Blind, 2012; Pelkmans & Renda, 2014, Cave and Webb, 2015). Extensive research has been conducted to identify innovation-constraining aspects of regulation (Bailey, 1974; Stewart, 1981; OECD, 1996; Prieger, 2002; Alesina et al., 2005; Prieger, 2008; Stewart, 2010; Bauer, 2010; Ehrlich et al., 2010; Bauer & Shim, 2012; Blind, 2012; Pelkmans & Renda, 2014). Similarly, innovation-enabling aspects of regulation have been classified (Porter & van der Linde, 1995; Gann et al., 1998; Gerard & Lave, 2005; Nentjes et al., 2007; Ambec et al., 2013; Lane et al., 2013; Pelkmans & Renda, 2014). Due to lack of a common understanding of the positive or negative effects of regulation on innovation, a case-by-case approach is suggested to design regulation, taking account of innovation-constraining and innovation-enabling regulatory aspects typical of a specific sector (Pelkmans & Renda, 2014). When designing regulation, a choice is to be made between centralised and decentralised regulatory structures (Black, 2001; Senn, 2005). In the EU, such choice impacts on the distribution of competences between EU and national institutions (Cave & Webb, 2015). In addition, the relevance of the centralisation-decentralisation dilemma is not limited to the EU context (Wyplosz, 2015). On the contrary, such policy concern is critical for private organisations (Campbell et al., 2011; Deloitte, 2016); national economic systems (Coase, 1960; Pigou, 1920; Bardhan, 2002; Demsetz, 2011); as well as international institutions (Koremenos et al., 2001; Leben, 2003; Falkner, 2003).

2.2. Theoretical concepts

In Paper 1, theories of international relations have framed the analysis of the role of the EU in the international regulatory context of radio spectrum. In Paper 2, theories of EU integration have provided the basic tools to contextualise the issue of competence distribution between EU and EU member states in the policy field of radio spectrum. Lastly, a review of existing literature on the regulation-innovation relation has supported the discussion in Paper 3 on effects of a specific national radio spectrum regulatory tool on investment and innovation in the telecommunications market.

2.2.1. Theories of international relations: agenda-setting and coalition building

Theories of international relations have been used to understand and analyse the role of the EU as an international actor participating in international negotiations on radio spectrum regulation. In particular, the analysis draws on two main concepts: agenda-setting and coalition building. Theories of international relations indicate agenda-setting as a key determinant of the outcomes of international negotiations (e.g. Livingston, 1992; Modelski, 1999). According to agenda-setting theory, agenda setting can be seen as a dynamic process whereby actors compete against each other to earn their issues a place on the agenda and keep others' issues off the agenda. Competition arises because the agenda is finite in scope and the political system possesses limited means and resources. Therefore, a finite number of issues can be addressed, among all possible issues perceived by the political community as requiring public intervention (e.g. Cobb & Elder, 1972; Parsons, 1995; Sarpu, 2004; Birkland, 2006 & 2007; Gupta, 2011; Buonanno & Nugent, 2013; Baumgartner et al., 2014). The agenda thus includes few issues, which are to be acted upon by decision-makers. Clearly, influencing the process of agenda-setting is crucial, since decisions are taken only on the issues that have found a place on the agenda. In addition, the actors whose issues gain a place on the agenda are usually more influential during the entire policy-making process (e.g. Schattschneider, 1975; Birkland, 2006 & 2007). In order to increase the power to influence the agenda, actors often form coalitions. A coalition is formed when a number of actors, who share the same

interests, bring together their means and resources to find a common solution. The issues that find support from a large number of actors usually gain more visibility in the policy-making process (e.g. Birkland, 2007; Baumgartner, 2010).

2.2.2. Theories of EU integration: shared competence

The EU possesses a unique institutional set-up (EC, 2013; EU, 2016a) and it is considered a *sui generis* case of international cooperation and integration (Wallace, 1994; Andreatta, 2011). Therefore, getting familiar with theories of EU integration process has been deemed crucial to understand the distinctive distribution of competences between EU and national institutions in the policy field of radio spectrum. The policy field of radio spectrum belongs to the category of policy areas where EU and national institutions share legislative power.

Within the EU systems, policy fields can be distinguished in three main categories, based on the distribution of competences between EU and EU member states. The first category includes policy areas where the EU has exclusive legislative competence, which means that only the EU institutions can legislate. The second category includes policy areas which are exclusive domain of the EU member states. The third category includes policy areas of shared competence between EU and EU member states. Competence is shared when both EU and national institutions can legislate. This division of competences is grounded in the principle of EU law known as *principle of conferral* (EU, 2012: art. 5 TEU), whereby the EU can exercise its legislative power within the limits of the competences voluntarily conferred upon it by the EU member states, by means of the so-called EU treaties. Any policy area not mentioned in the EU treaties remains in the exclusive domain of the EU member states (EU, 2012: art. 4 TEU).

In policy areas of shared competence, the exercise of legislative power by the EU institutions is regulated by two general principles of EU law: *the principle of subsidiarity* and *the principle of proportionality* (EU, 2012: art. 5 TEU). These principles aim to ensure that decisions are taken at the most appropriate level of government. According to the definition provided in the TEU, the EU can take action only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the EU Member States either at national or at sub-national level, and can therefore, by reason of the scale or effects of the proposed action, be more effectively achieved by the EU. The principle of subsidiarity is closely bound up with the principle of proportionality, which seeks to set actions taken by EU institutions within specified limits. Under this principle, an action taken at EU level is required to be commensurate with the objectives set in the EU treaties. The creation and implementation of EU law inevitably restricts national sovereignty. As set forth in the *principle of supremacy of EU law* (EU, 2012: Declaration No. 17 TFEU), the EU law supersedes the legal order of the EU member states, including their national constitutions.

2.2.3. Theories on the regulation-innovation relation: dynamic efficiency

Existing research on the regulation-innovation relation has guided the assessment of a specific national radio spectrum regulatory tool in terms of its capacity to foster investment and innovation in advanced broadband networks and services. Discussions on the regulation-innovation relation includes reflections on the notion of dynamic efficiency. The relation between regulation and dynamic efficiency is generally acknowledged (e.g. Bourreau & Doğan, 2001; Bauer, 2002; Quigley, 2004; Bijl & Peitz, 2004; Prieger, 2007; Bauer & Bohlin, 2008; Prieger, 2008; Bauer & Shim, 2012; Blind, 2012; Yang et al., 2013; Pelkmans & Renda, 2014). Furthermore, dynamic efficiency has been recognised, by several scholars, as a main contributor to social welfare (Bourreau & Doğan, 2001; Blaug, 2001, Kathuria; 2015). There is no clear definition of dynamic efficiency as radio spectrum regulatory principle. Nevertheless, the claim can be made that dynamic efficiency occurs when the radio spectrum is regulated and used in such a way that investment and innovation in technologies, services, allocation and assignment procedures are constantly promoted (Cave, 2002; Cave et al, 2007; Bauer & Bohlin, 2008).

Promoting investment and innovation in the telecommunications sector has become one of the main public policy priority of the EU (COM(2015), 192; COM(2016) 590). A growing telecommunications sector not only directly generates economic and social growth, but also indirectly contributes to the development of other industries, such as transport, health, manufacturing, logistics, energy, media and entertainment (Bauer, 2010; Bauer & Shim, 2012; Yang et al., 2013; 5G manifesto, 2016; COM(2016) 588). In particular, policies that spur investment and innovation in advanced broadband networks and services could foster economic and social development (OECD, 1996; Bourreau & Doğan, 2001; Alesina et al., 2005; Bauer & Shim, 2012). In this context, it is to be placed the relevance of assessing whether new national regulatory tools of radio spectrum enable dynamic efficiency in the deployment of next generation of network technologies.

3. Research Strategy

This section describes the research strategy adopted during the whole research process. The research strategy has been the outcome of well-grounded decisions on the analytical tools to approach the research problem. Decisions have been guided by the ambition to find the appropriate key for understanding and interpreting the research problem. In summary, a qualitative research strategy was adopted. Furthermore, the relation between theory and empirical data was characterised by an iterative inductive-deductive process, whereby purpose, theoretical framework and data collected have progressively and mutually shaped one another. The research work was based on secondary data, retrieved from official documents, reports, news articles, academic papers and books. The section concludes by pointing out methodological limitations and opportunities for improvements.

3.1. Qualitative research

The research work described in this thesis was conducted by adopting a qualitative research strategy. Qualitative research strategy is generally applied to study social phenomena that cannot be analysed and understood according to the model of objectively defined cause-effect relations, typical of quantitative research strategy (Croom, 2009; Flick, 2009). In qualitative research, the researcher does not manipulate aspects of the phenomenon under investigation, whereby hypotheses, extracted from theory, are tested. Rather, social phenomena are studied as they unfold, in their complex entirety (Patton, 2002; Golafshani, 2003). The overall aim is to achieve local and specific knowledge. Furthermore, the researcher's subjectivity is part of the research investigation, the research outcome being dependent upon the judgement of the researcher (Patton, 2002; Golafshani, 2003).

The quality of qualitative research investigation is generally assessed by using the trustworthiness criterion, which is characterised by four main dimensions, as shown in Table 4 (Lincoln & Guba, 1985; Bryman & Bell, 2011).

Table 4. Quality assessment for quality research: trustworthiness criteria

Trustworthiness
Credibility
Transferability
Dependability
Confirmability

Source: Bryman & Bell (2011)

Credibility refers to the soundness and integrity of the research findings. If the research findings represent truthfully the reality, they are defensible (Golafshani, 2003; Bryman & Bell, 2011). Triangulation is a technique usually employed to strengthen the credibility of qualitative research findings (Denzin, 1978; Patton, 2002; Bryman & Bell, 2011). In this regard, theory triangulation was used in this research work, adopting different theoretical perspectives to examine and interpret the data. Furthermore, data triangulation was employed to guarantee the accuracy of the data collected. In this case, data triangulation has consisted in gathering the same information from different sources, such as official documents from various EU and national institutions, news articles, and reports from diverse stakeholders.

Transferability consists on producing findings which can be transferred to other contexts. A traditional way to enhance transferability is carefully describing the research context. In this regard, this thesis offers an accurate description of the research context. In this way, the findings of this study may offer useful insights for understanding broader EU issues, which go beyond the policy area of radio spectrum, such as the EU participation in international organisations and the issue of competence distribution between EU and EU member states.

Dependability corresponds to the concept of reliability used in quantitative research according to which an experiment is reliable when leads to the same results, if conducted several times. Dependability requires the researcher to carefully document step by step the research investigation and related outcomes. A technique widely used to assess dependability is to undergo an external audit, whereby the research process and outcome of a study are examined by a third party. The strategy adopted to make the present work dependable have included the participation in several workshops, training seminars and conferences where different parts of the research work have been presented and discussed with individuals not involved in this research investigation, including researchers, policy makers and industry practitioners from various fields.

Confirmability is concerned with ensuring that the findings represent the outcome of the study rather than the point of view, motivation or interest of the researcher. The researcher's judgement may be influenced by cognitive biases, which are tendencies to reason in a certain way, due to existing knowledge and expectations on the process of collecting, analysing and interpreting data (Bryman & Bell, 2011; Halldórsson & Aastrup, 2003). On this aspect, the present thesis cannot be considered free from cognitive biases. Notwithstanding the aim for rationality and good judgement, the research findings are strongly dependent of the researcher's own understanding of the research problem.

In addition to the trustworthiness criterion, a core concept in quality of qualitative research is methodological fit, which stresses the importance of carefully choosing the various elements of the research strategy to make sure that they work together as a system. In this regard, an iterative inductive-deductive approach have been adopted to ensure an adequate methodological fit, whereby the various elements of the research design have been iteratively adjusted and re-oriented overtime, based on new knowledge and better understanding of the research problem, acquired during the research investigation.

3.2. Iterative inductive-deductive approach

The research strategy was characterised by an iterative inductive-deductive approach between theoretical and empirical world. As illustrated in Figure 3, learning is the result of moving back and forth between deductions from theory and empirical data (Box, 1976; Rossiter, 2011).

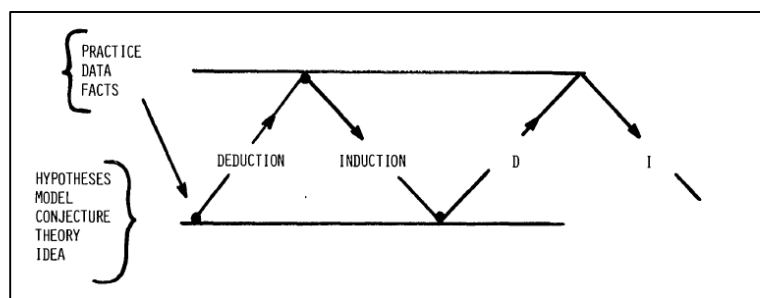


Figure 3. Iterative inductive-deductive approach

Source: Box (1976)

By means of such iterative process, purpose, theoretical framework and empirical data are systematically adjusted and carefully matched. The choice for such iterative process has not been taken *a priori*. Rather, the need to modify purpose and theoretical framework emerged during the research process as a consequence of collecting and analysing data. Several iterations between theory and empirical data helped re-focus the overall purpose and refine the theoretical model, as well as adjust the lenses on the empirical world, accordingly. Qualitative research is generally conducted by setting up flexible research designs, which allows for the different elements of the research design to be reiteratively adjusted in correspondence to the knowledge accumulated during the research process (Maxwell, 2013).

3.3. Document analysis

This research work relies on secondary data sourced from official documents, reports, news articles, academic papers and books. Empirical data on aspects of radio spectrum regulation have been collected from official documents, reports and news articles. The official documents considered are publicly available on the websites of: the ITU; the CEPT; the EC; the EP; the Council; the RSPG; the RSC; the Body of European Regulators for Electronic Communications (BEREC); and national institutions, such as NRAs and government ministries. In addition, reports published by recognised consulting companies have been taken into account. News articles have been published online by PolicyTracker, which is a specialised newsletter that only addresses radio spectrum policy issues. A wide range of academic papers and books have been scrutinised to build the theoretical framework. Most of them have been collected through Google Scholar and the Chalmers library.

Backward and forward snowballing techniques⁷ have been used to systematically find relevant secondary sources. Backward snowballing consists of identifying documents from reference lists, while forward snowballing consists of looking at citations to documents (Paradis & Zimmerman, 2002; Jalali & Wohlin, 2012). The snowball method requires a starting set of documents, whose references and citations can be looked at. The starting documents considered for this research work are seminal work published by well-known authors in the theoretical streams used to build the theoretical framework.

One of the drawbacks of backward snowballing is that the search moves back in time to literature that may be obsolete (Paradis & Zimmerman, 2002). This drawback is overcome by using a combination of backward and forward snowballing. In fact, forward snowballing moves the search forward in time to more recent publications. Furthermore, forward snowballing facilitates the identification of relevant works which might have been published in unfamiliar journals (Greenhalgh & Peacock, 2005). This is considered particularly relevant for this research work because there is no consistent research on the policy field of radio spectrum. Therefore, relevant sources have been published on journals and books of widely differing kinds. Eventually, all data sources collected have been skimmed off by considering leading journals and relevant books for the research phenomenon under investigation (Wohlin, 2014).

⁷ These techniques are also referred to as snowball method and citation method, respectively.

With regard to the quality of documents, Scott (1990) proposes four criteria for evaluating the quality of secondary sources. These criteria are indicated in Table 5.

Table 5. Criteria for evaluating secondary sources of data

Quality of secondary sources
Authenticity
Credibility
Representativeness
Meaning

Source: Scott (1990)

Authenticity considers whether secondary sources are of unquestionable origin and their content has not been subsequently altered. Credibility refers to whether the content of secondary sources, although genuine, does in fact represent truthfully the reality. Representativeness ascertains whether the secondary sources considered are representative of the totality of the relevant documents, or whether some essential documents have been left out. Finally, meaning aims to assess whether the documents are comprehensible and clear.

With respect to the current research work, two major groups of documents have been used. Official documents and academic papers. Official documents can generally be considered authentic as they are of dependable origin. Similarly, the authenticity of academic papers is guaranteed by selecting only academic papers published in well-known journals. With regard to credibility, it must be said that official documents are often the outcome of public consultations whereby all relevant stakeholders are invited to express their views on a topic. The contributions provided by stakeholders, with often competing interests, may be interpreted as a form of data source triangulation. With regard to academic papers, relying on journals which require journal articles to go through a peer review process for publication might guarantee an appropriate level of credibility. In terms of representativeness, an extensive number of official documents and academic papers has been scrutinised. The process of gathering documents has stopped when additional documents were not providing any new information, according to the researcher's own understanding and interpretation of the data. With regard to meaning, the strategy adopted by the author of this thesis was to read the documents several times, at different point in times. Increasing accumulated knowledge about the research problem and theoretical framework have helped achieve a satisfactory level of understanding of the documents considered.

3.4. Methodological limitations

The quality of the research strategy adopted could be strengthened in a number of ways. In particular, the weakest aspect of the present research work is represented by the reliance on documents as the sole data source. One of the main problems associated with using documents as sources of data is accessibility. In fact, necessary documents might not be available, either because they are not retrievable or because their access is blocked (Flick, 2009: 259). Moreover, document analysis can be extremely time-consuming, because of the vastness and the amount of details. Lack of accessibility and time-constraints might undermine the ability of the researcher to identify all relevant documents and collect all important data (Bryman & Bell, 2011: 550). Another critical issue is related to the fact that, using documents as the sole sources of data is often seen as a complementary rather than a stand-alone method (Bryman & Bell, 2011: 550). In this regard, the credibility of the research findings could be increased by using primary sources of data, such as first-hand observation, in addition to documents, in order to perform data triangulation. Furthermore, the dependability dimension of trustworthiness would be enhanced by publishing the appended papers to peer-reviewed journals.

4. Summary of appended papers

This section summaries the appended papers included in the thesis and outlines theoretical and practical contributions of each paper to the overall purpose.

4.1. Paper 1

Massaro, M. (2017), *Declining effectiveness of the European Union in the International Telecommunication Union: evidence from recent World Radiocommunication Conferences*.

This paper won the 2017 Yale M. Braunstein Student Prize Award of the Pacific Telecommunications Council (PTC) and was presented at the 2017 PTC Annual Conference, Honolulu, Hawaii, USA, 15-18 January 2017.

Summary. Notwithstanding an increasing EU commitment to represent EU interests at international level, very little is known about the EU's participation in WRCs. In this respect, a document analysis was conducted in Paper 1 to assess the effectiveness of the EU in influencing the outcomes of the three most recent WRCs, held in 2007, 2012 and 2015. More than one hundred documents were scrutinised, including official documents, academic papers, news articles and reports. Effectiveness was intended as the ability of the EU to achieve its objectives in specific multilateral settings (Jørgensen et al., 2011; Wessel, 2011; Schaik, 2013). To assess the effectiveness of the EU, a comparison was made between EU's objectives set prior to WRCs and WRCs' outcomes. The degree of match between EU's objectives and WRCs' outcomes was taken as explanatory of the EU's capability to fulfil its objectives through international negotiations. The motivation of this study draws upon existing research which ascertains the EU's declining leading role in WRCs (El-Moghazi et al., 2014 & 2016). Theories of international relations, in particular the concepts of agenda-setting and coalition building, constituted the conceptual framework for the analysis.

The document analysis shows that the EU was partially effective in influencing the outcomes of the three WRCs considered. Three explanatory factors were identified. Firstly, the EU failed to contain the pressure exercised by other countries to earn their issues a place on the agenda. Secondly, the EU was not able to create or keep coalitions in support of its objectives. Thirdly, the EU role as global actor has been watered down by a growing number of active participants at WRCs. In particular, developing countries are increasingly interested in radio spectrum regulation, being mobile broadband services a key driver of economic growth.

Paper 1 concludes that the effectiveness of the EU in WRCs depends, to a large extent, on the preparatory work prior to WRCs. In this regard, it is recommended that the EU recognises radio spectrum regulation as a matter of EU foreign affairs, in order to restore its leading role in international negotiations on radio spectrum regulations. In particular, the EC is encouraged to promote intra- and inter-regional cooperation prior to WRCs. Firstly, the EC may facilitate the dialogue between the CEPT and the other regional organisations active in Region 1, aiming for one single regional proposal instead of four sub-regional proposals to be discussed at WRCs. Secondly, the EU may facilitate the dialogue between the CEPT and the regional organisations active in Region 2 and 3, aiming for inter-regional compromises on the most critical issues before WRCs. Decisions at WRCs are taken by consensus and ITU member states are the only actors who have the right to participate in the decision-making process. Building coalitions prior to WRCs might help the EU promote its interests at WRCs, since the larger the number of supporters of the EU's interest, the stronger it may be the EU's effectiveness at WRCs.

Contribution. From a theoretical perspective, Paper 1 aims to contribute to the literature on the EU as an international actor, broadening its scope of analysis to include the role of the EU in the ITU. From a practical perspective, Paper 1 provides a detailed description of the EU's participation in WRCs, articulated in three levels: the EU member states, the EC and the CEPT.

Main limitation. Paper 1 only focuses on radio regulation for mobile broadband services. The assessment of the EU's effectiveness might change if all issues discussed at WRCs were considered.

4.2. Paper 2

Massaro, M. & Bohlin, E. (2017), *EU radio spectrum legislation: four stages of development*.

A previous version of this paper was presented at the 20th Biennial Conference of the International Telecommunications Society (ITS), Rio de Janeiro, Brazil, 30 November-3 December 2014; and at the 2015 Scientific Seminar “Policy challenges in Digital Markets” of the Florence School of Regulation (FSR) - Communications & Media, Florence, Italy, 27-28 March 2015.

Summary. Scholars have paid particular attention to the issue of competence distribution between EU and national institutions in policy areas of shared competence. However, none of these studies focus on the policy area of radio spectrum. Recently, the increasing demand for access to the radio spectrum has unveiled radio spectrum policy as a fertile breeding ground for research investigation. In this respect, the aim of Paper 2 was to trace changes of competence distribution between EU and EU member states overtime, since the beginning of EU radio spectrum policy, eventually focusing on the most recent EU legislative proposals. Changes of competence distribution were traced by documenting the expansion of EU radio spectrum legislation, paying particular attention to the type of legal instruments adopted by the EU. All main EU regulations, directives and decisions which constitute the EU radio spectrum legislation were scrutinised. EC communications were also included in the document analysis.

The development of EU radio spectrum legislation is organised in four stages. Each stage was triggered by a substantial transfer of competence from national to EU institutions. This was shown by the expansion of topics covered by EU radio spectrum legislation overtime, as well as the type of EU legal instruments adopted. Initially, the EU body of radio spectrum legislation was mainly constituted by directives. Subsequent revisions of such directives and the adoption of some decisions reinforced EU competences in the matter of radio spectrum. However, the gradual transfer of power from national to EU institutions stalled with the 2013 legislative proposal to adopt a regulation in order to reform the directives that constituted the existing EU legislative framework for radio spectrum. Regulations are the strongest EU legal instruments because they are directly and generally applicable.

Probably due to the unsuccessful 2013 legislative proposal, in 2016, the EC proposed to reform existing provisions on radio spectrum, by adopting a directive, which has a weaker centralising power compared to regulations. Furthermore, the 2016 directive presents a more voluntary character, compared to the 2013 legislative proposal: EU member states are encouraged, but not legally forced to undertake certain actions. At the same time, the 2016 directive would strengthen the role of the EC by granting it the right to adopt implementing acts in a wide variety of matters related to radio spectrum assignment. Adopting the 2016 directive would lead to an expansion of EU competences in the policy field of radio spectrum, although to a lessened extent compared to the 2013 proposed regulation. In fact, the implementing power exercised by the EC would be monitored by the EU member states. Therefore, EU member states might agree to relinquish national sovereignty with regard to radio spectrum assignment, as long as there exists an oversight mechanism to control the EC implementing power. However, the EU's system of delegated and implementing powers seems to suffer from critical downsides, including great complexity, lack of transparency, limited accountability and lack of democratic efficiency (Stratulat & Molino, 2011; Christiansen & Dobbels, 2013). Such problems might weaken the efficacy of granting the EC implementing powers. This opens doors for future research. In particular, studies on the issue of competence distribution in other policy fields might bring useful insights for evaluating costs and benefits of centralisation and decentralisation of legislative power with regard to radio spectrum and of distribution of legislative power between the EU institutions.

Contribution. From a theoretical perspective, Paper 2 follows the tradition of studies that address the issue of competence distribution in policy fields of shared competence, adding the policy area of radio spectrum, which has been so far neglected by European studies. From a practical perspective, Paper 2 structures EU radio spectrum legislation in four stages of development, highlighting the main changes of competence distribution between EU and EU member states.

Main limitation. The classification of EU radio spectrum legislation in four stages of development is arbitrary and subject to the personal interpretation of the authors.

4.3. Paper 3

Massaro, M. (2016), *Next generation of radio spectrum management: Licensed Shared Access and the trade-off between static and dynamic efficiency*.

This paper has been submitted to Journal of Telecommunications Policy, Special Issue “Optimising Spectrum”, guest editors Martin Cave and Jock Given. A previous version of this paper was co-authored with Professor Gérard Pogorel, Telecoms ParisTech, and Professor Erik Bohlin, Chalmers University of Technology, and presented at the 26th European Regional Conference of the International Telecommunications Society (ITS), San Lorenzo de El Escorial, Spain, 24-27 June 2015; and at the 2015 Regional Conference of the International Telecommunications Society (ITS), Los Angeles, California, USA, 27-28 October 2015.

Summary. One of the current EU policy priorities is to promote dynamic efficiency in the telecommunications sector (EC, 2016b). In this context, the EU has recently promoted a new spectrum sharing arrangement called LSA. LSA is regulatory approach that allows for shared use of already assigned but underused spectrum bands between incumbents and new LSA licensees by means of individual spectrum licences. These individual licences would include sharing conditions to allow both incumbents and new users to provide a certain quality of service (QoS) (RSPG, 2015).

Several studies have argued for the implementation of spectrum sharing arrangements to promote dynamic efficiency (Noam, 2003; Peha, 2009; Bunel & Lescop, 2012; Khun -Jush et al., 2012; RSPG, 2013; Plum Consulting, 2013; Werbahc & Mehta, 2014; Rysavy, 2014). Continuing this tradition, the aim of Paper 3 was to provide a full-fledged assessment of LSA in terms of its potential to promote dynamic efficiency in the telecommunications sectors. In Paper 3, dynamic efficiency was intended as the capability of the LSA regulatory regime to provide mobile operators with incentives to invest in advanced broadband networks. A document analysis was conducted to assess the impact of LSA on investments in advanced network technologies. Policy documents, academic papers, position papers and reports were scrutinised to gather information on technical and regulatory aspects of LSA, as well as the state-of-the-art of the research on the regulation-innovation relation, with a focus on the trade-off between static and dynamic efficiency.

The assessment showed that the LSA regulatory regime could provide important stimuli for mobile operators to invest in advanced network deployment. However, some regulatory aspects still need to be refined, in particular with regard to enforcement mechanisms. LSA is an example of a new generation of radio spectrum regulatory tools based on spectrum sharing arrangements. Finding additional spectrum for mobile services is deemed necessary and LSA offers mobile users the opportunity to access spectrum, in a timely manner, while avoiding the costs related to participating in authorisation procedures. Similarly, incumbents would avoid lengthy and costly re-allocation processes, and receive monetary or other forms of benefits from LSA licensees, while maintaining control over the spectrum in the long-term. Nevertheless, LSA does not provide the regulatory certainty necessary for stepping forward from LSA testing to actual implementation. In particular, the benefits of implementing LSA would be lessened without the development of proper enforcement mechanisms, which are fundamental for LSA to promote investment and innovation. Enforcement mechanisms are necessary to ensure that incumbents and LSA licensees comply with agreed frequency, location and time sharing conditions, by providing incentives for compliance and/or punishments for non-compliance. Furthermore, enforcement mechanisms to safeguard privacy and security of sensitive information regarding spectrum usage of both incumbents and LSA licensees should be put in place.

Contribution. From a theoretical perspective, Paper 3 attempts to dig into the theoretical discussion on the trade-off between static and dynamic efficiency, by addressing this issue with respect to radio spectrum regulation. From a practical perspective, Paper 3 offers an overview of the evolution of radio spectrum management practices. Three generations of radio spectrum management are identified, highlighting their respective policy objectives, regulatory approaches and assignment procedures.

Main limitation. The identification of three generations of radio spectrum management is arbitrary and subject to the personal interpretation of the author. Similarly, the assessment of the LSA regulatory regime with respect to dynamic efficiency is conditional to the author's own understanding of the concepts of static and dynamic efficiency.

5. Analysis and Discussion

This section builds on the analysis conducted in the three appended papers and provides an exhaustive answer to the main research question: *how does the EU influence the three-level regulatory context of radio spectrum?* To this aim, the contributions of the appended papers to the overall research question are integrated and further discussed.

The EU legislative framework for radio spectrum lies across the three-level regulatory context of radio spectrum, adding on and, to some extent, overlapping with international, regional and national regulatory levels. The role of the EU in regulating the radio spectrum has to be placed in a context where countries own the power to decide on both radio spectrum allocation and assignment. Countries take decisions on radio spectrum allocation at international level, periodically participating in WRCs, and regionally coordinate during the preparatory work prior to WRCs. Furthermore, NRAs are in charge of radio spectrum assignment, granting radio spectrum licences for the provision of radio-based services at national level. Nevertheless, the EU radio spectrum policy and its regulatory framework do exert influence on both radio spectrum allocation and assignment.

The EU is a sui generis international actor. The EU does not own any decisional power at WRCs. Only ITU member states have the right to participate in the WRC decision-making process for radio spectrum allocation. Nevertheless, the EU does contribute to shape WRC decisions. In particular, the EC, on behalf of the EU, attends WRCs as observer, supervising the actions of EU member states. Although without formal seat and vote, participating in WRCs gives the EC the possibility to encourage EU member states to collectively support EU interests (e.g. Shahin, 2011; COM(2015) 234).

The EU does not belong to the category of regional organisations active in the three ITU Regions, which promote cross-country coordination of radio spectrum use and formulate regional proposals for modifications of the RR. Nevertheless, the EU undertakes a similar function, promoting harmonised allocation of radio spectrum across the EU. In order to promote harmonisation, the EC works intensively to build consensus among EU member states during the preparatory work to WRCs. In particular, the EC adopts the so-called common EU position in order to inform national governments about EU interests in the matter of radio spectrum allocation. The common EU position takes the form of a Communication to the Council (as well as to the EP, the European Economic and Social Committee and the Committee of the Regions). Members of the Council are national government ministers. The Council (together with the EP) is required to endorse the common EU position by adopting a decision with binding effects on all the EU member states.⁸ In addition, the EC formulates the common EU position, taking into consideration the opinion expressed by the RSPG. Members of the RSPG are high-level governmental experts from EU member states and a high-level representative from the EC (Decision 2009/978/EU). Cooperation between the EC and the RSPG allows the EU member states to contribute to and shape the common EU position. Furthermore, the EC collaborates with the CEPT, during the preparatory work prior to WRCs, providing support for developing and adopting ECPs (CEPT, 2009). Although the CEPT has a broader scope than the EU, ECPs facilitate convergence of national interests into a common position on radio spectrum allocation. Furthermore, it is worth mentioning that the EU member states' participation in WRCs is bounded by the TEU and TFEU, as well as the EU legislative framework for electronic communications, which incorporates the body of EU radio spectrum legislation.

⁸ Interestingly, the Council adopted Council Conclusions in preparation for the WRC held in 2015. Council Conclusions are not legally binding on the EU member states. According to the EC, the Council acted in breach of the art. 218 of the TFEU (Council of the EU, 2015).

Since the 1980s, the body of EU law in the policy field of radio spectrum has gradually expanded, in terms of number and types of legal instruments adopted and range of topics covered, generating a gradual transfer of competence from national to EU institutions. Scattered legal interventions marked the beginning of the EU body of law in the policy field of radio spectrum. A number of directives were adopted in order to promote harmonised allocation of selected radio spectrum bands for mobile communications. EU radio spectrum legislation started to develop in a systematic manner since the implementation of the revised 2002 legislative framework for electronic communications. The directives forming the 2002 legislative package aimed at removing differences between national systems by introducing general regulatory principles such as objectivity, transparency, equality, and proportionality to be applied in both allocation and assignment of radio spectrum, and by simplifying authorisation rules for granting radio spectrum licences. A decisive moment in the evolution of EU radio spectrum legislation was the adoption of the 2002 Radio Spectrum Decision (Decision 676/2002/EC), which institutionalised the role of the EU in radio spectrum policy by introducing the existing comitology mechanism whereby the EC is supported by RSPG and RSC in setting up EU radio spectrum policy. Contrary to directives, decisions are directly applicable and immediately affect national legal systems. The second review of the EU legislative framework for electronic communications further strengthened EU competence in the policy field of radio spectrum. In particular, the 2009 Better Regulation Directive (Directive 2009/140/EC) encouraged the set-up of the first tailor-made legislative initiative on radio spectrum. The first Radio Spectrum Policy Programme (RSPP) was adopted with Decision 243/2012/EU. The measures included in the RSPP aimed at harmonising both radio spectrum allocation and assignment, setting up, among other things, a deadline for allocation and assignment of certain radio spectrum frequencies for mobile broadband services across the EU. The gradual transfer of legislative power from national to EU institutions has come to a halt with the unsuccessful 2013 legislative proposal to reform the 2009 legislative framework (COM(2013) 627). The 2013 legislative proposal took the form of a regulation. Regulations possess the strongest centralising power as they are directly and generally applicable throughout the EU. The proposed reforms would have determined a substantial transfer of power to the EC to supervise many aspects of radio spectrum assignment procedures, conditions of use attached to radio spectrum rights of use as well as timetables, for the coordinated availability of radio spectrum and harmonised conditions of use, across the EU. EU member states considered these reforms to be unreasonably intrusive of national sovereignty. A new legislative proposal was put forward in 2016 (COM(2016) 590). In the light of the 2013 failed attempt to reform the 2009 legislative framework by implementing a regulation, the 2016 legislative proposal includes radio spectrum reforms in a directive. Furthermore, the provisions included in the 2016 directive present a more voluntary character, recommending rather than forcing the EU member states to manage the radio spectrum in a certain manner. At the same time, more responsibilities are attributed to the EC, which would be granted the power to adopt implementing acts in a relatively wide range of matters related to radio spectrum assignment. Implementing acts are adopted to ensure uniform implementation of EU legislation at national level. The 2016 legislative proposal has been submitted to the EP and the EC, which will decide upon adoption, amendment, or rejection of the proposed reforms (EU, 2012: art. 289 TFEU).

As matter stands, the EU's influence on the national regulatory level of radio spectrum is rather limited. Radio spectrum rights of use are granted at national level by NRAs. Currently, radio spectrum rights of use are generally assigned by means of auctions. NRAs are responsible for choosing auction formats and setting reserve prices and timetables. Furthermore, NRAs usually include regulatory remedies in the auction design, such as coverage obligations and competitive measures. Coverage obligations are set to achieve certain national policy objectives, such as broadband coverage in underserved areas. Competitive measures, such as spectrum caps and set-aside spectrum, are often introduced to protect or promote competition in the national downstream market. Notwithstanding lack of legislative power with regard to assignment procedures, the EU may indirectly influence

the national regulatory level of radio spectrum by providing EU member states with ideas on innovative regulatory tools. Recently, the EU has shown an increasing interest in the LSA regulatory regime, to meet the increasing demand for access to the radio spectrum, in particular for mobile broadband services. LSA has attracted the attention of several EU member states, which sought the possibility to open public sector spectrum for mobile broadband services. Although LSA was initially proposed by an industry consortium composed by Qualcomm and Nokia, the EU's promotion of such spectrum sharing arrangement may have contributed to its acknowledgement at national level.

6. Concluding Remarks

This section concludes the cover paper by providing a summary of the research work and outlining opportunities for future research. The reader is encouraged to consider this thesis as a starting point which hints to several research paths to be further explored in the future.

6.1. Summary

This research work was conducted to grasp the implications of the EU regulatory framework for radio spectrum. This thesis has been structured around a main research question: *how does the EU influence the three-level regulatory context of radio spectrum?* In order to answer this research question, the research work was conceived to explore the international, regional and national regulatory levels of radio spectrum, devoting effort to ascertaining the influence of the EU legislative framework for radio spectrum on each regulatory level. Although the implications of the EU legislative framework on radio spectrum regulation are not captured thoroughly, interesting conclusions can be drawn from this thesis. Overall, the EU legislative framework for radio spectrum lies across the three-level regulatory context of radio spectrum, adding on and, to some extent, overlapping with international, regional and national regulatory levels.

Firstly, the EU influences the international level of radio spectrum regulation by means of the EC's participation in WRCs. Although the EC does not own any decisional power, its role as observer at WRCs might create pressure on the EU member states to support EU interests during the negotiations. Secondly, the EU pursues the same general objective of the CEPT and the other regional entities: promotion of cross-country coordination of radio spectrum use in a certain regional area. In this regard, the EU impacts on the regional regulatory context of radio spectrum by promoting harmonised availability of radio spectrum across the EU. To this objective, the EU adopts policy instruments which are legally binding for all EU member states. Furthermore, the EC cooperates with the CEPT in order to build consensus across the EU. Thirdly, the EU's influence on the national level of radio spectrum regulation is confined to general regulatory principles that all NRAs are required to comply with when designing and conducting radio spectrum assignment procedures. However, NRAs are the sole entities in charge of choosing assignment procedures and setting up conditions of use of the radio spectrum in their national territories. Nevertheless, the EU may still leverage on the national regulatory level of radio spectrum. In particular, the EU can provide EU member states with ideas on alternative ways to assign and use the radio spectrum at national level. The EU may be seen as a catalyst for regulatory experimentation, EU member states capturing knowledge on otherwise unseen regulatory opportunities, promoted by the EU.

A qualitative research strategy was adopted to explore the research problem at hand, whereby the researcher's subjectivity has played a key role. Furthermore, the different elements of the research design have been gradually adjusted and matched thanks to several iterations between the conceptual framework and the empirical data. This research work was primarily based on archival data retrieved from official documents produced by national, regional and international organisations, as well as, reports, news articles, academic papers and books.

The relevance of this research work stands out from the current need to find additional radio spectrum for mobile broadband services. The increasing demand for access to the radio spectrum has unveiled the impossibility of the existing regulatory framework for radio spectrum to accommodate emerging spectrum needs. Creating a regulatory environment which would promote investment and innovation in the telecommunications sector has become one of the main public policy priorities worldwide. Currently, the radio spectrum is in the limelight of

policy makers and industry practitioners engaged in the global race for deployment of 5G networks and provision of the next generation mobile services.

The novelty of this thesis lies on the choice to set the scope of investigation on the EU context. To the knowledge of the author, the role of the EU in radio spectrum regulation has so far been neglected by political science research. In this regard, this thesis offers a preliminary attempt to theorise about the role of the EU as an international actor and about the issue of competence distribution between EU and national levels of government, in the policy field of radio spectrum. Nevertheless, this thesis is not without limitations. The reader is encouraged to look at these limitations not as fallacies of the present work, but as opportunities for future research. Such opportunities are outlined in the following paragraph.

6.2. Opportunities for future research

This research work may have raised more questions than it has answered. Nevertheless, the hope is that the reader's expectations have been fairly met. An additional hope is that the role of the EU in radio spectrum regulation will be more systematically studied in the future. In this regard, some opportunities for future research are pinpointed in this paragraph, to deepen the analysis of the EU's influence on the three-level regulatory context of radio spectrum.

The EU participation in the ITU still needs to be thoroughly assessed. Although this thesis claims that the EU influences the WRC decision-making process, a sound justification of such claim is lacking. In other words, this thesis fails to measure the magnitude of the EU's influence and, consequently, the significance of the EU as an international actor. In this regard, a more systematic evaluation of the EU's actorness (Bretherton & Vogler, 2006) is to be conducted in order to capture the relevance of the EU's influence for the international regulatory level of radio spectrum. EU actorness can be intended as the capability of the EU to act in international settings (Bretherton & Vogler, 2006) actively and deliberately participating in multilateral negotiations with other actors (Greiçevci, 2011). Literature on EU actorness in international institutions may offer the necessary theoretical tools whereby measure the external influence exercised by the EU. For instance, Bretherton & Vogler (2006) elaborate on three indicators for identifying EU actorness in international relations. These indicators are: opportunity, presence and capability. Opportunity refers to factors in the external environment, which might enable or constrain the EU's ability to take action; presence refers to the influence that the EU might exert as a direct consequence of its existence; while capability refers to factors internal to the EU context, which might enable or constrain the EU's ability to take action. According to Bretherton & Vogler (2006), combinations of exogenous opportunities and endogenous resources determine EU actorness, i.e. the EU ability of act at international level. Similarly, the model proposed by Jupille & Caporaso (1998) includes four dimensions of EU external actorness: cohesion, authority, autonomy and recognition; upon which Groenleer & Schaik (2007) add considerations about informal practices which might influence the capability of the EU to exert its influence. Cohesion refers to the capability of the EU to formulate its own preferences; authority refers to whether the EU has the competence to act in a certain policy area; autonomy indicates the existence of the EU as an actor on its own right, separate from the EU member states; recognition is about the acceptance of the EU's role as an international actor by the other actors active in the international arena. In addition to this theory-guided investigation, further empirical research is needed to demonstrate the capability of the EU to actively and deliberately participate in international negotiations (Groenleer & Schaik, 2007). In this regard, greater awareness of the EU participation in the ITU might be gained by assessing the phenomenon of EU actorness in different international contexts. More specifically, a comparative study (Bryman & Bell, 2011) may be set up to look at the EU as an international actor in two international organisations: the ITU and the Universal Postal Union (UPU). ITU and UPU present a number of

similarities which would guarantee a consistent comparison (Flick, 2009; Bryman & Bell, 2011). In fact, both organisations are UN specialised agencies where the EU is granted observer status. Both ITU and UPU are responsible for periodically reviewing and revising international regulations for radio spectrum and postal services, respectively. In addition, both radio spectrum policy and postal policy are relevant with respect to the EU's overall policy objective to complete the EU internal market (Directive 2008/6/EC).

Similarly, a comparative study could be built to better understand whether and to what extent the EU influences the regional regulatory level of radio spectrum. In fact, the EU interacts with both European organisations active in the respective telecommunications and postal sectors, such as the CEPT and the European Committee for Postal Regulation (CERP). Therefore, such comparison may contribute to assess the degree of *regional* actorness of the EU. Literature on EU actorness may also help explain the EU actor capacity on a regional level identifying exogenous factors which may enable or constrain the EU ability to take action with respect to the other regional organisations active in the three ITU regions. In addition, the issue of competence distribution between EU and EU member states is to be taken further in order to comprehensively assess the role of the EU as a regional actor.

Studies on the issue of competence distribution in other policy fields might bring useful insights for evaluating costs and benefits of centralisation and decentralisation of legislative power in the policy field of radio spectrum. In turn, such evaluation would contribute to identify endogenous elements of the EU system which would promote or preclude EU regional actorness in radio spectrum regulation. Overall, the authority dimension of EU external actorness depends on the extent of legislative competence transferred from national to EU institutions (Gehring et al., 2013). Other elements of EU external actorness, such as autonomy and recognition, may be evaluated by examining the issue of competence distribution from the perspective of the EU member states. More precisely, a multiple case study could be set up to analyse in detail national approaches to radio spectrum. In turn, this analysis may help clarify whether the EU is recognised as a relevant actor in its own right by EU member states and it is able to exercise its influence on the national regulatory level of radio spectrum.

In addition, the degree of EU action capability with respect to the national regulatory level may be better assessed by broadening the scope of the analysis to include the perspectives of the subjects regulated, such as the mobile service operators. Their view on the issue of competence distribution between EU and EU member states may help understand whether the EU has actually gained control or it is expected to gain control over essential aspects of radio spectrum assignment or whether radio spectrum assignment is exclusively seen as a national responsibility.

The three-level regulatory context of radio spectrum has been so far neglected by political science research. In particular, no systematic research has been conducted to assess the influence that the EU exercises on radio spectrum regulation. The increasing importance of radio spectrum use for the future of mobile communications services has unveiled an interesting and stimulating field of research, which offers a wide variety of opportunities to expand existing knowledge, contributing to the conceptualisation of the EU as an actor on its own right and opening up door for more efficient ways to regulate the radio spectrum.

List of references

- 5G Manifesto for timely deployment of 5G in Europe (2016). Retrieved January 10, 2017, from <https://ec.europa.eu/digital-single-market/en/news/commissioner-oettinger-welcomes-5g-manifesto>.
- AGCOM (2016, April), Al via consultazione pubblica su modalità di accesso condiviso allo spettro (LSA), Press Release. Retrieved January 10, 2017, from <https://www.agcom.it/-/consultazione-pubblica-concernente-l-accesso-condiviso-allo-spettro-in-modalita-licensed-shared-access-lsa-per-sistemi-terrestri-di-comunicazioni-elet>.
- Alesina, A.; Nicoletti, G. & Schiantarelli, F. (2005), Regulation and Investment, *Journal of the European Economic Association*, 3(4), 791-825.
- Ambec, S; Coheny, M. A.; Elgiez, S. & Lanoie, P. (2013), The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?, *Review of Environmental Economics and Policy*, 7(1), 2–22. DOI: 10.1093/reep/res016.
- Andreatta, F. (2011), The European Union’s International Relations: A Theoretical View, in Hill, C. & Smith, M. (eds.), *International Relations and the European Union*, Oxford: Oxford University Press, pp. 21-43.
- Ansip, A. (2016), Connectivity, radio spectrum and the Digital Single Market: preparing for the future, Blog post. Retrieved January 10, 2017, from http://ec.europa.eu/commission/2014-2019/ansip/blog/connectivity-radio-spectrum-and-digital-single-market-preparing-future_en.
- Bache, I. (1998), *The Politics of European Union Regional Policy. Multi-Level Governance or Flexible Gatekeeping?*, UACES/Sheffield Academic Press.
- Bailey, E. E. (1974), Innovation and Regulation, *Journal of Public Economics*, 3(3), 285-295.
- Bardhan, P. (2002), Decentralization of Governance and Development, *Journal of Economic Perspectives*, (16)4, 185-205.
- Bauer, J. M. (2002, September), A comparative Analysis of Spectrum Management Regimes. Paper presented at the 30th Research Conference on Communication, Information and Internet Policy, Alexandria, VA, USA, 28-30.
- Bauer, J. M. (2010), Regulation, public policy, and investment in communications infrastructure, *Telecommunications Policy* 34(1-2): 65-79. <http://dx.doi.org/10.1016/j.telpol.2009.11.011>.
- Bauer, J. M. & Bohlin, E. (2008), Form static to dynamic regulation. *Recent Developments in US Telecommunications Policy*, *Intereconomics*, 43(1), 38-50.
- Bauer, J. M. & Shim, W. (2012, July), Regulation and digital innovation: Theory and evidence. Paper presented at the 23rd European Regional Conference of the International Telecommunication Society, Vienna, Austria.
- Baumgartner, F. R. (2010), Interest Groups and Agendas, in Maisel, S.; Berry, J. M. & Edwards II, G. C. (eds.), *The Oxford Handbook of American Political Parties and Interest Groups*, Oxford: Oxford University Press, pp.676-695. 10.1093/oxfordhb/9780199542628.003.0027.
- Baumgartner, F. R.; Jones. B. D. & Mortensen, P. B. (2014), Punctuated Equilibrium Theory: Explaining Stability and Change in Public Policymaking, in Sabatier. P. A. (ed.), *Theories of the Policy Process*, 2nd edition, Boulder, CO: Westview Press, pp. 155-187.
- Benz, A. & Zimmer, C. (2010), The EU’s competences: The “vertical” perspective on the multilevel system, *Living Reviews in European Governance*, 5(1), 1-31.

- Bijl de, P. W. L. & Peitz, M. (2004), Dynamic regulation and entry in telecommunications markets: A policy framework, *Information Economics and Policy*, 16(3), 411–437. DOI: <http://dx.doi.org/10.1016/j.infoecopol.2004.01.008>.
- Birkland, T. A. (2006), *An Introduction to the Policy Process: Theories, Concepts, and Models of Public Policy Making*, 3rd edition, London: Routledge.
- Birkland, T. A. (2007), Agenda Setting in Public Policy, in Fisher, F.; Miller, G. J. & Sidney, M. S. (eds.), *Handbook of Public Policy Analysis. Theory, Politics, and Methods*, Boca Raton, FL: CRC Press, Taylor & Francis Group, pp. 63-68.
- Black, J. (2001), Decentring regulation: understanding the role of regulation and self-regulation in a "post-regulatory" world, *Current Legal Problems*, 54(1), 103-146.
- Blaug, M. (2001), Is Competition Such a Good Thing? Static Efficiency versus Dynamic Efficiency, *Review of Industrial Organization*, 19(1), 37–48.
- Blind, K. (2012), *The Impact of Regulation on Innovation*, Nesta Working Paper No. 12/02.
- Bourreau, M., & Doğan, P. (2001), Innovation and Regulation in the Telecommunications Industry, *Telecommunications Policy*, 25(3), 167-184.
- Box, G. E. P. (1976), Science and Statistics, *Journal of the American Statistical Association*, 71(356), 791-799.
- Brantner, F. & Gowan, R. (2009), Complex Engagement: the EU and the UN system, in Jørgensen, K. E. (ed.), *The European Union and International Organisations*, London: Routledge, pp. 37-60.
- Bretherton, C. & Vogler, J. (2006), *The European Union as a Global Actor*, 2nd edition, London: Routledge.
- Bryman, A. & Bell, E. (2011), *Business Research Methods*, 3rd edition, Oxford: Oxford University Press.
- Bunel, A. & Lescop, D. (2012, November), Shared Access, Cognitive Radio and Transition Issues. Paper presented at the 19th Biennial Conference of the International Telecommunication Society, Bangkok, Thailand.
- Buonanno, L. & Nugent, N. (2013), *Policies and Policy Processes of the European Union*, New York: Palgrave Macmillan.
- Burchill, S.; Linklater, A.; Devetak, R.; Donnelly, J.; Paterson, M.; Reus-Smit, C. & True, J. (2005), *Theories of International Relations*, 3rd edition, New York: Palgrave Macmillan.
- Campbell, A.; Kunisch, S. & Müller-Stewens, G. (2011), To centralize or not to centralize?, *McKinsey Quarterly*.
- Cave, M. (2002), *Review of Radio Spectrum Management. An independent review for Department of Trade and Industry and HM Treasury*.
- Cave, M.; Doyle, C. & Webb, W. (2007), *Essentials of Modern Spectrum Management*, Cambridge: Cambridge University Press. DOI: <https://doi.org/10.1017/CBO9780511536724>.
- Cave, M. & Webb, W. (2015), *Spectrum Management. Using the Airwaves for Maximum Social and Economic Benefit*, Cambridge: Cambridge University Press.
- CEPT (2009), *CEPT Rules of Procedure*.
- CEPT (2014a, June), Trends and principles in spectrum management. PowerPoint presentation at CEPT Workshop on European Spectrum Management and Numbering. Retrieved January 10, 2017, from http://www.cept.org/files/1051/Workshops/CEPT%20workshop%20june%202014/3-2-Trends_principles_examples_spectrum%20management.pptx.
- CEPT (2014b), *ECC Report 205 Licensed Shared Access (LSA)*.

- Chalmers, D.; Davies, G. & Monti, G. (2010), *European Union Law*, second edition, Cambridge: Cambridge University Press.
- Christiansen, T. & Dobbels, M. (2013), *Delegated Powers and Inter-Institutional Relations in the EU after Lisbon: A Normative Assessment*, *Journal of West European politics*, (36)6, 1159-1177.
- Cobb, R. W. & Edler, C. D. (1972), *Participation in American Politics: The Dynamics of Agenda Building*, Boston: Allyn and Bacon.
- COM(2010) 471, *Accompanying document to the Proposal for a Decision of the European Parliament and of the Council establishing the first radio spectrum policy programme.*
- COM(2012) 478, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Promoting the shared use of radio spectrum resources in the internal market.*
- COM(2013) 627, *Proposal for a Regulation of the European Parliament and of the Council laying down measures concerning the European single market for electronic communications and to achieve a Connected Continent, and amending Directives 2002/20/EC, 2002/21/EC and 2002/22/EC and Regulations (EC) No 1211/2009 and (EU) No 531/2012.*
- COM(2015) 234, *Commission proposal for a Council Decision on the position to be adopted, on behalf of the European Union, in the International Telecommunication Union (ITU) World Radiocommunication Conference 2015 (WRC- 15).*
- COM(2015) 192, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A Digital Single Market Strategy for Europe.*
- COM(2016) 588, *Communication for the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 5G for Europe: An Action Plan.*
- COM(2016) 590, *Proposal for a Directive of the European Parliament and of the Council establishing the European Electronic Communications Code.*
- ComReg (2016), *Radio Spectrum Management Strategy 2016 to 2018*, Commission for Communications Regulation, Ireland.
- Council of the EU (2015), *Council Conclusions on the World Radiocommunication Conference 2015 (WRC-15) of the International Telecommunication Union (ITU)*, No. 13460/15.
- Croom, S. (2009), *Introduction to Research Methodology in* Karlsson, C. (ed.) *Operations Management in Researching Operations Management*, London: Routledge, pp. 42-83.
- Demsetz, H. (2011), *The Problem of Social Cost: What Problem? A Critique of the Reasoning of A.C. Pigou and R.H. Coase*, *Review of Law & Economics*, 7(1), 1-13.
- Ehrlich, E. M.; Eisenach, J. A. & Leighton, W. A. (2010), *The Impact of Regulation on Innovation and Choice in Wireless Communications*, *Review of Network Economics*, 9(1), 1-49.
- Coase, R. H. (1959), *The Federal Communications Commission*, *The Journal of Law and Economics*, 2, 1-40.
- Coase, R. H. (1960), *The Problem of Social Cost*, *The Journal of Law and Economics*, 3, 1-44.
- Commission Decision 2002/622/EC of 26 July 2002 establishing a Radio Spectrum Policy Group.
- Commission Decision 2009/978/EU of 16 December 2009 amending Decision 2002/622/EC establishing a Radio Spectrum Policy Group.

- Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, (Radio Spectrum Decision), Official Journal of the European Communities.
- Decision 243/2012/EU of the European Parliament and of the Council of the EU of 14 March 2012 establishing a multiannual radio spectrum policy programme.
- Deloitte (2016), Addressing the challenges of decentralisation, Third Party Governance and Risk Management.
- Denzin, N. K. (1978). *The research act: A theoretical introduction to sociological methods*, New York: McGraw-Hill.
- Directive 2008/6/EC of the European Parliament and of the Council of 20 February 2008 amending Directive 97/67/EC with regard to the full accomplishment of the internal market of Community postal services.
- Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009 amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorisation of electronic communications networks and services.
- Dixon, H. (2014, October), *Unlocking Europe's capital markets union*, Centre for European Reform, London.
- EC (2013), *How the European Union Works, Your Guide to the European Institutions*, Luxembourg: Publications Office of the European Union. DOI: 10.2775/87270.
- EC (2014), *EU countries are dismantling barriers to the European Single Market*, Press Release. Retrieved January 10, 2017, from http://europa.eu/rapid/press-release_IP-14-844_en.htm.
- EC (2016a), *Digital Single Market. Bringing down barriers to unlock online opportunities*. Retrieved January 10, 2017, from https://ec.europa.eu/priorities/digital-single-market_en.
- EC (2016b), *Commissioner Oettinger welcomes 5G Manifesto*, European Commission's website, Retrieved January 10, 2017, from <https://ec.europa.eu/digital-single-market/en/news/commissioner-oettinger-welcomes-5g-manifesto>.
- El-Moghazi, M.; Whalley, J. & Irvine, J. (2014), *European influence in ITU-R: The end of an era of dominance?*, *Info*, 16(4), 1-17.
- El-Moghazi, M.; Whalley, J. & Irvine, J. (2016), *The 700 MHz Mobile Allocation in Africa: Observations from the Battlefield*, *Australian Journal of Telecommunications and the Digital Economy*, 4(3), 8-20. DOI: <http://doi.org/10.18080/ajtde.v4n3.56>.
- EP (2016), *Sources and Scope of European Union Law, Fact Sheets on the European Union*. Retrieved January 10, 2017, from http://www.europarl.europa.eu/ftu/pdf/en/FTU_1.2.1.pdf.
- ETSI (2013), *Electromagnetic compatibility and Radio Spectrum Matters (ERM); System Reference Document (SRdoc); Mobile broadband services in the 2300 MHz-2400 MHz frequency band under Licensed Shared Access regime*, Technical Report No. 103 113 V.1.1.1.
- EU (2007), *Treaty of Lisbon, amending the Treaty of the European Union and the Treaty Establishing the European Community*, Official Journal of the EU, Volume 50.
- EU (2012), *Consolidated version of the Treaty on European Union and the Treaty on the Functioning of the European Union*, Official Journal of the European Union, Volume 55.
- EU (2016a), *EU institutions and other bodies*. Retrieved January 10, 2017, from https://europa.eu/european-union/about-eu/institutions-bodies_en.
- EU (2016b), *EU law*. Retrieved January 10, 2017, from https://europa.eu/european-union/law_en.

- Falkner, R. (2003), Private environmental governance and international relations: exploring the links, *Global Environmental Politics*, 3(2), 72-87.
- Faulhaber, G. R. & Farber D. (2002), *Spectrum Management: Property rights, Markets, and the Commons*, Working Paper 02-12, ICT Regulation Toolkit. Retrieved January 10, 2017, from <http://www.ictregulationtoolkit.org/en/toolkit/docs/Document/3629>.
- FCC (2016), FCC Adopts Rules to Facilitate Next Generation Wireless Technologies, News Release and Report and Order. Retrieved January 10, 2017, from <https://www.fcc.gov/document/fcc-adopts-rules-facilitate-next-generation-wireless-technologies>.
- Flick, U. (2009), *An Introduction to Qualitative Research*, 4th edition, London: Sage Publications.
- Gann, D. M.; Wang, Y. & Hawkins, R. (1998), Do regulations encourage innovation? - the case of energy efficiency in housing, *Building Research and Information*, 26(5), 280-296. DOI: 10.1080/096132198369760.
- Gehring, T.; Obertür, S. & Mühleck, M. (2013), European Union Actorness in International Institutions: Why the EU is Recognized as an Actor in Some International Institutions, but Not in Others, *Journal of Common Market Studies*, 51(5), 849–865.
- Gerard, D. & Lave, L. B. (2005), Implementing technology-forcing policies: the 1970 Clean Air Act Amendments and the introduction of advanced automotive emissions controls in the United States, *Technological Forecasting and Social Change*, (72)7, 761-778.
- Golafshani, N. (2003), Understanding Reliability and Validity in Qualitative Research, *The Quality Report*, 8(4), 597-606.
- Greenhalgh, T. & Peacock, G. (2005), Effectiveness and efficiency of search methods in systematic reviews of complex evidence: audit of primary sources, *BMJ*, 331, 1064-1065. DOI: <http://dx.doi.org/10.1136/bmj.38636.593461.68>.
- Greiçevci, L. (2011), EU Actorness in International Affairs: The Case of EULEX Mission in Kosovo, *Perspectives on European Politics and Society*, 12(3), 283–303.
- Grether, H. (2008), Agriculture policy: What Roles for the EU and the Member States?, in Gelauff, G.; Grilo, I and Lejour, A. (eds.), *Subsidiarity and Economic Reform in Europe*, Berlin/Heidelberg: Springer, pp. 191-218.
- Groenleer, M. L. P. & Schaik van, L. G. (2007), United We stand? The European Union's International Actorness in the Cases of the International Criminal Court and the Kyoto Protocol, *Journal of Common Market Studies*, 45(5), 969–998.
- GSMA (2013), *Licensed Shared Access (LSA) and Authorised Shared Access (ASA)*, GSMA Public Policy Position.
- Gupta, D. K. (2011), *Analyzing Public Policy. Concepts, Tools and Techniques*, 2nd edition, Washington, D.C.: CQ Press.
- Haas, Ernst B. (1958), *The Uniting of Europe: Political, Social and Economic Forces, 1950-1957*, Stanford: Stanford University Press.
- Haas, Ernst B. (1961), International Integration: the European and the Universal Process, *International Organization*, 15(3), 366-392.
- Halldórsson, Á., & Aastrup, J. (2003), Quality Criteria for Qualitative Inquiries in Logistics, *European Journal of Operational Research*, 144(2), 321-332.
- Hooghe, L. & Marks, G. (2001), Types of Multi-Level Governance, *European Integration online Papers (EIoP)*, 5(11), 1-24.

- Heidbreder, E. G. (2014), Why widening makes deepening: unintended policy extension through policy expansion, *Journal of European Public Policy*, 21(5), 746–760.
- Henke, K.-D. (2006), Managing subsidiarity from an economic point of view: soft co-ordination and hard rules in European economic policy, *Intereconomics*, (41)5, 240-245. DOI: 10.1007/s10272-006-0194-3.
- Henkel, C. (2002), The Allocation of Powers in the European Union: A Closer Look at the Principle of Subsidiarity, *Berkeley Journal of International Law*, 20(2), 358-386.
- Hoffman, S. (1966), Obstinate or Obsolete? The Fate of the Nation-State and the Case of Western Europe, *Daedalus*, 95(3), 862-915.
- ICN UCWG (2007, May), the Objectives of Unilateral Conduct Laws, Assessment of Dominance/Substantial Market Power, and State-Created Monopolies. Report for the 6th Annual Conference of the ICN, Moscow, Russia.
- ITU (2012a), Radio Regulations.
- ITU (2012b), Economic Aspects of Spectrum Management, Report ITU-R SM. 2012-1.
- ITU (2015a), IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond, Recommendation No. ITU-R M.2083-0.
- ITU (2015b), Technology trends of active services in the frequency range 275-3000 GHz, Report No. SM.2352-0.
- Jackson, R. & Sørensen, G. (2016) Introduction to International Relations. Theories and Approaches, 6th edition, Oxford: Oxford University Press.
- Jalali, S. & Wohlin, C. (2012), Systematic Literature Studies: Database Searches vs. Backward Snowballing, *Proceedings of the ACM-IEEE international symposium on ESEM*, pp. 29-38.
- Jupille, J. & Caporaso, A. (1998), States, Agency, and Rules: The European Union in Global Environmental Politics, in Rhodes, C. (ed.), *The European Union in the World Community*, Boulder: Lynne Rienner Publishers.
- Jørgensen, K. E.; Oberthür, S. & Shahin, J. (2011), Introduction: Assessing the EU's Performance in International Institutions – Conceptual Framework and Core Findings, *Journal of European Integration*, 33(6), 599-620.
- Kathuria, V. (2015), A conceptual framework to identify dynamic efficiency, *European Competition Journal*, 11(2-3), 319-339.
- Khun-Jush, J.; Bender, P.; Deschamps, B. & Gundlach, M. (2012, December), Licensed shared access as complementary approach to meet spectrum demands: Benefits for next generation cellular systems. Paper presented at ETSI Workshop Reconfigurable Radio Systems, Cannes, France.
- Koremenos, B., Lipson, C. & Snidal, D. (2001), The Rational Design of International Institutions, *International Organization*, (55)4, 761-799.
- Kulovesi, K.; Morgera, E. & Muñoz M. (2011), Environmental Integration and Multi-Faceted International Dimensions of EU law: Unpacking the EU's 2009 Climate and Energy Package, *Common Market Law Review*, 48, 829-891.
- Lane, K.; Brocklehurst, F.; Siderius, H-P & Ellis, M. (2013), The role of technology-forcing standards and innovation to dramatically accelerate product energy efficiency, *ECEEE Summer Study Proceedings*, pp. 2017-227.
- Leben, C. (1998), Hans Kelsen and the Advancement of International Law, *European Journal of International Law*, 9, 287-305.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*, London: Sage Publications.

- Lindberg, L. N. & Scheingold, S. A. (1970), *Europe's would-be polity: patterns of change in the European community*, Englewood Cliffs, N.J.: Prentice-Hall.
- Livingston, S. G. (1992), *The Politics of International Agenda-Setting: Reagan and North-South Relations*, *International Studies Quarterly*, 36(3), 313-329.
- Maxwell, J. A. (2013), *Qualitative Research Design. An Interactive Approach*, 3rd edition, London: Sage Publications.
- McLean Foster & Co. in collaboration Cave, M. & Jones, R. W. (2007), *Radio Spectrum Management, Module 5, Executive Summary, ICT Regulation Toolkit*.
- Melody, W. H. & Lemstra, W. (2011), *Liberalization in radio spectrum management in Finger, M. and Kunneke, R. W., International handbook of Network Industries. The liberalization of Infrastructure, Cheltenham UK and Northampton, MA, USA: Edward Elgar*, pp. 123-143.
- Menon, A. (2011), *European Defence Policy from Lisbon to Libya*, *Survival*, 53(3), 75-90.
- Milczarek, D. (2013), *Genesis of the United Europe – From the Roman Empire to the European Union*, in Milczarek, D.; Adamczyk, A. and Zajączkowski, K., *Introduction to European Studies: A New Approach to Uniting Europe*, Centre for Europe, University of Warsaw.
- Modelski, G. and Thompson, W. R. (1999), *The Long and the Short of Global Politics in the Twenty-first Century: An Evolutionary Approach*. *International Studies Review*, 1(2), 110–140. DOI: 10.1111/1521-9488.00157.
- Moga, T. L. (2009), *The Contribution of the Neofunctionalist and Intergovernmentalist Theories to the Evolution of the European Integration Process*, *Journal of Alternative Perspectives in the Social Sciences*, 1(3), 796-807.
- Moravcsik, A. (1993), *Preferences and Power in the European Community: A Liberal Intergovernmentalist Approach*, *Journal of Common Market Studies*, 31(4), 473-524.
- Moravcsik, A. (1994), *Why the European Union Strengthens the State: Domestic Politics and International Cooperation*, CES Working Paper No. 52.
- Moravcsik, A. (2005), *The European Constitutional Compromise and the neofunctionalist legacy*, *Journal of European Public Policy*, 12(2), 329-386.
- Motta, M. (2004), *Chapter 2: Monopoly: static and dynamic efficiency*, in *Competition Policy: Theory and Practice*, Cambridge: Cambridge University Press.
- Mueck, M. D.; Srikanteswara, S. and Badic, B. (2015), *Spectrum Sharing: Licensed Shared Access (LSA) and Spectrum Access System (SAS)*, Intel White Paper.
- NASA (2013), *The Electromagnetic Spectrum*, NASA website, Retrieved January 10, 2017, from <https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html>.
- Nentjes, A; Vriese de, P. & Wiersmab, D. (2007), *Technology-forcing through environmental regulation*, *European Journal of Political Economy* 23(4), 903-916.
- Noam, E. M. (2003), *The Third Way for Spectrum*, *Financial Times*, Retrieved January 10, 2017, from http://msl1.mit.edu/ESD10/docs/ft_spectrum_policy_e_noam_mar_14_2003.pdf.
- Nugent, N. (2010), *The Government and Politics of the European Union*, 7th edition, New York: Palgrave Macmillan.
- OECD (1996), *Regulatory Reform and Innovation*, Report.

- Palola, M.; Matinmikko, M.; Prokkola, J.; Mustonen, M.; Heikkilä, M.; Kippola, T.; Yrjölä, S.; Hartikainen, V.; Tudose, L.; Kivinen, A.; Paavola, J. Heiska, K. (2014, April), Live field trial of Licensed Shared Access (LSA) concept using LTE network in 2.3 GHz band. Paper presented at the 2014 IEEE International Symposium on DYSpan, McLean, VA, USA, pp. 38-47.
- Paradis, J. G. & Zimmerman, M. L. (2002), *The MIT Guide to Science and Engineering Communication*, 2nd edition, Cambridge MA: The MIT Press.
- Parsons, D. W. (1995), *An Introduction to the Theory and Practice of Policy Analysis*, Cheltenham UK and Northampton, MA, USA: Edward Elgar Publishing.
- Patton, M. Q. (2002). *Qualitative Evaluation and Research Methods*, 3rd edition, London: Sage Publications.
- Peha, J. M. (2009), Sharing Spectrum Through Spectrum Policy Reform and Cognitive Radio, *Proceedings of the IEEE*, 97(4), 708-719.
- Pelkmans, J. (2005), Subsidiarity between Law and Economics, *Research Papers in Law No. 2005/1*, Retrieved January 10, 2017, from <https://www.coleurope.eu/research-paper/subsidiarity-between-law-and-economics>.
- Pelkmans J. (2006), Testing for Subsidiarity, BEEP Briefing No. 13.
- Pelkmans, J. & Renda, A. (2014), Does EU regulation hinder or stimulate innovation?, CEPS Special Report No. 96.
- Pigou, A. C. (1920), *The Economics of Welfare*, 4th edition, London: MacMillan & Co.
- Pollack, M. A. (2000), The End of Creeping Competence? EU Policy-Making Since Maastricht, *Journal of Common Market Studies*, 38(3), 519-538.
- Pollack, M. A. (2001), International Relations Theory and European Integration, *Journal of Common Market Studies*, 39(2), 221-244.
- Pollack, M. A. (2005), Theorizing the European Union: International Organization, Domestic Polity, or Experiment in New Governance?, *Annual Review of Political Science*, 8, 357-398. DOI: 10.1146/annurev.polisci.8.082103.104858.
- Porter, M. E. & Linde van der, C. (1995), Toward a New Conception of the Environment-Competitiveness Relationship, *The Journal of Economic Perspectives*, 9(4), 97-118.
- Prieger, J. E. (2002), Innovation, and the Introduction of New Telecommunications Services, *The Review of Economics and Statistics*, 84(4), 704-715.
- Prieger, J. E. (2007), Regulatory Delay and the Timing of Product Innovation, *International Journal of Industrial Organization*, 25(2), 219-236.
- Prieger, J. E. (2008), Product Innovation, Signaling, and Endogenous Regulatory Delay, *Journal of Regulatory Economics*, 34(2), 95-118.
- Plum Consulting (2013), *The economic benefits of LSA in 2.3 GHz in Europe*. Report for Ericsson, NSN and Qualcomm.
- Quigley, N. (2004), *Dynamic Competition in Telecommunications, Implications for Regulatory Policy*, C.D. Howe Institute Commentary No. 194.
- Rosamond, B. (2000), *Theories of European Integration*, New York: Palgrave-Macmillan, New York: Saint Martin's Press.
- Rositer, F. G. (2011, May), *Research Concepts & Skills*, Version 3.0. Retrieved January 10, 2017, from http://www.changes-itn.eu/portals/0/content/2011/poland/research%20skills_concepts.pdf.

- Rosston, G. L & Steinberg, J. S. (1997). Using Market-Based Spectrum Policy to Promote the Public Interest, *Federal Communications Law Journal*, 50(1), 87-110.
- RSPG (2013), Opinion on Licensed Shared Access.
- RSPG (2015), Opinion on Common Policy Objectives for WRC-15.
- Rysavy, P. (2014, March), Challenges and Considerations in Defining Spectrum Efficiency, *Proceedings of the IEEE*, 102(3), 386-392.
- Sarpu, R. K. (2004), *Public Policy: Formulation, Implementation and Evaluation*, Sterling Publishers Private Limited.
- Schaik van, L. G. (2013), *EU effectiveness and unity in multilateral negotiations. More than the sum of its parts?*, New York: Palgrave McMillan.
- Schattschneider, E. E. (1975), *The Semisovereign People: A Realist's View of Democracy in America*, Hinsdale, Ill: Dryden Press.
- Schmitter, P. C. (2004), Neo-neofunctionalism, in Wiener, A., & Diez, T. (eds.) (2004), *European integration theory*, Oxford: Oxford University Press, pp. 45-74.
- Scott, J. (1990), *A Matter of Record: Documentary Sources in Social Research*, Cambridge, England: Polity Press.
- Senn, M. (2005, March), Decentralisation of Economic Law – An Oxymoron. Discussion Paper No. 28, ESRC Centre for Analysis of Risk and Regulation, London School of Economics and Political Science.
- Shahin, J. (2011), The European Union's Performance in the International Telecommunications Union, *Journal of European Integration*, 33(6), 683-698.
- Simon, L. (2012), CSDP, Strategy and Crisis Management: Out of Area or Out of Business?, *The International Spectator*, 47(3), 100-115.
- Smaghi, L. B. (2009), A single EU seat in the International Monetary Fund? In Jørgensen, K. E. (ed.), *The European Union and International Organisations*, London: Routledge, pp. 61-79.
- Stewart, R. B. (1981), Regulation, Innovation, and Administrative Law: A Conceptual Framework, *California Law Review*, (69)5, 1256-1377.
- Stewart, L. A. (2010, June), *The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review*, Information Technology & Innovation Foundation.
- Stratulat, C. & Molino, E. (2011), *Implementing Lisbon: what's new in comitology?* Policy Brief, European Policy Centre, Brussels.
- SWD(2016) 313, Commission Staff Working Document, Evaluation of the regulatory framework for electronic communications. Accompanying the document Proposal for a Directive of the European Parliament and of the Council establishing the European Electronic Communications Code.
- Varwick, J. & Koops, J. (2009), The European Union and NATO: "Shrewd interorganizationalism" in the making?, in Jørgensen, K. E. (ed.), *The European Union and International Organisations*, London: Routledge, pp. 101-130.
- Waele de, H. & Kuipers, J.-J. (2013), The Emerging International Identity of the European Union - Some Preliminary Observations, in Waele de, H. & Kuipers, J.-J. (ed.), *The European Union's Emerging International Identity*, Leiden: Brill/Nijhoff, pp. 1-19. DOI: 10.1163/9789004230996_002.
- Wallace, W. (1994), *Regional Integration: The West European Experience*, Washington, D.C.: Brookings Institution Press.

- Wessel, R. A. (2011), The Legal Framework for the Participation of the European Union in International Institutions, *European Integration*, 33(6), 621-635.
- Werbach, K. & Mehta, A. (2014), The Spectrum Opportunity: Sharing as the Solution to the Wireless Crunch, *International Journal of Communication*, 8, 128-149.
- Wyplosz, C. (2015), The Centralization-Decentralization Issue. Discussion Paper No. 014, European Commission Directorate-General for Economic and Financial Affairs.
- Wohlin, C. (2014), Guidelines for Snowballing in Systematic Literature Studies and a Replication in Software Engineering, *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering (EASE)*, pp. 1-10.
- Wunderlich, J.-U. & Bailey, D. (eds.) (2011), *The European Union and Global Governance. A Handbook*, London: Routledge.
- Yang, A.; Lee, D.; Hwang, J. & Shin, J. (2013), The Influence of regulations on the efficiency of telecommunications operators: A meta-frontier analysis, *Telecommunications Policy*, 37(11), 1071–1082.