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Innovation in European telecommunication regulation: The diffusion of regulatory remedies

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October 2014

Abstract

Regulation of traditional narrow- and broadband networks remains a key issue in telecommunication policies. Due to the vertical structure of telecommunication markets and to promote investment, regulatory policies in many European Member States focus on wholesale obligations (so-called remedies) which mandate incumbent operators to share sell or split their infrastructure. On the European level, such remedies were introduced with regularity (e.g. "Local Loop Unbundling" in 2000). Interestingly, in most cases the obligations were before implemented and tested at the national level. This paper analyses the process of diffusion of different regulatory means across European Member States and presents respective factors of influence on the event of (non-)adoption by the NRAs. Using a panel of European countries for a time period of 17 years, we find different patterns for different regulatory policies and in particular an effect of current state of broadband penetration levels.

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1. Introduction

The diffusion of policies between countries has been studied intensively in the political science literature (see e.g. Dobbin et al 2007, Gilardi 2012, Graham et al 2013). By including the idea of multi-level systems, as the European Union, lower level governmental institutions have the potential to operate as policy laboratories, experimenting with new ideas, abandoning failures and exporting success to other jurisdictions (McVoy 1940). A vital element of the diffusion of policies across borders is the ability of policymakers to learn from others' experience and to adapt policies to meet different circumstances at home. However, whether and how governmental institutions learn from the actions of others depends on various factors (see e.g. Shipan and Volden 2014). The idea of innovative policy diffusion has also been adopted in European telecommunication literature. Scholars focused on the diffusion of mobile telecommunication services (Gruber and Verboven 2000), specific issues, such as the spread of the internet (Kiiski and Pohjola 2002), the expansion of privatization and liberalization of infrastructure (Fink 2011) or the diffusion of a regulatory Standard Cost Model across Europe (Coletti 2013).

However, the diffusion of regulatory wholesale remedies across Europe has been widely ignored by academic literature, despite the ongoing importance of these obligations in regulatory practice. To fill this gap, we perform a panel analysis of four crucial regulatory concepts, introduced between 1998 and 2013 (namely "local loop unbundling", "line-sharing", "bitstream access" and "wholesale line rental"). Further we analyze the diffusion of the concept of "Long-run Incremental costs", which is a cost accounting system for wholesale charges. Therefore, we use a newly collected dataset (Data provided by Cullen International), complemented by other databases (such as the ITU database and an own small survey, where we addressed national regulatory authorities). We also consider vital European (hard and soft) law publications.

The rest of the paper is organized as follows. In Section 2, we give some background information on the economic theory of federalism and the role of the national regulators in EU telecommunications. In the following section 3 we present the regulatory means which are included in our analysis more in detail. In Section 4we identify diffusion processes for the obligations across countries and time. In the subsequent section 5, we outline our empirical model, which is used for our empirical analysis (section 6). Section 7 concludes.

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2. Laboratory federalism, rationales for policy diffusion and the role of national regulators

The concept of "laboratory federalism" is typically designated to a situation, where decentralized jurisdictions experiment with different approaches to solve a similar problem. Underlying idea is the lack of sufficient knowledge about optimal public policies (Hayek 1996). Given technological, social and industrial change in a jurisdiction or a sector engraves this lack and permanently amends existing challenges for public policy decision makers. Oates (1972, 1999) found the concept of laboratory federalism and the possibility to learn from others success and failures to be a crucial characteristic of federal systems. The given interdependence of jurisdictions is also reflected in the concept of policy diffusion, which Gilardi 2012 defines as the "process whereby policy choices in one unit are influenced by policy choices in other units".

In literature, two main underlying reasons for the spread of policies are indicated: competition and learning.¹ Inter-jurisdictional competition finds application where jurisdictions aim to attract firms or inhabitants by implicating a superior policy.² In the classical Tibout (1959) model of fiscal competition, citizens reveal their preferences for local public goods by moving around localities that offer different combinations of taxation and public goods. A translation of the argument to general regulatory policies has been done by Easterbrook (1983). In most network industries, capital is sunk and therewith mostly immobile. The regulated industries capital will therefore not move in reaction to bad regulatory policies.³ In terms of regulatory wholesale obligations, the so-called *yardstick* competition between jurisdictions is particular relevant. For this type of competition only information must be mobile between jurisdictions. Through parallel processes of experimentation with different (regulatory) policies in various member states, overall knowledge about public policies through mutual learning processes may be increased (Kollman et al 2000, v. d. Bergh 2000, Kerber and Eckardt 2007). Learning is therefore the process through which policy makers seek to formulate effective policies to solve a problem by adopting already tested policies. When a policy is effective and others learn about its success (or failure), diffusion naturally follows (Volden 2006) or not.

¹ Authors, in particular in political sciences also consider coercion and socialization as causes (e.g. Graham et al 2013). These will not find consideration in our article.

² Information on inter-jurisdictional competition including innovation and diffusion of public policies can be found in Vanberg and Kerber 1994.

³However, other businesses (related to the regulated firms) and individuals may move as a result of an environment of bad performance of the regulated sector caused by inefficient regulation (Trillas 2010:4).

In economics, evolutionary approaches focus on dynamic learning processes, adaptive behavior and an ongoing search for improvements by finding superior technologies or policies. The policy maker is engaged in imitative policymaking, seeking for improvements in its current setting. The first application of a newly invented policy is seen as policy innovation, which is followed by an adoption or non-adoption process with an experimental character.⁴ A practical example for such a policy imitation and learning process in the European sector of telecommunication is the mean of functional separation of incumbent wire-line telecommunication broadband networks. After the United Kingdom introduced such a concept in 2005, the European Commission took this example to discuss a possible adoption of related models in the rest of Europe.

However, from a federal perspective the national regulatory authorities (in short: NRAs), responsible for the regulation of national telecommunication markets have most potential to function as decentral policy laboratories. The European Commission obligated the Member States to create independent regulatory authorities in the telecommunication sector in 1990.⁵ Their establishment followed in the period 1996 until 1998.⁶ The national regulators were installed as decentral institutions to implement European legislation on the national level in a unified approach but under consideration of their respective market particularities. With the amended Regulatory Framework in 2002, the role of national regulators has been upgraded (Gröbel 2005, Larouche and deVisser 2006). Beside their entrustment with the key role in implementing and enforcing legal specifications, new flexible powers in the areas of market definition, competition tests and the need (or no need) for regulatory interventions were assigned to the NRAs. Since for the latter, the European Commission was not provided with the right to veto a national decision, a particular high level of discretion for the NRAs exists in the designation of regulatory

⁴ An analysis, combining the concept of laboratory federalism with evolutionary economic elements to investigate on the issue of policy learning in Europe can be found in Kerber and Eckhardt 2007.

⁵Recital 29 and Article 7 of Commission Directive 90/388/EEC of June 1990 on competition in the markets for telecommunications services; Article 7 of the Directive 90/388/EEC says: "Member States shall ensure that from 1 July 1991 the grant of operating licenses, the control of type approval and mandatory specifications, the allocation of frequencies and surveillance of usage conditions are carried out by a body independent of the telecommunications organizations (...)"

⁶As there was no obligation on design or character of the new institutions, the Member States often chose strongly varying attempts to fulfil European obligations. The newly created institutions were therefore all very different, reflecting national administrative traditions and the political expedience of the moment (see Sutherland 2008).

obligations on the incumbent firm.⁷ The European framework provided as guidance a "remedies toolbox"⁸, which give some orientation for the choices of national remedy decisions. However, most of the provided options were before introduced and tested on the national level. The factual moment of adoption of a regulatory mean by a regulator may also be influenced by the specific market conditions in a Member State. This will therefore find consideration in the next section and in our empirical analysis.

3. Selected Regulatory means

In contrast to early expectations of liberalization in European telecommunications, local network rollout has been rather disappointing.⁹ Respectively, former monopolistic firms maintain a key position in national local access and fixed telephony markets and the mandatory access to traditional narrow- and broadband networks on the wholesale level remains an important issue in telecommunication policies. It is important to consider, that National Regulatory Authorities are not per-se obligated to impose specific obligations on the market-dominant firm. Rather, the regulators on the national level face the challenge to choose the remedies, which fit best to their respective market situation. However, for some access types a European binding obligation exists from a certain point on.

We include five key wholesale remedies in our analysis: full local loop unbundling (LLU), linesharing (LS), bitstream access (BSA) and wholesale line rental (WLR). All five types of wholesale access products allow entrants without owning a local network to reach final customers. In such a service-based competition, the entrant relies on the facilities or the services of the incumbent to provide Digital Subscriber Lines (DSL) services.¹⁰The fundamental differences between the five wholesale obligations are the varying levels of investment, control and flexibility of the competitor to offer services. Considering the need for different input products for heterogeneous business models for various phases of market entry, a thoughtful regulatory choice of wholesale obligations is essential. A central input for the national regulatory agency, when deciding on the introduction of a new wholesale

⁷If market power is found, the regulator has the choice between different instruments, which were applicable according to the heaviness of a found competition problem. See Article 16 (4) framework directive 2002, Article 8 Access Directive. This flexibility in remedy choice is still a central leeway for NRAs in the current framework 2009.

⁸Article 9-13 Framework Directive and Article 17-19 Universal Service Directive.

⁹ See de Bijl and Peitz (2005).

¹⁰With DSL, copper loops are upgraded to support high-speed data access; see Bourreau and Dogan (2004) for a more detailed explanation.

remedy, is naturally the domestic market situation. Same countries in our data set show particular high shares of DSL connections and high household broadband penetration rates (i.e. France, Sweden and the UK). In accordance with the ladder of investment approach¹¹, resale and bitstream access wholesale products were relatively early introduced in these countries (see also Winter 2008).

Since it is often central *how* these remedies are implemented by the regulator, the respective design matters. Here, too, the spreading of certain concepts across the EU Member States is observable. A good example is the concept of Long Run Incremental Cost, which has been adopted by a few Member State in 1998 and spread afterwards across other jurisdictions. In the following, the regulatory means, which we include in our analysis, will be presented in more detail.

To offer voice services, competitors to traditional incumbents needed for a long time the mean of full **local loop unbundling**¹² to obtain full control of the copper pair.¹³Local loop unbundling occurs when the incumbent rents access to its physical copper lines to new entrants. This implicates that entrants have to build a core network down to the local exchange of the incumbent, and to install their own broadband equipment.¹⁴ This gives entrants more control over the types and quality of services, they provide to the end-users. local loop unbundling has been fostered by the European Institutions with the Regulation on unbundled access to the local loop dated 5 December 2000.¹⁵ The Regulation set out the obligation for incumbent operators to provide the other operators with physical access to the connection between the final customer and the main local exchange until 21 December 2000.¹⁶ Apparently, the European Regulation speeded up the adoption of local loop unbundling by the National Regulators. According to our data, Finland was in 1996 the first

¹¹In European telecommunications national regulators widely adopted a regulatory approach, which includes the idea of a "ladder of investment", as proposed by Cave (2006). The concept of a ladder should reflect the idea that entrants acquire, as a first "rung", access to the incumbents` infrastructure at a level which typically requires little investment to provide a service (e.g. resale) and are supposed to climb this ladder henceforth, motivated by increasing prices for the climbed rungs.

¹² LLU comes in two types. With "full" unbundling, entrants rent the copper line as a whole, whereas "shared" unbundling includes only the rent of the upper bandwidth of a line. Since we are only interested in the first introduction of a remedy, we ignore the option of "shared" unbundling in our analyses.

¹³ Due to technological progress, other ways developed to enable voice services, see de Bijl and Peitz 2005: 34).

¹⁴ This is the installation of a Digital Subscriber Line Access Multiplexers (in short: DSLAM) in the incumbent's local exchanges; see Bacache et al. (2013:4f).

¹⁵ Regulation of the European Parliament and of the Council on unbundled access to the local loop, 2000/0185, preceded by EC Recommendation 2000/417/EC, dated 25 May 2000.

¹⁶ For more details see Gallo and Pontarollo (2005:12f).

Member State Regulator, who introduced the mean. All other countries quickly followed up and introduced full unbundling until 2001.¹⁷

In contrast, with **bitstream access**, incumbents remain in control and can still provide services to consumers, since the copper pair spectrum is shared by the incumbent and the entrant. Since the incumbent provides ADSL technology and modems, entrants do not have control over the physical line and are not allowed to add other equipment. Therefore, entrants are restricted to supply services designated by the incumbent.¹⁸ In distinction from full unbundling, the provision of bitstream access is not mandated under European law.¹⁹ This leaves the National Regulators with more flexibility about if and when to apply bitstream access obligations on the dominant firm. Therefore, the year of introduction of the mean by the National Regulator differs significantly more than in the case of full unbundling and covers the time period 1999 (introduction date in Spain) until 2006 (introduction date in Greece).

The concept of **line sharing** is another type of unbundling, which is similar to bitstream access. In both cases, the copper pair spectrum is shared by the incumbent and the entrant. However, the difference is with line sharing the incumbent does not provide the ADSL technology and modems. The entrant installs splitters at the incumbent's main distribution frame and connects to the shared local loop. The shared access loops remain therefore connected to the incumbent's network and consumers continue to receive voice services from the incumbent.²⁰ Compared to bitstream access, line sharing is therefore a more capital-intensive access measure. As outlined by Grajek and Röller 2010:13, capital-intensive access measures are typically introduced earlier than less capital-intensive ones. This is also confirmed by our data. Additionally, line sharing has been introduced on the European level by Regulation (EG 2887/2000), which entered into effect in January 2001.

The concept of **wholesale line rental** is also known as "Resale" (Germany), "Resale of Land Line Services" (Denmark) or "Resale of Subscription" (Norway) and enables competitors to

¹⁷ Exception is Switzerland, where LLU and BSA are not regulated ex-ante, but ex-post.

¹⁸ See de Bijl and Peitz (2005:36)

¹⁹ However, in case that an incumbent operator provides bit-stream services to its own services, subsidiarities or third parties, the access product must also be available under transparent and non-discriminatory terms to others, see Directive 98/10/EC, Article 16.

²⁰ De Bijl and Peitz 2005:36.

both line rental and calls to end-users over the incumbent's local network.²¹ Usually, this includes that the final customer is billed by the wholesale line rental provider and has no longer a contractual relationship with the incumbent. The competitor typically buys wholesale line rental in conjunction with other wholesale products, such as carrier preselection (see below). Therewith, the firm is able to produce a single bill for the end user, which covers calls and line rental.²² These one-stop shopping offers lead to a highly complex competitive nature of this remedy. Wholesale line rental is assumed to support particular strongly service-based competition instead of leading to infrastructure-based competition in the longer term.²³Therefore, the national regulator has to conduct careful economic analyses on the competitive impacts of the mean. In some countries therefore, wholesale line rental has never been adopted (for example in Finland applied).Others struggled with its introduction for a long time, as in the case of Austria.

Since 2001 the Austrian Regulator (RTR) and Tele2, a competitor, tried unsuccessfully to negotiate a wholesale line rental offer by A1 (formerly "Telekom Austria"). In November 2004, the request of Tele2 was discussed with RTR, but retired with a negative notification.²⁴However, RTR required A1 Telekom to offer a wholesale line rental product by the market analyses notifications in 2004 and 2007.²⁵ In a later market analysis, notification²⁶ the obligation to make a wholesale line rental offer was replaced by the obligation to offer a voice-over-broadband-wholesale product due to technical progress.²⁷Both notifications have been removed by the Administrative Court in November 2013.

This example of Austria outlines tellingly the legal and bureaucratic and legal complexity of the introduction of wholesale obligation by a National Regulator. This might also have a negative impact on the ability of a National Regulator to function as innovator or early

²¹ Weber (2004) defines WLR as the bundle of services which an incumbent fixed operator offers to his retail subscribers in connection with access to his voice telephony network covered by subscriber's payment of a monthly line rental and which is made available to alternative communication service providers on a wholesale basis.

²² It should be noted, that WLR cannot be considered as direct substitute to BSA or copper access services, since WLR typically offer customers PSTN services and not broadband access, see Bohlin et al. DIW (2005:101).

 ²³Neumann (2004); see also Weber (2004:9f) for economic issues included with the introduction of WLR.
²⁴ https://www.rtr.at/de/tk/W2-02.

²⁵ M 1/03 v. 20.12.2004, https://www.rtr.at/de/tk/M-1-03, M 1/06 v. 2.04.2007, https://www.rtr.at/de/tk/BescheideM1-06.

²⁶ M 1/09 v. 20.09.2010, see https://www.rtr.at/de/tk/M_1_09

²⁷ EU Commission comments critically in, see https://circabc.europa.eu/sd/a/bd717847-afd4-4135-a0f6-f92e3b996d51/AT-2010-1117-1118%20Acte_DE+date%20et%20nr.pdf).

adopter of a new mean. Wholesale line rental has not been covered by the European regulatory framework until 2009. With the new framework, wholesale line rental was outlined as a remedy on the wholesale level.²⁸

For the determination of access prices in a regulatory setting, various costing methodologies are available. Contrary to other cost accounting standards, **Long Run Incremental Costs** or Long Run Average Incremental cost (LRAIC) (if the average costs of one service unit are concerned) include only costs, which are required to provide a certain additional service in the long term. Common costs are not included.²⁹European Legislation includes the cost standard in Recommendation 98/195/EC, where the use of long run average incremental costs for the assessment of cost orientated interconnection tariffs for terminating access is suggested.³⁰

4. Data and diffusion processes

The data we use is two-fold. First, we use a collection of the implementation of the different regulatory means discussed above. The information is gathered by Reports collected by Cullen International, regulatory agencies that have been directly contacted and several Reports and auxiliary sources. The respective source is shown in table 1. Additionally, the introduction date of a wholesale product by a regulator, i.e. by a regulatory decision is provided. It is important to notice, that a mean may have been available in a market before, without the obligation of the authority or may afterwards not find application in a market, for example because there is no demand. Since we are particular interested in the innovative adoption of a regulator, both latter cases do not find consideration in our analysis.

²⁸ According to Article 12 Access Directive.

²⁹ Barth and Heimeshoff (2011); Background information on cost-based concepts, LRIC and additional literature is provided e.g. in Neu and Kulenkampff (2009).

³⁰ Before, in Directive 97/33/EC of the European Parliament and Council, Recital 10 outlines that charges for interconnection should be based on a price "closely linked" to the long-run incremental cost (http://europa.eu.int/abc/off/index_en.htm).

	LLU		BSA		WLR LRIC/LRAIC		LRAIC	LS		
Country	Year	Source	Year	Source	Year	Source	Year	Source	Year	Source
AT	1999	OECD 2005, RTR	2000	RTR	2004	RTR	1998	Cullen	2002	Cullen
BE	2000	BIPT Annual Report (2001)	2000	BIPT	2006	RTR	2007	Cullen	2002	Cullen
DK	1998	OECD 2005	2000	OECD 2005	2003	Cullen	1998	Cullen	2002	Cullen
FI	1996	OECD 2005	2004	FICORA 2004	NI	FICORA, Cullen	NI	Cullen	2001	Cullen
FR	2000	ARCEP	2001	ARCEP	2000	ARCEP	1998	Cullen	2001	Cullen
DE	1998	OECD 2005, Cullen	2006	BNetzA	2002	BNetzA	1998	Cullen	2003	Cullen
EE	2001	OECD 2005, EETT	2006	EETT	2006	EETT	2001	Cullen	2002	Cullen
IR	2001	OECD 2005	2000	Cullen	2003	Cullen	1999	Cullen	2003	Cullen
ІТ	2000	OECD 2005, AGCOM	2006	AGCOM	2006	AFCOM	1998	Cullen	2003	Cullen
NL	1999	OPTA (Guidelines 1999_3)	2003	Gallo/ Pontarollo (2006:10)***	2007	Cullen	2004	Cullen	2002	Cullen
NO	2001	OECD 2005; NPT	2001	NPT	2001/ 2006	NPT**	NI	Cullen	2002	Cullen
РО	2001	OECD 2005; ANACOM	2000	ANACOM	2005	ANACOM	1999	Cullen	2002	Cullen
ES	2001	OECD 2005	1999	Cullen	2008	Cullen	1998	Cullen	2002	Cullen
SE	2000	PTS	2004	PTS	2005	PTS	1998	Cullen	2001	Cullen
CH*	2007	COMCOM	2007	COMCOM	2007	COMCOM	1998	Cullen	2003	Cullen
UK	1999	OFCOM	2004	OFCOM	2002	OFCOM	1998	Cullen	2002	Cullen

Table 1 Dates of introductions of regulatory means plus the respective sources; * Special case Switzerland: here LLU and BSA are not regulated ex-ante, but ex-post; ** WLR in Norway: 2001 NPT ordered Telenor to offer WLR. However, decision was revoked by the Ministry of Transport and Communications in 2003. Nevertheless, Telenor chose to continue to offer the product. In 2006 NPT imposed WLR as a required obligation; *** BSA decision overruled by national court in December 2003; NI= never introduced; the sixteen countries were chose as we had sufficient and reliable data on their introduction dates.

It can be easily seen that there is a large variety in the introduction of the particular regulatory means. However, one has to consider that full local loop unbundling and line sharing are mandated by European Regulatory law, while the other policies are only recommended. This becomes important when interpreting the different results.

Theoretical literature on innovation diffusion focused primarily on the spread of new technologies and products across countries or industries. The fundamental work of Griliches (1957) assesses for example how diffusion speed or timing of a particular technology correlates with independent factors. The cumulative adoption of such an innovation over time is illustrated as a horizontal s-shaped curve when an innovation saturation point is reached (Rogers 1995). However, research evidence is often inconclusive and it is not known when or why such a curve applies (Wolfe 1994).

With our investigation on the diffusion of regulatory wholesale remedies, we want to identify a key part of relevant influence factors, influencing the shape of the respective diffusion curve.



Figure 1: Diffusion of policies

Figure one shows the cumulative diffusion rates of the regulatory means and countries, which we included in our analysis, over time. The figure indicates a large heterogeneity in the adoption process, while the curves for local loop unbundling and line sharing agreements are rather steep, the diffusion curves for wholesale line rental, bit stream access and LRIC accounting are converging less fast to total diffusion. In particular, the process of implementation of local loop unbundling is in line with the forced implementation process. However, this regulatory mean is therefore a less optimal candidate for an institutional learning process.

To add covariates we use Data from the ITU telecommunications database, in particular, regarding the diffusion of broadband internet. Table 2 now provides an overview of the main variables used in the analysis.

Table 2 Overview variables

Variable	Short description
LLU	Local loop unbundling adoption over time
Bsa	Bitstream access adoption over time
Wir	Wholesale line rental adoption over time
Share	Line sharing adoption over time
LRIC	Long-Run Incremental costs/Long run incremental average costs adoption over time
Llu_nei	Local loop unbundling average rate of adoption in other EU countries, excluding the country under observation
Bsa_nei	Bitstream access average rate of adoption in other EU countries, excluding the country under observation
Wlr_nei	Wholesale line rental average rate of adoption in other EU countries, excluding the country under observation
Share_nei	Line sharing average rate of adoption in other EU countries, excluding the country under observation
LRIC_nei	LRIC/LRAIC average rate of adoption in other EU countries, excluding the country under observation
AN	Broadbandpenetration per household
policy_Interact	Interaction of Broadband penetration rate and average adoption of the policy in the other countries

5. Empirical Model

Motivation for chosen influences on the adoption probability of a wholesale mean in a country

The four wholesale obligations, included in our analysis, illustrate varying possibilities to enhance competition in DSL markets by enforcing mandatory access for entrants to a part of the infrastructure of the incumbent. Beside the boost of quality of service, the percentage of households, having broadband access should, be enhanced.

The penetration rate of broadband on the other hand, may also have impact on the probability that a country adopts a certain wholesale remedy at a certain point in time. Polykalas and Vlachos (2006) outline that in markets with low broadband penetration, the local NRAs should primarily promote service competition, which allows the fast introduction of broadband services. Therefore, we assume that if a country is in a relatively early stage of the broadband diffusion process, the probability of adopting a wholesale product, which pushes broadband uptake quickly, but potentially not sustainably in terms of setting investment incentives, (e.g. Resale) is higher. In case, that the market is already more developed, i.e. the broadband penetration is already high, the regulator may treat the incumbent more "softly" (Höffler, 2007:412). Therewith the probability that a NRA introduces a wholesale product, which pushes quick broadband uptake (but potentially to the disadvantage of facility-based competition) in a more mature market, is assumed to be lower. Furthermore, as stated earlier, we attempt to identify the impact of an introduction of certain wholesale remedy in other countries on the country under investigation. With a positive impact, learning processes may be spotted.

The main idea is the description of influences on the adoption process of regulatory policies. To show how this works, we use a linear probability model and estimate a fixed effect model on a country level to investigate whether a particular country introduced a regulatory mean.

$$policy_{i,t} = \beta + \beta \ policy_{i,t-1} + \beta \ policy_{in}EU_{i,t-1} + \beta \ Broadbandpenetration_{i,t-1} + \beta \ policy_{in}EU_{i,t-1}xBroadbandpenetration_{i,t-1} + \beta \ FE + \mu$$

The variable *policy* indicates the particular regulatory policy, the variable *policy in EU* includes the average rate of adoption, without considering the treated country, the variable *Broadband penetration* describes the percentage of household having broadband available. In addition, the interaction of broadband penetration and the average adoption is included. The time period considered is from 1997 to 2013 and captures the time including the new regulatory framework as well as the diffusion process of broadband.

The usage of a fixed effects model allows controlling for time-invariant unobserved heterogeneity on the level of the fixed effect, i.e. the country. Still one may consider a non-linear model, e.g., probit model with fixed effects. Those models, however, suffer from an incidental parameters problem, which is difficult to solve (Neyman and Scott 1948, Wooldridge 2001, 483ff). The linear probability model is in this case estimating consistently the impact of the control variables, and is rather precisely approximating partial effects, but lacks of efficiency, in particular regarding the point estimates (Wooldridge 2001, 454ff). Moreover, one drawback of our approach is the fact that we cannot control for endogeneity and reverse causality fully. This means, we use a lagged variable structure in the estimation, reducing reverse causality, but do not have proper instruments at this point. Therefore, the interpretation has to be the interpretation of controlled correlations that help us to explore general patterns without inferring causality.

6. Empirical analysis

Table 3 provides the estimation regarding the implementation of the first regulatory mean: unbundling. Since unbundling was mandatory enforced, the estimation provides us with baseline results. Column (1) shows that the likelihood depends on the general trend, i.e. year. The later the year the more probable is the introduction of the particular policy. In addition, the likelihood seems to be negatively affected by the introduction of unbundling by other EU countries. This means that the more other countries implemented the policy the less likely is the implementation. This negative correlation is a hint to a learning spillover. Controlling for an already existing implementation, one can see that this implementation increases the probability strongly, which is what one would expect. Column (3) analysis whether the broadband penetration rate has any effect for the implementation, but no one can be found. Column (4) interacts the broadband penetration rate with the implementation in other countries (LLU Interact) and reveals a positive coefficient. However, the non-interacted coefficient becomes negatively significant. This means if only few other countries have implemented the policy, than the likelihood of implementing unbundling has been lower if there has already been a high penetration rate. This indicates some slow adaption of the policy if a country is already rather successful (in terms of broadband adoption). However, one has to be cautious since the descriptives show that the process of implementation was short, fast and demanded by the Commission.

	(1)	(2)	(3)	(4)
	b/se	b/se	b/se	b/se
llu_nei (1lag)	-1.3576*	-0.0778**	-0.1880**	-0.1342*
	(0.6713)	(0.0361)	(0.0710)	(0.0637)
llu (1lag)		0.6239***	0.5547***	0.5820***
		(0.0242)	(0.0626)	(0.0844)
AN (1lag)			-0.0033	-0.1143***
			(0.0057)	(0.0262)
LLU_interact				0.1187***
(1lag)				
				(0.0322)
Year	0.0403***	0.0065***	0.0141	0.0121
	(0.0047)	(0.0019)	(0.0147)	(0.0155)
_cons	-78.7922***	-12.6327***	-27.5907	-23.6265
	(9.4288)	(3.8485)	(29.3671)	(30.9799)
R ²	0.4050	0.6282	0.5653	0.5693
Observations	256	256	231	231

Table 3	Local	Loop	Unbur	ndling
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Cluster Robust Standard errors, *0.10% **0.05% ***0.01% Fixed Effects on a country level

Table (4) now considers another policy whose implementation has been forced by the Commission: Line Sharing. Here one can see that the patterns in column (1) and column (2) are similar, i.e. a negative correlation with other countries implementation and a determining effect of previous periods implementation. However, adding more controls as in Table 3, one can see that only the effect of previous period's implementation remains significant. This indicates, together with rather low R-squared values, that that the

introduction was not affected by institution learning impulses or differences of implementation rates. The enforcement by the Commission may have been the decisive driving force.

Table 4 Line sharing

	(1)	(2)	(3)	(4)
	b/se	b/se	b/se	b/se
share_nei (1lag)	-0.7895*	-0.0162	0.0009	-0.5736
	(0.4164)	(0.0127)	(0.0614)	(0.4829)
share (1lag)		0.2153**	0.2183**	0.2062**
		(0.0732)	(0.0754)	(0.0719)
AN (1lag)			-0.0009	-0.1579
			(0.0032)	(0.1340)
share_interact				0.1678
(1lag)				
				(0.1429)
Year	0.0096**	0.0012*	0.0036	0.0025
	(0.0039)	(0.0006)	(0.0088)	(0.0089)
_cons	-17.5836**	-1.6006	-6.5194	-3.6597
	(7.6026)	(1.2284)	(17.7008)	(17.8110)
R ²	0.1025	0.2038	0.2043	0.2145
Observations	192	192	192	192

Cluster Robust Standard errors, *0.10% **0.05% ***0.01% Fixed Effects on a country level

Table (5) now investigates the correlates of bit stream access implementation. Over all, the same pattern as in Table (4) can be seen. However, the negative impact of learning indications remains significant in all specifications. Given that the literature mostly claims a majorly short-run impact on the broadband penetration and potential negative effects on investment³¹, this negative learning makes sense. Still, the interaction with the broadband penetration is weak in this specification. The general explanatory quality of this specification seems to be stronger than in the case of line sharing, with an R-square well above 50 per cent.

³¹ For an good overview see Cambini and Jiang (2009).

Table 5 Bit stream access

	(1)	(2)	(3)	(4)
	b/se	b/se	b/se	b/se
bsa_nei (1lag)	-1.3038*	-0.1102**	-0.1063**	-0.0671**
	(0.6459)	(0.0452)	(0.0390)	(0.0280)
bsa (1lag)		0.5974***	0.5888***	0.6212***
		(0.0322)	(0.0457)	(0.0750)
AN (1lag)			-0.0047	-0.0611
			(0.0045)	(0.0706)
BSA_interact (1lag)				0.0596
				(0.0760)
Year	0.0435***	0.0094***	0.0207	0.0204
	(0.0075)	(0.0028)	(0.0134)	(0.0136)
_cons	-85.3091***	-18.3821***	-41.0419	-40.4179
	(14.8945)	(5.5735)	(26.8585)	(27.1131)
R ²	0.3919	0.5940	0.5781	0.5799
Observations	240	240	231	231

Cluster Robust Standard errors, *0.10% **0.05% ***0.01% Fixed Effects on a country level

Table (6) investigates the adoption of wholesale line rental. Most importantly, the specifications differ when considering the learning effect of the neighbors. Here we can see that there is a positive significant effect in specifications 2 and 4 (in column 3 it only slightly deviates from the 10). This is an indicator of a positive learning effect of this policy. Given that the effect of the broadband penetration is negatively correlated, this indicates that the learning is leading to more adoption if the penetration of broadband internet is low.

If the market is in a more mature phase, the probability that the wholesale line rental is adopted is rather low. This is in line with the assumptions made at the beginning of the chapter.

	(1)	(2)	(3)	(4)
	b/se	b/se	b/se	b/se
wlr_nei (1lag)	0.2088	0.2236**	0.1678	0.1913*
	(0.1824)	(0.0861)	(0.1013)	(0.0965)
wlr (1lag)		0.6811***	0.6470***	0.7230***
		(0.0270)	(0.0410)	(0.0610)

Table 6 Wholesale line rental

AN (1lag)			-0.0060	-0.0870*
			(0.0051)	(0.0488)
WLR_interact				0.0919
(1lag)				
				(0.0572)
Year	0.0576***	0.0067	0.0264*	0.0209
	(0.0141)	(0.0058)	(0.0143)	(0.0152)
_cons	-115.0082***	-13.3287	-52.7961*	-41.7430
	(28.1308)	(11.4950)	(28.6132)	(30.3231)
R ²	0.5474	0.7560	0.7089	0.7139
Observations	240	240	217	217

Cluster Robust Standard errors, *0.10% **0.05% ***0.01% Fixed Effects on a country level

Table (7) now investigates how the diffusion of the LRIC standards proceeded. Actually, the only relevant covariate is the previous implementation such that one can deny institutional learning processes.

	(1)	(2)	(3)	(4)
	b/se	b/se	b/se	b/se
lric_nei (1lag)	0.0980	-0.2526	-0.9645	-0.9163
	(0.1180)	(0.1450)	(0.7132)	(0.7822)
lric (1lag)		0.5443***	0.5844***	0.5904***
		(0.0915)	(0.1146)	(0.1537)
AN (1lag)			0.0051	0.0012
			(0.0030)	(0.0338)
LRIC_interact (1lag)				0.0044
				(0.0383)
Year	0.0156	0.0047*	-0.0086	-0.0088
	(0.0090)	(0.0023)	(0.0057)	(0.0056)
_cons	-30.6361	-8.8870*	18.4277	18.6851
	(18.0043)	(4.5569)	(11.9108)	(11.6730)
R ²	0.1485	0.4651	0.6034	0.6034
Observations	256	256	231	231

Table 7 LRIC/LRAIC standard

Cluster Robust Standard errors, *0.10% **0.05% ***0.01% Fixed Effects on a country level

7. Conclusion

The preliminary analysis has shown that institutional learning is relevant in the diffusion of some, but hardly all regulatory policies. Future analysis should therefore investigate more detailed what factors are important and how learning takes place. Our analysis also shows, that the maturity of a market, in terms of broadband penetration, is relevant for the question of remedy adoption, in particular for the case of wholesale line rental. In this case, a low broadband penetration rate increases the probability of a country that WLR is introduced. In a next step, an overview and description shout be provided, which policies may be more relevant for learning processes that others. Also the influence of European obligations should find more explicit consideration. Additionally, more factors of influence, e.g. the time length of membership, size of the NRA, differences before and after required introduction of a mean by the European level.

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