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REGULATORY FEDERALISM AND INDUSTRIAL POLICY IN BROADBAND TELECOMMUNICATIONS *

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ABSTRACT: We analyse the impact of regulation, industrial policy and jurisdictional allocation on broadband deployment using a theoretical model and an empirical estimation. Although central powers may be more focused and internalize interjurisdictional externalities, decentralized powers may internalize local horizontal policy spillovers and use a diversity of objectives as a commitment device in the presence of sunk investments. The latter may, for instance, alleviate the collective action problem of the joint use of rights of way and other physical infrastructures. In the empirical exercise, using data for OECD and EU countries for the period 1999-2006, we examine whether centralization promotes new telecommunications markets, in particular the broadband access market. The existing literature, in the main, claims it does, but we find no support for this claim in our data. Our results show that indicators of national industrial policy are a weakly positive determinant of broadband deployment and that different measures of centralization are either irrelevant or have a negative impact on broadband penetration.

JEL Codes: L50, L96, K23, H77

Keywords: Regulation, industrial policy, decentralization, broadband

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1. Introduction

Both theory and empirical evidence suggest that there are two main types of public intervention in broadband Internet access markets: those related to market power (regulation and competition policy) and those related to positive externalities (network externalities or impact on overall economic growth). The first of these two types of intervention is carried out in the United States by the Federal Communications Commission (FCC) and by the states, and in the European Union by the European Commission and the National Regulatory Authorities (NRAs) of the member states. The third package of European directives on telecommunications created the *Body of European Regulators for Electronic Communications* (BEREC), a pan-European telecommunications regulator based on the coordination of NRAs. Policies related to the promotion of broadband through different combinations of subsidies and public investments ("industrial policies") are mainly carried out at decentralized levels both in the US[1] and in Europe. This is in contrast with countries that have achieved very high levels of broadband deployment, such as South Korea and Japan, which have promoted strong national policies to promote broadband penetration for many years (see Trillas, 2008a).

In this paper, we present both a theoretical model and an empirical estimation to analyse the interaction of regulation, industrial policy and jurisdictional allocation, and their impact on broadband deployment. Although central powers may be more focused, internalize the relevant territorial externalities and have a more balanced matching of instruments and objectives, decentralized powers – lacking regulatory specialization – may internalize local horizontal policy spillovers (such as the promotion of e-health and e-learning) and use a diversity of objectives as a commitment device in the presence of sunk investments. A significant part of the investments needed to deploy broadband is highly specific (for example, underground optical fibre) and its value for alternative uses is very low or close to zero. This commitment by local authorities may be reflected in a variety of policies, for instance, local powers may have incentives to help alleviate the collective action problem of the joint use of rights of way and other physical

[1] At least until President Barack H. Obama initiated the promotion of broadband in his 2009 fiscal stimulus package.

infrastructures.[2] This enhanced commitment, similar to that mentioned by Weingast (1995) in the so-called theory of market-preserving federalism, may counter-balance the temptation of local powers to make expropriating or confiscatory demands when managing the rights of way (see among others Troesken, 1996, and Neufeld, 2008,).

The analysis of how policy intervention is organized in the vertical structure of government matters for historical, technological and political reasons. The history of network industries, including telecommunications, shows an evolution from an essentially local industry[3] to an increasingly larger geographic market size that ran parallel to the increasing role of the state and federal levels (see Trillas, 2008b). Modern physical networks in telecommunications exhibit increasing returns to scale but require local rights of way. At the beginning of the twenty-first century all levels of government are active (through regulation, competition policy or "industrial policy") in the broadband sector. The degree and nature of the involvement of each level of government are of great importance to telecommunications firms, which have lobbied exhaustively for the approval of the third package of European directives on telecommunications with the argument that increased regulatory harmonization and market integration will reduce the costs of European wide operators.

The aim of this paper, therefore, is to provide insights into the impact of policy centralization or decentralization on broadband penetration. For this purpose we first develop a theoretical framework to show the existing trade-off between the different spillovers internalized by each level of government: the central government (centralization) internalizes territorial spillovers while regional/local governments (decentralization) internalize policy spillovers. As a result, the empirical prediction of our model is that the impact of decentralization on network extension is ambiguous. In the empirical exercise, using data for OCDE and EU countries for the period 1999-2006, we examine whether centralization is necessary to promote new

[2] Local powers have a choice of either charging a high price (in monetary or other terms) for the use of rights of way or expediting procedures and minimizing the transaction and disruption costs of digging streets and of other collective infrastructures. Moreover, rights of way were the policy instrument that inaugurated regulation at the local level in the nineteenth century and it remains crucial in the telecommunication sector.

[3] Historically there has been a trend to move regulation up the vertical structure of government. Troesken (1996) analyzes the transition from local to state regulation in the US gas industry. Electricity and telecommunications also started being regulated at the local level but at the beginning of the 20th century it was moved to the state level. Yet there are still many instances of local intervention, and regulation is still mainly carried out at the state level, despite the creation of the Federal Communications Commission (FCC) in 1934 in the US and the increasing role played by the European Commission (EC) since the late 20th century.

telecommunications markets, in particular the broadband access market. The existing literature, in the main, claims it is, but we find no support for this claim in our data. Our results show that indicators of national industrial policy are a weakly positive determinant of broadband deployment and that different measures of centralization are either irrelevant or have a negative impact on broadband deployment.

The paper is organized as follows. Section 2 reviews the two branches of the existing research to which this paper refers: the literature on the economics of federalism and the empirical literature on the determinants of broadband penetration. Section 3 presents the theoretical framework. Section 4 contains the econometric model specification, the data set and the empirical results. Finally, section 5 concludes.

2. Literature review

2.1. The economics of federalism and network industries

The main arguments presented in the literature examining the economics of federalism are also applicable to network industries, as argued by Trillas (2008b).[4] The Tiebout (1956) argument that jurisdictional competition may, under factor mobility and certain other conditions, select optimally differentiated policies was strengthened and applied to commitment for private investment by the market-preserving theory of Weingast (1995). Treisman (2007) provides casual evidence that infrastructures devoted to public utilities or local airports have been used by local authorities to compete for mobile capital. However, regulatory competition may also unleash undesirable phenomena such as "*race to the bottom*" or "*beggar thy neighbour*" policies; an example of the latter in the telecommunication sector is high termination rates for calls originating from other countries. Nevertheless, laboratory federalism and tailoring arguments can also be used to defend a role for local powers, although inter-jurisdictional externalities, coordination and scale (at the product or administrative level) could tilt the balance in favour of central powers.

Although geographic market definition, in the sense with which it is employed in competition policy, could in theory be used as a criterion to choose the optimal regulatory jurisdiction, the fact is that often market boundaries do not coincide with those of political jurisdictions. Under certain specific conditions, it is worth going beyond traditional political boundaries and organizing regulation by special districts,

[4] The pros and cons of decentralization in competition policy are discussed in Budzinski (2006).

such as the PJM regional transmission organization[5] or the NordPool wholesale market[6] in the case of electricity.

Inman and Rubinfeld (1997) argue that in the absence of significant inter-jurisdictional externalities, the allocation of policies should depend not only on efficiency criteria, but also on the objective of promoting political participation. This would justify local policies (that do not necessarily promote economic efficiency) if they are approved with sufficient levels of participation and transparency. In the energy (gas and electricity) sector, Troesken (1996) and Neufeld (2008) argue that a key factor in moving regulation from the local to the state level was the inability of local powers to commit to acceptable rates of return for private investors. In particular, Neufeld (2008) shows that for US electricity regulation, quasi-rents due to specific investments were a more important determinant than monopoly rents in the decision to move from local to state regulation.[7] Nonnenmacher (2001), however, argues that in the diffusion of the state regulation of the telegraph industry a cycle characterized by promotion followed by regulation was more important than quasi-rents considerations.

More recently, several authors have applied contract theory models of asymmetric information to their analysis of the role of issues such as capture, commitment and contractual externalities in the centralized versus decentralized debate.[8] These contributions focus on very specific regulatory and industrial structures, which makes it difficult to generalize their conclusions to more generic settings. They show, however, the potential of analyzing explicitly the incentives of policy makers at each level. Along these lines, Mulligan and Shleifer (2005) present and test a model of the political costs and benefits of regulation, where only communities with large populations are able to afford the fixed costs of specialized regulation. The authors find that below a certain population threshold it is not worthwhile incurring the fixed administrative and political costs of writing, passing and enforcing specific legislation for different policy areas.

Nuechterlein and Weiser (2007), who interpret the evolution of telecommunications in the US after the 1996 Telecommunications Act as a (largely failed) exercise in cooperative federalism between the FCC and the states, claim that all levels of

[5] This organization started in the states of Pennsylvania , New Jersey and Maryland, and then expanded to other US states.
[6] This is the electricity market organization of Scandinavian countries.
[7] Troesken (1996) reports that the vice-president of the Pacific Gas and Electric Company argued that under local regulation, corporations were "at the mercy of as pitiless a pack of howling destroyers, as would the lonely traveller on the Siberian steppes be against the gaunt and hungry wolves".
[8] See Laffont and Pouyet (2004), Caillaud *et al.* (1994), Bardhan and Moockerjee (2006).

government are needed in modern telecommunications markets given that central powers may be overwhelmed by local problems or that they might not have the necessary information to regulate the market properly.

However, some scholars such as Hoffinger (2003), Hahn *et al*. (2003), Lehr and Kiessling (1998) and Sun and Pelkmans (1995) take a very strong view against any sort of decentralized intervention in the telecommunications sector arguing that differentiated geographic regulation has enormous compliance costs for firms in terms of red tape and uncertainty. Hence, they defend the argument that centralization is the only way to liberalize telecommunications markets.[9] In keeping with these arguments, central regulation in the sector should therefore be strengthened and should focus on those aspects that amount to clear externalities, for example:

i) "*Beggar thy neighbour*" policies in roaming wholesale termination charges (but keeping a balance that avoids precluding any cross-jurisdictional commercial initiatives on the part of companies to reduce retail roaming rates).

ii) Any policies that cause, what Sun and Pelkmans (1995) call, the "*frontier effect*", namely the fact that equally costly products or services are more expensive when they cross a jurisdictional border than when they remain within the borders of a jurisdiction. More generally, legal barriers to entry should be eliminated and only structural barriers to entry should prevail in the long run, which implies helping to integrate those markets that are only impeded by legally separate jurisdictions.

iii) Protectionist terms of access or licensing policies that entrench the position of local incumbents or which are equivalent to state aid in the promotion of the international competitiveness of local incumbents. Credible entrants are typically foreign incumbents and the temptation to adopt subtle methods to promote local incumbents is often hard to control when conventional checks against state aid operate.

A contradictory position is reported by Brennan (2001) who, when analyzing disputes concerning the imposition of open access conditions on cable company mergers by local authorities in the US, argues that such authorities should be granted freedom to choose in local markets, even if they decide erroneously, along the lines of Inman and Rubinfeld (1997). His only caveat is in line with the arguments presented by Troesken (1996), in the sense that there is a risk that local powers might hold up private

[9] Without adopting such a strong point of view, Aubert and Laffont (2002) and Smith (2000) consider that telecommunications should be included on the list of industries that need to be regulated at the central level.

operators, and stresses that this is particularly true when these operators are earning rents at the national level. In this case, the risk of hold-ups at the local level imposes a negative externality on the rest of the country. Brennan (2001), however, stresses that in matters of local access the relevant markets are local, not national: "The issue at hand is not agreeing to a standard Internet protocol, but one of the structure of the local ISP market. Local officials presumably are both closer to the affected consumers and more knowledgeable regarding relevant market conditions than is the federal government. To the extent that the policy is based on alleviating problems created by monopolies in relevant markets, the policy choice and the risk of error should be a local prerogative, unless a wrong local choice will substantially reduce the value of Internet access elsewhere in the country."

Table 1 organizes the literature summarised up to this juncture in three dimensions. First generation arguments include those made before the emergence of contract theory. The arguments in italics are concerned with the structural conditions of markets, which have the virtue of providing a clearer guide than is provided by other arguments. It can also be seen from Table 1 that more recent arguments have tended to provide more ambiguous conclusions.

<INSERT TABLE 1 AROUND HERE>

2.2. Empirics: decentralization and determinants of broadband penetration

From an empirical point of view, few studies, to the best of our knowledge, have analysed, as we do, the impact of the jurisdictional allocation of regulation in network industries. Humplick and Estache (1995) look at the impact of different measures of decentralization on the performance of road investment, electricity and water without finding clear cut results.[10]

For the telecommunications sector, Wallsten (2005) analyzes evidence of a variety of promotion policies in the US at the state and local levels and reaches the conclusion that it is unclear whether such policies solve any market failure. In accounting for broadband diffusion in the EU, Distaso *et al*. (2006) include as one of their control variables whether the control of rights of way is centralized at the country level (rather

[10] It is not entirely clear what their dummy variable for spatial decentralization captures. That is, it is not clear if all relevant legislation and tariff setting is performed at a sub-central level. In this sense, we use standard variables in the decentralization literature, which allows us to account for the level of decentralization of the sample of countries under analysis.

than being in the hands of regional or local governments). In their discussion of the hypotheses forwarded, their expectation is that centralization will have a positive impact on deployment. The authors do not explain why they expect such an impact, they merely state that "one should expect less delay under centralized authority granting rights of way to broadband access providers". Presumably they have in mind the implicit expectation that local powers may use the control of rights of way to extract onerous revenues from the operators. Their empirical result is that the centralized control of rights of way had a positive, but not significant, impact on broadband penetration between 2000 and 2003.

Wallsten (2006), Gual and Jodar (2007), Waverman *et al*. (2007), Friederiszick *et al*. (2007) analyze the determinants of broadband penetration for developed countries using panel data techniques. All of them stress the importance of distinguishing between platform-based and access-based competition, but none of them explicitly uses decentralization or industrial policy regressors as we do in this study.

Interesting case studies covered in Trillas (2008a) shed additional light on specific determinants of broadband penetration in countries such as Canada (geographical differentiation), Japan and Korea (subsidised networks), the UK (vertical separation with hybrid management of network) and the US (platform based competition without federal public intervention). On the existing evidence, any analysis focusing on new specific determinants of broadband penetration must use as control variables those that have proved significant in most other studies, including, GDP per capita, population density (mainly of urban areas), education level of the population, competition (distinguishing between platform-based or access-based) and the complementarity of goods.

3. Theoretical framework: A broadband investment model

We present a simple theoretical model of broadband investment to develop our intuitions on the impact of the centralization/decentralization of regulatory decisions on broadband deployment, and to provide a framework for the empirical estimations performed in the section that follows.

In broadband markets, consumption at adequate levels of quality depends on specific investments by operators. The incentives of these operators to invest, however, depend, among other factors, on a vector of policies: regulation, competition policy, control of rights of way needed to deploy lines, subsidies and taxes. With the so-called

next generation networks, for example, connection speeds crucially depend on the number of fibre lines that reach households (fibre to the home); these fibre lines require expensive electronic equipment and also public works and access to buildings.[11]

In our simple model, in the centralized case there is internalization of the network externalities present in the telecommunication sector whereas in the decentralized case policy spillovers are internalized. For instance, when deciding on broadband policy, the government takes into account not only market power objectives, but also objectives in fields such as e-health and e-learning. Moreover, in the latter case we assume that this diversity of policy objectives can be used as a commitment device to facilitate high investment. That is, local decision makers may be concerned about total surplus in the regulated market as well as about local development, inflation, security of supply, the welfare of particular firms, input providers or groups of consumers.[12] To the extent that these objectives require high broadband investment, local government is able to commit itself not to expropriate investments.

In our model there are two jurisdictions and potentially one central power that may take decisions that affect both jurisdictions. A regulatory policy x_i (with $i = 1,2$) can be set locally (x_i^L) or centrally (x_i^C). This must be interpreted as an index that summarizes a vector of prices (retail and access), subsidies and other policies (such as a lenient competition policy) that have a positive impact on the firm's profits. If $x_1 = x_2$, policies are said to be uniform (centralized policies may be uniform or not and local policy makers may set policy at the same level in both jurisdictions). If $x_i^L = x_i^C$, policies are said to be equivalent. Local and central decision makers have different objective functions. π_i and v_i are firms' profits and consumer surplus in jurisdiction i, respectively. Moreover, we assume that no authority has commitment powers, so that investment is chosen by the firms before the (central or local) authority fixes the policy. In this sense, it is an incomplete contracts model.

There is one central regulator that fixes x_i^C as implementing a bargaining solution reached by firms and consumers where firms' *ex-post* surplus is α times that of consumers. Parameter $\alpha > 0$ measures the weight of the welfare of shareholders in the

[11] In 2006, Japan had 7.8 million of fibre to the home lines, whereas the core EU countries (the UK, France, Germany, Italy, Spain, Sweden and the Netherlands) had just 870.000 such lines. As a result, Japan had an average speed for downloading files of 63.6 megabits per second, whereas Spain, for example, had an average speed of 1.2 megabits per second.

[12] It is not that central governments are unconcerned by these issues, but it is implicitly assumed that they have specific instruments to deal with them, for instance, central banks for dealing with monetary policy.

central regulator's objective function relative to that of consumers (a measure of capture of the regulated industry or a measure of the bargaining power of telecommunications operators). If α = 1, consumers and shareholders have the same bargaining power. As for the parameter α, note that different central governments may differ in their scope for capture and in their commitment to policies. For example, casual evidence suggests that the central level is more "capturable" by businesses in the US than it is in Europe, and that the EU Commission has recently developed relatively more pro-consumer policies and, therefore, has been less able to commit.[13] In the US there is a *quid pro quo* between large firms and large political parties and, in recent decades, the Supreme Court has adopted a more pro-business stance (see the New York Times 03/16/2008).[14] In sum, the central decision makers care about consumer and producer surpluses in the broadband market, giving different weights to each, with these weights varying across central jurisdictions.

Local regulators care about their specific producers and consumers, as they do about various additional objectives (summarized by the variable Ω_i). Hence, each of the two decentralized jurisdictions chooses its policy with the objective of maximizing total surplus in the regulated industry plus various other objectives with a weight θ common across jurisdictions:

$$\pi_i + v_i + \theta\Omega_i, \tag{1}$$

subject to a firm's participation constraint. The fact that $\theta > 0$ at the local level but $\theta = 0$ at the central level can be endogenized with a version of the Mulligan and Shleifer (2005) model of the political costs and benefits of specialized regulation.[15]

In this basic model, one firm in each jurisdiction decides, prior to governments fixing policy, an investment level (I_i) at a cost given by:

[13] The reason might be that EU institutions are relatively new and still seek popular legitimacy.

[14] Moreover, many companies have a national scope in the US and most companies do not, at least as yet, have a European scope, and there are no effective pan-European political parties; so the institutions of supply and demand for political action are absent or only seminal in Europe.

[15] θ may also be interpreted as an inverse measure of the transaction costs of lobbying of interest groups other than consumers and shareholders (for example, the management of an incumbent firm that wants to maintain their position in case of a takeover). These transaction costs are assumed to be lower at the local level, because collective action problems are lower at this level, there is less policy specialization and the mandates of agencies are vaguer. As is sometimes said, at the local level all interested parties meet when they collect their children from the same school.

$$C(I_i) = \frac{I_i^2}{2}. \tag{2}$$

This investment has an impact on the demand function or consumer valuation (e.g., upgrading the network allows people to subscribe to highly valued broadband services due to increased download speed). In a unit demand framework firms' profits are given by

$$\pi_i = x_i - \frac{I_i^2}{2}, \tag{3}$$

while consumer surplus in jurisdiction 1 is given by

$$v_1 = (I_1 + tI_2) - x_1, \tag{4}$$

with $0 \le t < 1$ indicates a parameter reflecting the inter-jurisdictional externalities. This parameter captures the idea that the network in one jurisdiction may be of higher value to consumers when the neighbouring jurisdiction has a better network. These spillovers are both direct and indirect. Direct externalities refer to individuals of jurisdiction 1 benefiting from a good network in the neighbouring jurisdiction, allowing them to contact more people, firms or organizations in this country. Indirect externalities refer to the individuals of jurisdiction 1 benefiting from a good network in the neighbouring jurisdiction by creating incentives for the development of enhanced applications which require a large market.

Once we have the basic model set-up, we can solve it for the two cases of jurisdictional allocation of regulation in network industries.

Case A: Central Regulation

The solution $(x_1^C(I,t), x_2^C(I,t))$ chosen by the central regulator implements an *ex-post* bargaining game, as mentioned above. This solution is a function of the vector of firms' investments $I = (I_1, I_2)$, the externality parameter t, and α. So the important point is how investment and externalities relate to the *ex-post* central regulator's objective

function. The central regulator sets policy such that the *ex-post* surplus of producers is α times that of the consumers:

$$\sum x_i^C = \alpha\left(\sum I_i(1+t) - \sum x_i^C\right). \tag{5}$$

Therefore, under the simplifying assumption that central government policies across jurisdictions are uniform Eq. (5) can be rewritten as:

$$\sum x_i^C = \frac{\alpha \sum I_i(1+t)}{1+\alpha}, \tag{6}$$

substituting this expression in Eq.(3), at the investment decision stage the firms maximize (assuming no discounting):

$$\pi_i = \frac{\alpha \sum I_i(1+t)}{2(1+\alpha)} - \frac{I_i^2}{2}, \tag{7}$$

and from the first order condition of the firms' maximization problem we obtain:

$$I_i^C = \frac{\alpha(1+t)}{2(1+\alpha)}. \tag{8}$$

Equilibrium investment increases with the level of spillovers (t) and (non-linearly) with the weight of producers in the central regulator's objective function (α):

$$\frac{\partial I_i^C}{\partial \alpha} = \frac{(1+t)}{2(1+\alpha)^2} > 0. \tag{9}$$

Case B: Local Regulation

In this case, externalities (t) are not internalized and investment depends on the relationship between the other objectives of local governments (Ω_i) and investment (I_i). *Ex-post*, the regulatory authority maximizes Eq. (1) for a given level of investment, i.e. it maximizes:

$$x_i^L + \left(\left(I_i + tI_j\right) - x_i^L\right) + \theta\Omega_i\left(x_i^L, I_i\right) = \left(I_i + tI_j\right) + \theta\Omega_i\left(x_i^L, I_i\right). \quad (10)$$

For the comparison to be meaningful, local policies (x_i^L) and investment (I_i) must be related to profit and consumer surplus in the same way as in the central regulation case. So given that the same weight is attributed to consumer surplus and profits at the local level, and given the unit demand[16] and the sunk nature of investments, the decentralized regulator actually sets policy to maximize its second objective or local policies, that can be defined as:

$$\Omega_i\left(x_i^L, I_i\right) = \gamma I_i \ln x_i^L - x_i^L, \quad (11)$$

where we assume a specific functional form for the additional local policy objectives, which depend on investment by regulated firms and the local regulatory policy of the broadband sector and the parameter γ that indicates the degree to which the combination of the regulatory policy and firms' investment in broadband positively impact on the second objective of local regulators. The exact value of γ may depend on the maturity of the regulated industry or the appraisal of local economic development compared to the pressure to expropriate investments. Local policy makers may value firms' investment in broadband (I_i) because it contributes to the second objective of local polices (Ω_i).[17]

Note that Eq. (11) is concave so that there is an interior optimal local policy compatible with this second local objective. Moreover, the specification of this other local policies or second local objective, may also be interpreted as the reduced form of a number of additional objectives: for example, a combination of promoting local firms and keeping a low local unemployment rate. Eq. (11) must be interpreted as the fact that for local government, the investment in broadband undertaken by telecommunications firms also promotes local economic growth, "human development" (e-health, e-learning), political visibility of local politicians, etc. Moreover, telecommunications firms usually have strong cash flows (positively correlated with x_i^L) that may be

[16] So deadweight loss plays no role in this basic analysis.

[17] For instance, in Spain, it is quite common in some regions that the main shareholder in gas, water, highways and telecommunications is a large, influential non-profit savings bank that typically captures the deposits of a large proportion of that region's population and which is involved in social and cultural activities as a result of its foundational objectives. Examples include "La Caixa" in Catalonia and "Cajastur" in Asturias.

necessary for "other" local objectives including employment, local development, international influence, etc.[18]

Maximizing Eq. (10) taking into account Eq. (11) we obtain that the optimal regulatory policy in the decentralized case is:

$$x_i^L = \gamma I_i, \tag{12}$$

given Eq. (12) the firm chooses investment to maximize its profits, that is, from Eq. (3) we obtain:

$$\pi_i = \gamma I_i - \frac{I_i^2}{2}. \tag{13}$$

Maximizing Eq. (13) the firms' optimal solution yields $I_i^L = \gamma$ and, in equilibrium, $x_i^L = \gamma^2$. To the extent that γ varies across jurisdictions, the local regulatory policy would vary across jurisdictions, although we assume γ to be constant across jurisdictions for simplicity. Then when α = 1, that is, when at the central level consumers and shareholders have the same bargaining power, we obtain that,

$$I_i^L = \gamma < \frac{1+t}{4} = I_i^C \quad \text{if} \quad t > 4\gamma - 1 \tag{14}$$

That is, if inter-jurisdictional network externalities t are high enough relative to γ, central regulation achieves higher investment ($I^C{}_i$) than local regulation ($I^L{}_i$). Or, if we let α vary and fix the network externality at a given level, say $t = \frac{1}{2}$, then central regulation achieves higher investment than local regulation if

$$I_i^L = \gamma < \frac{3\alpha}{4\alpha + 4} = I_i^C, \tag{15}$$

[18] If a more intertemporal perspective is adopted, the fact that the second objective of local governments may change from time to time, because of global policies or the economic environment, introduces an additional level of volatility that may be absent at the central level owing to the more clearly focused objective function at this level. This would increase the costs of investment, reducing the relative attractiveness of the local regime.

which is the case when $\alpha > \frac{4\gamma}{3-4\gamma}$, i.e., when the weight of firms' profits in the central regulator's objective function, α, is high enough relative to γ, the degree to which the combination of the regulatory policy and investment enter in the second objective function of local regulators as stated in Eq. (11).

In general, the results from the model of firms' investment in broadband depend on the values of the model's parameters. A central solution is preferred (in terms of investment) if the weight of shareholders in the central regulator's objective function relative to consumers is high enough. But the other objectives of decentralized governments may act as a commitment device in the presence of sunk investments.

Moreover, if the regulatory policy is the control of rights of way then it is easy to see that the local powers will face a variety of (possibly conflicting) objectives. For example, network competition may be facilitated if different operators share the use of rights of way and other infrastructures cooperatively. In this case, there is a trade-off between the negative externalities produced by too much digging when the rights of way are not shared and local revenues which are maximized when different operators need different permits to dig up the streets. Local powers may help alleviate the collective action problem of the joint use of physical infrastructures, but they also have incentives to promote non-cooperation.

Going beyond our model, the decentralized solution may be preferred, in terms of firms' investment, if decentralized jurisdictions compete to attract private capital by investing in public infrastructure that complements these private investments.[19] This may result in a higher level of infrastructure, provided that the initial conditions in the local jurisdictions are sufficiently homogeneous. Decentralization also makes it possible to use existing institutions (so that fixed administrative costs do not have to be duplicated) to differentiate regulation by geographic markets with different potential for platform based competition.

Which case dominates, therefore, remains as the empirical question that we address in the following section.

4. Empirical evidence: data and main results

Based on our review of the literature presented in section 2, and on the predictions derived from the theoretical model presented in section 3, we hypothesize that, in

[19] In line with Treisman (2007), we assume that public investment (financed with taxes) in infrastructure is a complement to mobile private capital.

general terms, broadband penetration Y (as a proxy for private investment in telecommunications) is explained by a measure of centralization of the country (C), an indicator of industrial policy (P) as a proxy for public policies devoted to foster broadband penetration, variables that depend on regulatory decisions (R) and other control variables (V) that can affect broadband deployment, that is,

$$Y = F(C, P, R, V) + \varepsilon. \tag{16}$$

The dependent variable Y in the regressions performed is a measure of broadband penetration, i.e., the percentage of the population with a broadband connection. For robustness, we also perform all the regressions using the percentage of households with broadband access (measure of broadband household penetration) as our dependent variable. The data for constructing both variables have been obtained from Point Topic Ltd. Global Broadband Statistics.

The industrial policy variable used (*SUBSIDIES*) is calculated as government subsidies to private and public companies as a percentage of GDP (see Ades and di Tella, 1997) and is obtained from the World Competitiveness Yearbook for various years. We expect industrial policy to have a positive impact on broadband penetration in line, for instance, with the experience of leading countries such as Japan and Korea.[20]

We use two proxies to account for the effect of centralization/decentralization on broadband penetration. The first variable is *%CENTRAL_REV* and is calculated as the share of total central government revenue with respect to total general (including central, state and local) government revenue. Data are obtained from the OECD National Accounts Vol. IV-General Government Accounts. The second variable used is *ROW1*. This is a dichotomous variable taking the value of 1 when rights of way and digging permits on public land are granted by a single central authority and 0 when rights of way are granted by local authorities. This is the same variable as that used by Distaso *et al.* (2006) but with more observations. As explained in the theoretical model, the expected effect of centralization is ambiguous.

Our use of two proxies of centralization (which are quite different in nature) is in line with Treisman (2007) and Blume and Voigt (2008), who argue that it is important

[20] Industrial policy may also facilitate some forms of corruption. See Ades and di Tella (1997) where investment levels depend on anticipated industrial policies and corruption. Even if industrial policy promotes broadband investment, it could be that it has an opportunity cost in terms of other sectors not receiving much-needed public funds or tax distortions.

to use the relevant notion of decentralization in specific contexts. In particular, it is important to distinguish between administrative centralization and political centralization. In the first case, as captured by our variable of central revenues, it is the volume of public funds administered at the central versus the local levels that is measured, regardless of whether local funds are administered or not by elected local policy makers. In the second case, it is the degree to which policy making is carried out by democratically and locally elected policy makers. Some countries may have administrative decentralization without political decentralization. Similarly, some countries may be highly decentralized in terms of taxation and expenditures as well as politically, but be highly centralized in terms of their regulatory policies.[21] However, in line with Inman (2008), political decentralization may be correlated with administrative decentralization because elected local bodies are a commitment device for administrative decentralization and policy differentiation. This is confirmed by Treisman (2006) who reports that political federalism is positively correlated with the proportion of decentralized over total country revenues or expenditure.

In our estimations, to the extent that public intervention in telecom markets is characterized by a multidimensional vector of policies, administrative centralization as captured by the proportion of central revenues may be a proxy for the overall degree of centralization of the relevant policies. However, to the extent that we focus on specific elements of this vector, the location of the control of local rights of way is the appropriate measure of centralization for this specific element.

In line with the empirical literature on broadband penetration, we select two types of regulatory variable (*R*). The first are the measures of market concentration. On the one hand, *HH-INTER* accounts for the degree of concentration across platforms (inter-platform competition) and is calculated using the standard Herfindhal index. On the other hand, *HH-INTRA* is also a Herfindhal index measuring the level of market competition within the DSL technological platform. In both cases we assume that regulators control these degrees of concentration through regulatory instruments. We expect higher degrees of concentration to be negatively related to broadband penetration, as less competition reduces output. The data for constructing both

[21] For instance, in Spain public spending is fairly decentralized and there are strong democratically-elected authorities at both local and regional levels, but the regulation of airports, electricity, telecommunications and (most) railways and ports is still centralized.

Herfindhal indices have been obtained from Point Topic Ltd. Global Broadband Statistics.

Second, we also use as proxies for regulatory policies measures accounting for unbundling regulation: *FULL_UNBUND* is a dichotomous variable taking 1 when full unbundling is mandatory (0 otherwise), and *SUBLOOP* is a dichotomous variable taking 1 when subloop unbundling access is mandatory (0 otherwise). Both variables are obtained from the OECD (2003): Developments in Local Loop Unbundling. *LLP* is the price of a leased line calculated by adding the one-off to the annual charge of 2km of 2Mbps leased line, as in Distaso *et al*. (2006). This variable has been obtained from the EU reports on the Implementation of the Telecommunications Regulatory Package (2000-2006) and is only available for EU countries.

As control (demographic) variables we use *GDP PER CAPITA* in purchasing power parity terms (under the assumption that broadband is a normal good) from the International Monetary Fund (robustness checks have been performed with GDP per capita from the AMECO database from EUROSTAT). Population *DENSITY* (under the assumption that higher density countries have a lower deployment cost) is obtained as population per square kilometre (both from IMF databases).[22]

To empirically estimate Eq. (16) we have constructed a dataset for 29 OECD countries between 1999 and 2006. Our data contain information for Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, Germany, France, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, the United Kingdom and the United States. Our dataset is an unbalanced panel owing to the difficulties in obtaining data for all the variables used.

Tables 2 and 3 show the main results for OECD countries. More specifically, Table 2 presents the fixed effects panel estimations, while Table 3 takes into account possible problems of endogeneity in the panel estimations and presents the results using the instrumental variables (IV) approach.

<INSERT TABLE 2 AROUND HERE>

[22] It might be argued that what matters is the population density of the metropolitan areas. Unfortunately, we do not have data for this variable for all sample years and countries.

In our empirical framework, it could be argued that some of the regressors used in estimating Eq. (16) might be endogenous to broadband penetration. For instance, GDP per capita, the regulatory variables or the measure of public policy used could also be affected by the broadband penetration rate. To avoid this problem we use lag variables of the potential endogenous variables as instruments in our panel data framework.

<INSERT TABLE 3 AROUND HERE>

In both tables, we estimate different models according to the variables introduced. The regulatory variables accounting for competition (*HH-INTER* and *HH-INTRA*) are, in general, statistically significant and show a negative sign. The variables introduced to account for the existence of unbundling regulation perform differently. *FULL_UNBUND* is positive and statistically significant, indicating that when full unbundling is mandatory there is higher broadband penetration as we would expect from a third-party access regulation of this type. The variable *SUBLOOP* is not statistically significant in the various models estimated.

The control variables that account for the demographics of each country have the expected signs and are in most cases statistically significant. The proxy for industrial policies (*SUBSIDIES*) is not statistically significant, although its *t*-ratio increases when we instrument it (see Table 3), and in all the estimations performed it presents a positive sign. The degree of centralization, measured as the share of central government revenue - our main variable of interest (*%CENTRAL_REV*) - presents a negative and statistically significant effect on broadband penetration in Table 2, while its effect becomes statistically insignificant in Table 3 (albeit maintaining its negative sign). Thus, it would seem that centralization might negatively affect broadband penetration. As previously argued, however, our measure of centralization might be considered too general and, as such, be seen as being unrelated to broadband.

In line with Treisman (2007), we use a more specific variable to account for the centralization/decentralization of regulatory decisions in the broadband sector. In order to do this we restrict our estimations to countries within the European Union, for which we are able to use a decentralization variable that is specific to broadband policies: the centralization or otherwise of the control of rights of way, *ROW1*. This variable is the same as that used in Distaso *et al*. (2006), but in our case we include observations for

two more years. The estimations restricted to EU countries are presented in Table 4 (fixed effects panel estimation) and Table 5 (IV-fixed effects panel estimation).

Our results for the EU countries confirm those obtained for the whole sample of OECD countries. For the centralization variables, we obtain a negative and significant effect of *%CENTRAL_REV*, but a non significant effect for *ROW1*, rights of way and digging permits, although this variable presents a negative sign.

<INSERT TABLE 4 AROUND HERE>

As for the centralization/decentralization issue, our results seem to suggest that the ability of local powers to solve the collective action problem of the joint use of physical broadband infrastructures, and the concern for negative externalities and social welfare, is of a greater weight than any short-term concern for maximizing confiscatory revenues and, hence, decentralization promotes investment in broadband.

<INSERT TABLE 5 AROUND HERE>

5. Conclusions

In this paper we have presented a joint analysis of both regulatory and industrial policies and government jurisdictional allocation as they affect the penetration of broadband Internet access. We constructed a theoretical model to develop intuitions regarding the effect of centralization/decentralization on broadband investment. In the empirical exercise we examined whether centralization/decentralization is necessary to promote new telecommunications markets, in particular the broadband access market. The existing literature, in the main, concludes it is, but we find no support for this claim in our data. More specifically, our results show that measures of centralization are either irrelevant or have a negative impact on broadband deployment. As such, our evidence is inconsistent with the opinions expressed by a number of scholars against decentralizing telecommunications policies.

Europe seems to be currently seeking to internalize its network externalities via a progressively more centralized regulation, whereas in the US geographical externalities are being internalized through large national (and, therefore, continental) firms that compete in a variety of product and geographic markets.

One could be tempted to argue that as some telecommunications markets become more and more inter-jurisdictional (and, hence, more and more global) in nature as a result of enhanced technology, market regulation and policy intervention should also cease to be local, regional and even national. However, long distance communications or backbone Internet networks are also potentially competitive in nature, much more so than local communications. The regulation of telecommunications is being increasingly relegated to matters of local access and bottlenecks are predominantly local. Here it is worth highlighting the differences with electricity markets, in which long distance transmission is a natural monopoly that has to be regulated at the highest possible level.

Deregulation in the US and Europe has required centralized initiatives because entrenched monopolies have tended to be national, but this does not necessarily imply that any remaining or new regulations or policy interventions should be introduced centrally. The need for vertical and horizontal cooperation (discussed in Baron's, 1985, seminal contribution) is often seen in network industries. Administrative costs and distributional concerns, of course, make inter-jurisdictional cooperation difficult. However, differentiated regulation and geographically tailored policies might be required as local governments may have better commitment and other collective action abilities, and also because of the reasons forwarded for many years in the fiscal federalism literature: principally, that is, to take into account differences in collective preferences, costs and consumer demand, and to promote policy experimentation in the face of uncertainty. This uncertainty may be due to technological or demand unknowns or to experts disagreeing on what constitutes the best policy option. For example, in broadband markets, scholars hold different opinions[23] as to the best way to promote competition: either through facilities-based, vertically integrated rivalry or through a "ladder of investment" by which entrants are initially helped by regulators to use the infrastructure of the incumbent, and are progressively encouraged to build their own infrastructure.

The trend in Europe has been to strengthen the regulatory role of the European Commission and to create national (member state) independent regulatory agencies, with little consideration being given to the need to accommodate some degree of local or regional power and to coordinate such regulation with other policies. We claim that discussions of regulatory federalism should be the object of more research, especially as

[23] See Trillas (2008a) for a summary of this debate.

Europe has recently created a Pan-European regulator in its third package of European directives on telecommunications.

References

Ades, A.; di Tella, R. (1997), National Champions and Corruption: Some Unpleasant Interventionist Arithmetic, *Economic Journal*, 107: 1023-1042.

Aubert, C.; Laffont, J.J. (2002), Designing Infrastructure Regulation in Developing Countries, in Beato and Laffont, eds., *Competition Policy in Regulated Industries. Approaches for Emerging Economies*, Interamerican Development Bank.

Bardhan, P.; Mookherjee, D. (2006), Decentralisation and Accountability in Infrastructure Delivery in Developing Countries, *Economic Journal*, 116(508), 101-127.

Baron, D.P. (1985), Noncooperative Regulation of a Nonlocalized Externality, *Rand Journal of Economics*, 16(4): 553-568.

Blume, L.; Voigt, S. (2008), Federalism and Decentralization –A Critical Survey of Frequently Used Indicators, *Constitutional Political Economy*.

Brennan, T. (2001), Policy, Federalism, and Regulating Broadband Internet Access, Resources for the Future, Discussion Paper 01-02.

Budzinski, O. (2006), International Competition, Economics of Federalism, and Competence Allocation Rules, available at SSRN: http://ssrn.com/abstract=927709.

Caillaud, B.; Jullien, B.; Picard, P. (1996), National vs. European Incentive Policies: Bargaining, Information and Coordination, *European Economic Review*, 40: 91-111.

Distaso, W.; Lupi, P.; Manenti, F.B. (2006), Platform Competition and Broadband Uptake: Theory and Empirical Evidence from the European Union, *Information Economics and Policy*, 18: 87-106.

Friederiszick, H.W.; Grajek, M.; Röller, L.H. (2007), Analysing the Relationship between Regulation and Investment in the Telecom Sector, ESMT Competition Analysis.

Gual, J.; Jódar, S. (2007), European Telecoms Regulation: Past Performance and Prospects, "la Caixa" Working Paper Series 04/2007.

Hahn, R. W.; Layne-Farrar, A.; Passell, P. (2003), Federalism and Regulation. What Sorts of Regulation Are Best Handled on the Federal Level, *Regulation*, Winter 2003-2004, 46-50.

Hoffinger, R.E. (2003), "Cooperative Federalism" gone wrong: The Implementation of the Telecommunications Act of 1996, *Journal on Telecommunications and High Technology Law*, 2: 375-397.

Humplick, F.; Estache, A. (1995). Does Decentralization Improve Infrastructure Performance? in Estache, A., ed., *Decentralizing Infrastructure. Advantages and Limitations*, World Bank Discussion Paper 290.

Inman, R.P. (2008), Federalism's Values and the Value of Federalism, *CESifo Economic Studies,* 53(4): 522-560.

Inman, R.P.; Rubinfeld, D.L. (1997), Making Sense of the Antitrust State-Action Doctrine: Balancing Political Participation and Economic Efficiency in Regulatory Federalism, *Texas Law Review*, 75(6): 1203-1299.

Laffont, J.J.; Pouyet, J. (2004), The Subsidiarity Bias in Regulation, *European Economic Review*, 88(1-2): 255-283.

Lehr, W.; Kiessling, T. (1999), Telecommunications Regulation in the United States and Europe: The Case for Centralized Authority, in *Competition, Regulation and Convergence: Trends in Telecommunications Policy Research*, Gillett, S.E. and Vogelsang, I., eds., Lawrence Elbaum Associates.

Mulligan, C.B.; Shleifer, A. (2005), The Extent of the Market and the Supply of Regulation, *The Quarterly Journal of Economics*, 120(4): 1445–1473.

Neufeld, J.L. (2008), Corruption, Quasi-Rents and the Regulation of Electric Utilities, *The Journal of Economic History,* 68(4): 1059-1097.

Nonnenmacher, T. (2001), State Promotion and Regulation of the Telegraph Industry, 1845-1860, *The Journal of Economic History*, 61(1): 19-36.

Nuechterlein, J.E.; Weiser, P.J. (2007), *Digital Crossroads. American Telecommunications Policy in the Internet Age.* The MIT Press, Paperback Edition.

Smith, W. (2000), Regulating Utilities: Thinking about Location Questions, World Bank Summer Workshop on Market Institutions. Mimeo, World Bank, Washington, D.C., July 2000.

Sun, J-M.; Pelkmans, J. (1995), Why Liberalisation Needs Centralisation: Subsidiarity and EU Telecoms, *World Economy*, 18(5): 635-64.

Tiebout, C.M. (1956), A Pure Theory of Local Expenditures, *The Journal of Political Economy*, 64(5): 416-424.

Treisman, D. (2006), Explaining Fiscal Decentralization: Geography, Colonial History, Economic Development and Political Institutions, *Commonwealth and Comparative Politics*, 44(3): 289 325.

Treisman, D. (2007), *The Architecture of Government. Rethinking Political Decentralization*. Cambridge University Press.

Trillas, F. (2008a), L'economia de les telecomunicacions en banda ampla, *Document d'Economia Industrial 33*, Centre d'Economia Industrial.

Trillas, F. (2008b), Regulatory Federalism in Network Industries, IEB Working Paper 2008/8.

Troesken, W. (1996), *Why Regulate Utilities? The New Institutional Economics and the Chicago Gas Industry*, University of Michigan Press.

Wallsten, S. (2005), Broadband Penetration: An Empirical Analysis of State and Federal Policies, *AEI- Brookins Joint Center for Regulatory Studies Working Paper* 05-12.

Wallsten, S. (2006), Broadband and Unbundling Regulations in OECD Countries, *AEI-Brookings Joint Center for Regulatory Studies Working Paper* 06-16.

Waverman, L.; Meschi, M.; Rellier, B.; Dasgupta, K. (2007), *Access Regulation and Infrastructure Investment in the Telecommunications Sector. An Empirical Investigation*, LECG.

Weingast, B.R. (1995), The Economic Role of Political Institutions: Market-Preserving Federalism and Economic Development, *The Journal of Law, Economics & Organization*, 11(1), 1-31.

Table 1: Summary of arguments: the link between federalism and network industries

	Favours Central Regulation	**Favours Local Regulation**	**Ambiguous**
First Generation	-*Externalities and scale* -Coordination -Race to the bottom -Beggar thy neighbour	-Laboratory federalism -*Tailoring* -Regulatory Competition	-*Market definition* -Special districts
Second Generation	-Quasi-rents -Compliance costs -Regulatory capacity	-Market preserving federalism -Political participation -Accountability	-Contractual issues -Capture -Commitment

Source: authors' own.

Table 2. Fixed effects panel estimations for OECD countries.

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
Constant	-54.958 (-3.49)***	-64.324 (-3.90)***	-63.653 (-5.23)***	-75.367 (-6.33)***	-108.76 (-4.66)***	-82.267 (-5.36)***	-88.787 (-3.79)***	-69.632 (-4.71)***	-192.79 (-4.62)***
Demographics									
GDPpc	0.0004 (6.57)***	0.0005 (8.53)***	0.0004 (6.53)***	0.0006 (9.55)***	0.0011 (6.63)***	0.0006 (9.80)***	0.0010 (5.43)***	0.0005 (8.23)***	0.0014 (5.08)***
Density	313.91 (2.45)***	359.92 (2.75)***	369.59 (3.91)***	404.67 (3.89)***	536.39 (2.789)***	503.484 (4.40)***	428.58 (2.15)**	425.73 (3.62)***	1251.9 (3.26)***
Competition									
HH-inter	-0.693 (-0.41)	-4.312 (-3.69)***	--.--	-.-	--.--	--.--	--.--	--.--	3.485 (0.86)
HH-intra	-3.463 (-2.56)**	--.--	-4.005 (-4.39)***	-.-	--.--	--.--	--.--	--.--	-2.534 (-0.73)
Unbund regulation									
Full unbund	-.-	-.-	-.-	1.993 (3.78)***	--.--	--.--	0.915 (1.29)	2.001 (3.62)***	--.--
Subloop	-.-	-.-	-.-	-1.343 (-0.51)	--.--	--.--	--.--	--.--	--.--
Public policies									
Subsidies	-.-	-.-	-.-	-.-	12.508 (0.645)	--.--	13.111 (0.49)	--.--	22.853 (0.43)
Decentralization									
%Cent revenue	-.-	-.-	-.-	-.-		-19.364 (-2.90)***	--.--	-14.884 (2.27)**	18.617 (1.36)
N	186	195	186	224	140	208	135	200	71
Countries	29	29	29	28	29	27	28	26	15
R^2 *within*	0.6522	0.6691	0.6826	0.6803	0.6560	0.6522	0.5351	0.6768	0.7433

Note: Dependent variable is the percentage population of broadband penetration, i.e., total number of broadband subscribers/total population (source: Point Topic Ltd.). We use a logit transformation of the dependent variable ln(y/1-y). Results are robust to the use, as dependent variable, of the percentage of broadband household penetration (total number of broadband subscribers/total number of households). Full time period is 1999-2006 although the panel is unbalanced. No time effects used.

Table 3. IV Fixed effects panel estimations for OECD countries.

Variables	**Model I**	**Model II**	**Model III**	**Model IV**	**Model V**	**Model VI**
Constant	-76.355 (-4.70)***	-77.578 (-4.77)***	-65.543 (-5.51)***	-169.33 (-5.24)***	171.46 (-4.57)***	-154.19 (-4.07)***
Demographics						
GDPpc	0.0004 (5.13)***	0.0004 (6.00)***	0.0004 (5.23)***	0.0014 (5.57)***	0.0014 (4.66)***	0.0013 (3.85)***
Density	509.44 (3.70)***	537.66 (3.74)***	435.70 (4.20)***	916.91 (3.41)***	884.88 (3.16)***	824.89 (2.82)***
Competition						
HH-inter	2.711 (1.33)	-4.100 (-3.55)***	-.-	-.-	-.-	-.-
HH-intra	-5.971 (-3.61)***	-.-	-3.754 (-3.96)***	-.-	-.-	-.-
Unbund regulation						
Full unbund	-.-	2.374 (4.70)***	1.631 (2.93)***	-.-	-.-	0.645 (0.80)
Subloop	-.-	-1.591 (-0.73)	-2.080 (-0.97)	-.-	-.-	-.-
Public policies						
Subsidies	-.-	-.-	-.-	62.647 (1.39)	64.010 (1.37)	67.575 (1.43)
Decentralization						
%Cent revenue	-.-	-.-	-.-	-.-	-1.156 (-0.08)	-0.509 (-0.03)
N	172	176	168	111	103	99
Countries	29	28	28	29	27	26
R^2 *within*	0.6694	0.7305	0.7151	0.5924	0.5874	0.5841
Endogenous variables	*GDPpc HH-inter HH-intra*	*GDPpc HH-inter*	*GDPpc HH-intra*	*GDPpc Subsidies*	*GDPpc Subsidies*	*GDPpc Subsidies*

Note: see Table 2.

Table 4. Fixed effects panel estimations for EU countries.

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
Constant	-91.053 (-4.52)***	-94.681 (-4.46)***	-87.172 (-4.52)***	-114.32 (-5.91)***	-112.84 (-2.9)***	-73.923 (-3.87)***	-134.20 (-6.42)***	-82.923 (-3.70***)	-74.944 (-3.87***)
Demographics									
GDPpc	0.0002 (3.00)***	0.0004 (5.09)***	0.0003 (3.11)***	0.0003 (2.60)***	0.0008 (3.94)***	0.0006 (7.45)***	0.0004 (4.28)***	0.0004 (5.11)***	0.0003 (4.06)***
Density	547.56 (3.79)***	538.06 (3.58)***	522.79 (3.74)***	704.01 (4.62)****	572.75 (1.97)*	444.51 (3.18)***	767.33 (5.12)***	505.42 (3.34)***	478.94 (3.30)***
Competition									
HH-inter	1.399 (0.70)	-2.810 (-2.17)**	-.-	-.-	-.-	-.-	-.-	-2.382 (-1.80)*	-2.972 (-2.54)**
HH-intra	-4.247 (-2.69)***	-.-	-3.368 (-3.49)***	-.-	-.-	-.-	-.-	-.-	--.--
Unbund regulation									
Full unbund	-.-	-.-	-.-	2.106 (3.37)***	-.-	-.-	-.-	-.-	2.649 (4.84)***
Llp	-.-	-.-	-.-	-0.008 (-0.43)	-.-	-.-	-.-	-.-	-.-
Public policies									
Subsidies	-.-	-.-	-.-	-.-	14.166 (0.50)	-.-	-.-	-.-	-.-
Decentralization									
%Cent revenue	-.-	-.-	-.-	-.-	-.-	-22.862 (-3.27)***	-.-	-12.397 (-1.71)***	-4.963 (0.433)
Row1	-.-	-.-	-.-	-.-	-.-	--.--	-1.755 (-1.40)	-.-	-.-
N	111	118	111	112	91	150	120	117	109
Countries	19	19	19	14	19	19	15	19	18
R^2 *within*	0.6699	0.6824	0.6681	0.7291	0.4677	0.6648	0.6983	0.6884	0.7593

Note: see Table 2.

Table 5. IV Fixed effects panel estimations for EU countries.

Variables	**Model I**	**Model II**	**Model III**	**Model IV**	**Model V**	**Model VI**
Constant	-105.65 (-5.03)***	-92.893 (-4.63)***	-148.72 (-2.91)***	-104.69 (-2.65)***	-144.61 (-2.80)***	-154.19 (-4.07)***
Demographics						
GDPpc	0.0002 (2.11)**	0.0003 (2.23)**	0.003 (3.86)***	0.0007 (2.79)***	0.0011 (2.94)***	0.0013 (3.85)***
Density	653.64 (4.28)***	567.30 (3.57)***	740.17 (1.89)*	641.80 (2.12)**	787.93 (1.97)**	824.89 (2.82)***
Competition						
HH-inter	3.940 (1.59)	-.-	-.-	-.-	-.-	-.-
HH-intra	-6.185 (-3.04)***	-2.303 (-1.96)**	-.-	-.-	-.-	-.-
Unbund regulation						
Full unbund	-.-	2.585 (4.05)***	-.-	-.-	-.-	0.645 (0.80)
Llp	-.-	0.021 (1.16)	-.-	-.-	-.-	-.-
Public policies						
Subsidies	-.-	-.-	65.968 (1.27)	15.812 (0.55)	66.376 (1.27)	65.575 (1.43)
Decentralization						
%Cent revenue	-.-	-.-	-.-	-22.776 (-1.67)*	-11.146 (-0.71)	-0.509 (-0.03)
N	100	81	72	89	72	99
Countries	19	15	19	19	19	26
R^2 *within*	0.6858	0.7502	0.5372	0.4912	0.5419	0.5841
Endogenous variables	*GDPpc HH-inter HH-intra*	*GDPpc HH-intra*	*GDPpc Subsidies*	*GDPpc*	*GDPpc Subsidies*	*GDPpc Subsidies*

Note: see Table 2.

2009

2009/1. Rork, J.C.; Wagner, G.A.: "Reciprocity and competition: is there a connection?"
2009/2. Mork, E.; Sjögren, A.; Svaleryd, H.: "Cheaper child care, more children"
2009/3. Rodden, J.: "Federalism and inter-regional redistribution"
2009/4. Ruggeri, G.C.: "Regional fiscal flows: measurement tools"
2009/5. Wrede, M.: "Agglomeration, tax competition, and fiscal equalization"
2009/6. Jametti, M.; von Ungern-Sternberg, T.: "Risk selection in natural disaster insurance"
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