



Regulating Networks in the New Economy

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Abstract: The regulation of network industries has undergone profound transformation in the past twenty years. The regulated industry is no longer the same, being exposed to new competitive dynamics having revolutionized their industrial framework, technology and interactions with users. There also have been fundamental changes in what regulation is feasible. In an “information society” a model devised in the 19th century to set prices for monopoly infrastructures such as bridges, roads and railways no longer captures the essential: the interactive dynamics created by technologies, uses, and markets.

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1 Introduction

The regulation of network industries has undergone profound transformation in the past twenty years (Brousseau, Glachant, & Fares, 2002; Glachant, 2002). On one hand, the regulated object is no longer the same. These sectors have been exposed to new competitive dynamics that have revolutionized their industrial framework, technology, and interactions with users (Glachant & Lévêque, 2009). They have participated in the social and entrepreneurial revolution of the "Internet decades". On the other hand, there have been fundamental changes in what regulation is feasible (Joskow, 2002; Laffont, 2003; Kessides, 2004). In an information society based on creating knowledge, a regulatory model devised in the 19th century to set prices for monopoly infrastructures such as bridges, roads and railways no longer captures the essential: the interactive dynamics created by technologies, uses, and markets (Noam, 2001; Macintyre, 2003; Brousseau & Glachant, 2011). Finally, social and political processes have also reconstituted a large proportion of the stock of human assets while, metaphorically, the baby boomer generation has begun taking its curtain call and exiting the stage of decision makers. Regulations have thus profoundly changed and become more responsive, as is captured by the expressions "democracy of opinion" or "democracy of lobbies". We are in neither the economy nor the society of Keynes' Welfare State in the "Glorious Thirties" of the twentieth century.

To benchmark some of these fundamental changes we make some simplifying assumptions. We accept the notion of a "new economy" in which growth is propelled by innovation and the knowledge-based creations more than ever. We note that creative and productive processes have fundamentally and systemically fragmented into interacting blocks. Today, these processes are organized into "modules" articulated around "interfaces" that buffer the separability of their internal design and operation, while simultaneously ensuring their precise coordination in the execution of vast, multi-task and multi-agent programs (Aoki, 2001; Baldwin, 2008). This renewed differentiation of processes has profoundly infiltrated the structure of markets and goods, displacing the old "Fordism – Taylorism" paradigm with a new one of "mass customization". Modular processes - articulated around *ad hoc* interfaces for differentiated mass production - provide a logical, material, and logistical basis for a veritable globalization of creation, production, and use. Furthermore, on each link of these chains, at each of their interfaces, and even within each of their modules, we find a near-organic proliferation of new information and communications technologies.

What are the principal consequences? Which ones permanently alter the organizational and institutional underpinnings (Williamson, 2000; Brousseau & Glachant, 2008; Glachant & Perez, 2011) on which the economy of regulation rested for the second half of the 20th century in Europe and the United

States, around Marcel Boiteux or Alfred E. Kahn?

2 The Three Permanent Transformations of the Regulatory Economy

The operational framework within which the economics of regulation govern network industries has experienced three permanent mutations. They are, (1) a decline in information costs brought about by New Information and Communications Technologies (NICT), (2) the fact that the knowledge required to understand the issues surrounding innovation is inextricably embedded in its functioning, and (3) modularity in the production and usage processes of network industries.

The first permanent transformation is the NICT. These technologies undergird a real information-based monitoring of the new processes and new services and goods, as well as their new uses (Brousseau, Glachant, & Fares, 2002; Brousseau & Raynaud, 2006). These aids to "traceability" render obsolete the intimate economy built on relationships, learning, and strategies, as is borne out by the new microeconomics of information, incentives, and contracts. The "market failures" of the old microeconomic theory of market equilibria (partial and general equilibrium models of the years 1880–1980) identify many threats or hurdles to opportunities for trade, barter, and private interactions: be they the presence of externalities, technological inseparability, or strategic "small number" relationships. Today the wealth of information provided by Information and Communications Technologies (ICT) makes it possible to envision new arrangements that are feasible and Pareto-improving, encompassing the many cases of the "failure" of traditional markets. This is the creative field covered by "Market Design" (Wilson, 2002; Buchner, Carraro, & Ellerman, 2006). ICT permit monitoring the progress of complex chains of transactions on the basis of multi-criteria data points. In old industries, such as electricity, it was widely believed, as recently as 25 years ago, that the cost of collecting and processing real-time information on injections and withdrawals of power constituted an insurmountable barrier to the creation of open wholesale markets. Today, the Netherlands, Belgium, and France share a daily power exchange and wholesale electricity prices, already joined by Germany. Pursuing this new vein of microeconomic theory a little further, whether in the design of private arrangements or policies to monitor competition and compliance on markets, we observe an array of actual or potential ways in which ICT has redefined the problems inherent in overseeing complex transactions, from the robustness of cooperative frameworks to . . . collusion. ICT increase the informational potential and facilitate monitoring "complex" operations (i.e. multi-criteria, multitask, and multi-agent) by providing various forms of control and evaluation for new processes. ICT have also breathed new life into intelligent public administration. This involves delegating day-to-day opera-

tional tasks to outside contractors and leaving the hands-on management of transactional difficulties to private interactions (Saussier & Glachant, 2006). Public administration can refocuss on its core public mission: to identify attainable societal goals and define criteria for evaluating them, and to verify the acceptability of the processes and the compliance of performances.

However, a further transformation, on the same scale, undermines the promise of ICT for a new, intelligent, public administration. This second transformation is the ongoing fluidity of technological, industrial, and organizational innovation, commercialization by professionals, and application by users (B2B, B2C, and BacktoB). This is because these innovations are continually creating new frameworks of knowledge. Within these new knowledge frameworks, it is now practices (of design, production, commercialization, and application) that generate the codes and languages allowing order to be imposed on the information, processing and understanding the plethora of signals exchanged and stored thanks to new ICT. Outside of these communities of activity, even quite close to them, we can easily capture the messages and signals, but we have great difficulty decoding the data and comprehending the stakes. Here, the public administration is not deaf or blind because of insufficient information, but rather because of a lack of expertise. This weakness arises because public administration doesn't directly participate in the process of creating these practices and has no hands-on involvement. Obstacles to monitoring existing practices and anticipating future circumstances thus seriously obstruct the work of public bodies and agencies as they strive to oversee private decisions and regulate processes (Laffont & Tirole, 2001; Littlechild, 2006). One theoretical assumption from the microeconomics of incomplete contracts rings true: The public third party ("the judge") does not know what needs to be understood or done, even when the feuding parties to the contract provide all the databases relevant to the matter. Private order and private justice get things done... for better or worse, where both public order and public justice have been displaced by arbitrary decisions, lobbyists' manipulations and, finally, poor administration, and legal uncertainty. The cognitive framework for contemporary government regulation is given by an explosion of private activity in the production, warehousing, and transmission of informational signals. However, these are not easily evaluated by third party administrations, who eschew permanently creating new codes and new languages embedded in communities of professionals or users, communities of practitioners (Glachant, 2005; Glachant, Dubois, & Perez, 2008). This is the inevitable upshot of knowledge and capability embeddedness.

A third and final permanent transformation of the organizational and institutional underpinnings of the regulatory economy forms a hinge between the first two: It is the modular nature of the processes (Glachant & Perez, 2008; Finon & Perez, 2007). This modularity organizes the separability of tasks and changes around interfaces defined as standardized

points of entry, or gateways. This new nature of processes provides third parties that are outside of these changes with a little more time in which to make decisions and a little broader perspective for assessing the feasible alternatives. Of course, modularity renders the characteristics of the required adaptations uncertain (Gonzalez-Diaz & Vasquez, 2008), whether in terms of the modules impacted by a given cluster of innovations or the interfaces that must refocus onto these new targets. Here, too, we find that regulation is disrupted by innovation and the associated uncertainty, as well as by specific, or idiosyncratic, properties of information and the knowledge to which it gives rise. However, this process modularity creates challenges with adaptation that are similar for operators and the agents of change all along the chain of modules and interfaces affected by waves of innovation between technology, industry, commercialization, and use (Holburn & Spiller, 2002). In consequence, the regulator and the regulation may take advantage of these sequences of adaptive delays to carve out a role for themselves in the chain of modular innovations (Hogan, 2002). Regulator and regulation can open forums on "production in the public sphere" in which assorted private actors can continue competing in the creation of formal frameworks for future cooperation. In this competition, private actors will have to externalize knowledge to have an influence on publicly produced legitimized standards and mechanisms. This is because legitimate new operational codes will be actionable before all the general institutions of society (agencies, courts, administrative bodies, and parliament). Therefore, they exercise a long-term influence on private conflicts over definitions and coding, appropriation and valuation, access and usage. Public regulation based on forums, deriving from "green papers – white papers", from public hearings or soft-regulation tools (such as statements of intent or interpretation) thus constitute a broad mechanism for revealing information and knowledge. Here communities, interests, and lobbies come to meet or clash, compete or collide - and in so doing enrich or derail the creation of public legitimacy (Everlein, 2005). These "open" regulatory processes reduce informational asymmetry and the embedding of knowledge, thus favouring information revelation and knowledge transfer (Libecap, 2002; Kleindorfer, 2004). This third, and final, transformation of the modern regulatory economy thus contributes to the creation of a new regulatory mix combining a wealth of information and a dearth of comprehension into an imperfect, but viable, regulatory process. This is reminiscent of J. M. Clark's "workable competition", with which he reconciled the obvious imperfections of market failure with the administrative capacity expected of the Welfare State nearly sixty years ago.

In this radically new context for the economic regulation of network industries, which dimensions of the changes to regulatory activity should we address? We are not interested in the organizational and institutional machinery of regulation; nor in the machinery for creating laws, decrees, cir-

culars, and rules (Cameron, 2005); nor in the independence of the regulator, or its relationship with parliament or the government, with judges, with competition watchdogs, or with other regulators (financial markets, environment, police, privacy, etc.). In keeping with common practice among economists, we focus on modifications affecting the essence of regulatory activity. We identify four main themes in the remaking of regulation. (1) There is a renewed interest in allocating the monopoly's fixed costs among the various actors and users, between prolonging the decisions of the past and making new decisions to usher in the future. (2) Next, account is taken of property rights as the new "essential" institutional decision making infrastructure in these complex multi-task and multi-agent environments. Here, again, we are faced with the notion of an "institutional infrastructure" for market processes developed by the Nobel laureate R. Coase. (3) Thus, in a very Coasian sense, account is taken of all new modalities for managing network externalities. Negative externalities include congestion, by-products, and harm resulting from the operation of network industries. Positive externalities cover benefits arising from the interconnection and interoperability of networks, equipment, and network services. (4) Finally, and in contrast to the three spheres of fixed costs, property rights, and externalities, a last sphere focuses on producing the "the public weal" and public standards through regulatory activity. The public nature of this regulatory production also appears as strongly institutional, as it essentially springs from the interwoven process of legitimization across all formal mechanisms of the public institutional environment, from the judge's chambers to the office of the minister. The mechanisms of this process, crowned with formal legitimacy, confer a public character to the resulting norms and decision criteria to a much greater extent than the intrinsic content of the standard or criterion in question.

3 A Renewed Interest in the Economics of Fixed Costs

Since the second half of the 19th century and the early 20th century, the economics of fixed infrastructure costs under monopoly have provided the economic rationale for the public regulation of network industries (consider scientific contributions of: John Stuart Mill, Jules Dupuit, Augustin Cournot, Alfred Marshall, Alfred Picard, John Bates Clark, Clément Colson, and Léon Walras). These underpinnings experienced several theoretical revolutions during the 20th century, such as marginal welfare analysis under partial or general equilibrium, under first-best or second-best conditions, with or without consideration of incentives perceived by managers, users, and regulators in these industries, or the constraints arising from the limited information available to public authorities and regulators (consider scientific contributions of: Vilfredo Pareto, Arthur C. Pigou, Harold Hotelling,

Abba P. Lerner, Maurice Allais, Marcel Boiteux, Kenneth J. Arrow, Gerard Debreu, Jean-Jacques Laffont, Jean Tirole).

In the past fifteen years, the emergence of new technologies that make strong and nearly exhaustive traceability of infrastructure usage possible has raised hopes for the dawn of an era of intelligent regulation, finally based on data that is entirely objective. Numerous improvements, linked to the power of databases and computational ability, today allow short-term marginal costs to be assessed on a horizon approaching real time (every ten minutes) on electrical grids of the size France plus Germany.¹

However, these advances have not yet made it possible to rationally close the loop on fixed costs of infrastructure industries (Green, 2003; Joskow & Tirole, 2005; Joskow, 2006). On one hand, real time calculations of marginal network operating costs only allow these marginal costs to be allocated over very short time horizons. They provide no information on how to allot cumulative fixed costs resulting from historical investment decisions in the network to the various uses today. On the other hand, very short-term marginal costs do not tell us how to compute the marginal costs of network development that lie at the heart of new decisions. These marginal network development costs always reflect future network usage scenarios. Thus, they are based on "network demand" assumptions from both growth projections and the various potential configurations of potential network uses.

As long as network infrastructures remain integrated in ownership and in management of the production of the basic service consumed by the final user, a provision for "integrated" competition may frame the two activities simultaneously, as in the case of the network and the service of portable telephony. In this case, it is the producers of the basic service who make the decisions to invest in the network (in capacity and technology choice) and who assume the future consequences. Conversely, in instances in which network infrastructures remain monopolies having been separated from the basic service through "unbundling", it is the infrastructure manager - more or less well regulated - who makes investment decisions (Léauthier & Thelen, 2008; Rious et al., 2008). However, this requires anticipating the future activities of producers of the basic services and the future behaviour of final consumers (Rious, Glachant, & Dessante, 2010).

The proliferation of alternative uses for existing networks and potential future developments thus constitute a real limitation on the routinization of network infrastructure management decisions in practice. Of course, invoking competitive bidding to allocate current or future gas transportation or storage capacity (as "Open Season" does) allows some decisions related to investments in volume and price to be shifted onto the producers of basic services. Similarly, opening to secondary capacity markets (transportation

¹ Calculation of the marginal cost of injecting electricity in the PJM (Pennsylvania – New Jersey – Maryland) system which, in fact, reaches as far as Chicago.

or storage) extends this delegation of decisions to competing producers. However, neither one or the other of these two new types of competitive mechanisms truly eliminates the need for active entrepreneurship by the infrastructure manager, nor the role of "board of trustees" attributed to the regulator (World Bank, 2006; Glachant, 2011).

In this context, the regulator may opt to delegate its power to make major decisions to the manager of the network infrastructure, or simply yield to the pressures applied by the most vocal coalitions of interest groups. The regulator can also organize the production of relevant information, or at least a process for legitimizing choices, by inventing "open" methods of regulation, in which various interest groups can meet to clash and argue (Littlechild, 2012). The strategic manipulation of information by interest groups has also become one of the trickiest practical problems confronting regulatory bodies. This potential for manipulation is in no way curbed by the economic approach of "incentive regulation" that strives to shed light on the choices underlying the structural development of networks (in capacity and technology) (Helm, 2003; Jasmab & Pollitt, 2007). Nonetheless, the established fact that regulators are no better equipped in the 21st century than they were in the 20th, or even the 19th, to provide good guidance in infrastructure-related choices does not detract from the importance of the ongoing renewal (Guash, Laffont, & Straub, 2002; Guash, 2004).

In order to exercise the role of board of trustees for infrastructure, the regulator may elicit the generation of information and knowledge in "public town halls". The same is true for the other role played by the regulator, to wit, setting grid access fees. In the old regulatory economy, the vertically integrated monopolist limited the choice and quality of the services offered to users. Thus, in those days it was easier to set a price on this, more homogeneous, service on the basis of the total or marginal costs of the integrated monopoly. In the new regulatory economy, the expanding spectrum of uses, as well as their ongoing evolution on networks that are constantly being revamped by the addition or withdrawal of elements, makes the rationale underlying setting grid access and inter-network transfer fees increasingly foggy (Sappington, 2005). Here, too, the regulator can draw on forums for elements of identification and appreciation of the various options.

By opening a perennial space for discourse and confrontation to shed light on the unknown and the uncertain, the regulator is modifying her role and expanding her task list. The regulator thus becomes a sort of "common law" justice of the peace, like in the wild west, or a variant on the "code law" competition authority. In the act of organizing the nature and pace of these public debates, the regulator herself becomes a strategic player as an agenda setter for the production of public standards. As a second-rank strategic player, or a "soft power player", she interposes herself between the various interest groups, each possessing substantial private powers of information and significant social legitimacy, and from that position implements

her own strategic agenda of regulator: the legitimization of her decisions (Spiller, Stein, & Tommasi, 2003; Saleth & Dinar, 2004). To be able to sustainably link this strategic power of the regulator with the functioning of the rest of the public institutional environment, her decisions either must be subject to an appeal procedure in the courts (which opens the door to a progressive "judicialization" of regulation) or it must be construed as a legal body by at least partially assuming the status of a competition authority (Stephenson, 2005). This type of competition authority is clearly "impure" because it exercises a strategic power of manipulating conflicts between interest groups. However, the contemporary configuration of the regulator as a "competition authority" contributes a substantial degree of respectability. In this event, the regulator is legally active on two concurrent fronts (Tsebelis, 2002; Perrot, 2004). On one hand, as the regulator she retains influence over the formation of coalitions of interest groups. On the other hand, as the competition authority she controls the arrangements, dominance positions, and discrimination practised by these same interest groups. As a result, some of these regulators effectively exercise the function of "societal" competition authority arbitrating between interest groups competing to monopolize the supply of, or demand for, public standards (Rufin, 2003; Prosser, 2005).

4 The Institutional Core of the New Regulatory Economy: the Definition and Allocation of Property Rights

The importance of the role the regulator plays in arbitrating between interest groups competing in the supply of, or demand for, public standards is one of the *ex post* surprises of the new regulatory economy. *Ex ante*, the new regulatory economy is wagering on a Coasian reformulation of economic relations between agents active in network industries. With a sound allocation of well-designed and robust property rights, we should facilitate new private bargaining to bolster exchange mechanisms for the provision of all the variety and adaptations required by the functional and operational complexity of network industries (Libecap, 2002; Hadfield, 2005). This has effectively occurred, *grosso modo*, in the case of radio and television - for transmission on Hertzian waves and transportation by aeroplane (Glachant, 2002).

The reform of network industries has effectively laid the groundwork for opening to competition the definition of new rights, which may be allocated to either professionals or even directly to final consumers. When network infrastructures are duplicatable (long-distance fibre-optic networks and telecoms' Hertzian networks, or storage terminals for methane and liquefied natural gas), we have given all professionals the right of entry into

building and operating infrastructures, as well as into the production of basic or ancillary services. However, it is immediately apparent that the operation of these new, unregulated infrastructures needs to be coordinated with the general functioning of pre-existing regulated networks. This involves defining rules for interconnection and interoperability. These rules could be negotiated between the various operators (negotiated TPA) or imposed by an authority (regulated TPA).

However, when existing infrastructures (the electricity grid, local gas or telecom loop, hubs, etc.) cannot be duplicated under reasonable economic conditions, then the right to access this inescapable stock of infrastructure must be defined or redefined. New rights assigned to producers of the basic service (the electricity generator, the local gas distribution company, the Internet service provider, the airline) override the exclusiveness of other property rights, namely those of the infrastructure operator. The upshot is a juxtaposition of two groups of claims on the same economic resources: the rights of the user and the rights of the operator (Pagano, 2005).

However, this juxtaposition does not result in a voluntary rearrangement of rights after successive rounds of private bartering among agents brought together by their use of the same resources. On the contrary, this rearrangement of rights springs from an act of authority by which a public body (parliament, minister, regulator, or judge) assigns a specific position *ex ante* to the parties in the future bargaining. If the respective definitions of the rights of users and operators were as simple and traditional as in the "Bridges and Highways" case, then the full arsenal of conventional property law could easily be mobilized. However, the variety of uses and options, actual or potential, present or future, permitted by the opening of networks to competing service providers undermines the usefulness of a definition of network users' rights that is too simple and too standardized. This is obvious when the networks remain integrated with the activity of one of the service operators (in the absence of unbundling, the need to dismantle). Even if these networks are monopolies that are structurally independent of the service operators, the problem of defining rights persists when the profit functions and reaction functions of the network operators (operational criteria, technology choice, investment in capacity, etc.) are not properly controlled by regulators. This can make it difficult, sometimes even impossible, to find an *ex ante* definition of access rights that is good once and for all and is simple, general, and robust, allowing all actors to subsequently negotiate the succession of required adjustments amongst themselves (Libecap, 2002).

In principle, and often in practice as well, the regulator continues to play a key role in the property rights regime of all stakeholders. The regulator retains a role in defining and allocating access and usage rights amongst the actors. Of course, this function of the regulator is more decisive when innovations in production and use take the form of new variants in access rights or, symmetrically, new protections against actions that are harmful or

predatory to other actors. Thus, the very power to grant or deny to investors in new infrastructure exemptions to ceding access rights to third parties is a powerful lever for intervention by regulators (or government bodies).

On the whole, the property rights regime echoes the economics of fixed-costs. In the old regulatory economy, the property rights regime was simpler and more robust. This is because it was based on the general rights of a large-scale operator covering an industrial chain of infrastructure and integrated production of basic services and ancillary services. The interconnection and interoperability choices made by this integrated operator cannot be challenged by third parties. However, in the new regulatory economy, this chain has been fractured into conflicting and opposable rights over the same economic resources (IEA, 2001). Moreover, each time there is an advance in technologies and uses, this heterogeneous chain of rights must accommodate new specific rights arising from innovations in distribution and usage and adapt them to provisions for interconnection and interoperability. In these successive adaptive interplays of rights and uses, the regulator may prove particularly short-sighted or blind if it has no direct window on the dynamics underlying practices and knowledge.

5 In The Shadow of Property Rights: Negative Network Externalities

In theory, an appropriate redesign of property rights should allow network externalities to be reduced or even eliminated. By their nature these externalities represent market failures of the nonexcludability of benefits class, well known in public economics. Empirically, we often observe an exacerbation and an increased complexity of these externalities among network industries having been subject to pro-competitive reforms.

Negative network externalities primarily consist of congestion, accidents, and the provision of security for transactions. The increase we currently observe frequently springs from greater fragmentation of the chain of operations that is caused by vertical unbundling and exacerbated by free entry into production of the basic service or ancillary services along with free access to the grid. More fragmentation of the chain and a proliferation of operators, widespread externalization of tasks, and expanded variety of productions and uses, all contribute to raising the risks of congestion, accident, or security breaches (IEA, 2005). Repeated accidents and breakdowns in the British railway system, the most de-integrated train system in history, amply demonstrate the negative consequences that can arise from unbridled unbundling. Similarly, difficulties associated with securing data on the Internet reveal the risks inherent in free entry into very large-scale systems.

The fragility of the interfaces between the operational modules of the networks resulting from the expanding scale of operation of network systems emerges as another reality undermining the ability to regulate these

industries. Traditionally, the regulation of negative externalities has occurred on a much smaller scale, often national or sub-national. With the opening of networks, the real scale of operations of these industries may expand by orders of magnitude before the regulatory machinery is able to adjust. A devastating series of black-outs (the most spectacular affecting New York-Toronto and Italy in 2002, and Germany and continental Europe in 2006) repeatedly exposed the unpreparedness of authorities responsible for network security to cope with the new domino effects created by larger and more interactive zones. However, the direct management of local or within-zone congestion is facilitated by the introduction of economic mechanisms allowing congestion externalities to be internalized into the markets as they assign value to the use of networks at peak times: whether in the form of ironclad long-term rights (such as frequencies, routes and slots), "explicit" short-term capacity auctions, or "implicit" supply auctions that combine network capacity with the corresponding volume of the basic service, etc. Recourse to economic mechanisms for the management of network congestion can thus add to the simplicity or the complexity of transactions, depending on the stability and predictability of the corresponding uses (Brunekreft, Neuhoff, & Newbery, 2005).

The regulator ends up in the middle of regulating these activities. Nonetheless, the operational management of externalities is always under the aegis of third-party authorities, who may be systems operators - as in the case of gas and electricity, where the *Transmission Systems Operator* (TSO) is tasked with managing congestion and security. Thus, it is incumbent on the regulator to define the general rules for managing congestion and security since, practically, congestion management amounts to allocating a scarce resource (network access) between alternative uses. Security management, in turn, involves the right to define and control the characteristics of transactions and uses. These two dimensions of network externality management amount to as many *ad hoc* reconfigurations of the property rights of agents using the network - they impose strong constraints on access and usage rights. In order to limit the power of regulators, security authorities, or network managers to discriminate, we can restrict recourse to administrative procedures for managing capacity shortfalls during congestion; whether they serve non-economic priorities ("beauty contests"), giving priority to incumbent operators (grandfathering), first-come first-served allocation (queue), or prorata, etc. Market mechanisms for allocating scarcity may be preferred. These market mechanisms are based on auctions including or excluding secondary access rights and strict rules on usage (such as "use it or lose it" rules) (Ehrenmann & Smeers, 2005; Glachant, & Pignon, 2006).

Regulators play an important role in ensuring that infrastructure managers bring transparency and predictability to the management of congestion. Managers can envisage, in advance, attainable vectors of network us-

age that eliminate all foreseeable effects of structural congestion. These provisional computations make possible advance sales of firm commitments on usage rights guaranteed by capacity remaining available at the point of demand. We thus limit the random effects of congestion exclusively to random events. In this fashion, the opening of stable and recurring provisions for allocating peak capacity plays an important role in informing network users and securing their rights of access. However, placing the users of a rare infrastructure into competition through auctions managed by the monopolist provider of the capacity raises serious issues with regard to the temporal consistency of the regulation. The regulator must always strive to find a balance between the short-term economic equation, in which the auction mechanism drives down demand to the existing supply level, and the long-term equation in which development of network capacity fosters supply until it equals potential future demand (Glachant & Kalfallah, 2011; von Hirschhausen et al., 2011). All procedures for managing congestion thus address conflicts in usage involving owners of rights. However, some mechanisms are better than others at eliciting the revelation of information relevant to decision making by users and by network managers, and for rendering their action plans compatible. The generation of sufficient information to facilitate compatible action plans helps us coordinate reactions to congestion. When this coordination is adequate, most of the nasty effects of congestion can be avoided.

For this coordination to be truly possible, it is often necessary to adjust the operational scale of network regulation, which can frequently be at odds with the regional or national character of the institutional provisions of the regulation. We can see that a pan-European agency should be in charge of managing Europe's air traffic so as to maximize usage while minimizing risks. However, air traffic control is an institutional bastion of the member states. It isn't hard to see that a European agency should be responsible for a sensible ruling of the EU operation of electricity transmission grids and the security of gas pipelines and storage facilities. However, the operation of networks was another institutional bastion of the member states until the Third Energy Package creates a room for new EU bodies as ENTSOs and ACER. Again, we can see that a pan-European agency should define and allocate radio frequencies for the entire continent, so as to optimize and secure their usage, etc., etc. As A. Pigou observed in the *Economics of Welfare* in the 1920s, adapting the sphere of influence of regulatory authorities to changes in the operational dimensions of the services is one of the weak points of public systems of externalities management.

In conclusion, in the old regulatory economy most negative externalities were internalized into an integrated operational chain. This integration of network and user services operations, as well as - more often than not - the integration of externalities management with the definition of the rules under which they are managed, have disappeared in the new economy.

There are a number of acceptable provisions for managing negative externalities, but their effectiveness always requires a little extra zeal or effort from the regulator, authorities responsible for security, or congestion managers. Some of this activity can be stimulated with the appropriate economic incentives. However, the design and control of these incentive schemes requires extra zeal or effort from the regulator, in turn. The market-driven congestion management that works so well in the short term is useless or weak in the long term. That which proves effective when letting the market solve congestion problems is not appropriate for managing security and preventing accidents. As J. Tirole has reminded us on several occasions, firemen are paid a fixed salary, but they are subject to direct control by a formal hierarchy in the performance their duties. Unlike salesmen and representatives of business, these peace officers do not find their incentive in a percentage of the value of their productivity. However, it is the repeated actions of security agents and congestion managers that give rise to the operational content of network users' property rights. Thus, regulation and oversight by regulators are necessary to frame this process. In the aftermath of a succession of conflicts over network use, an entire jurisprudence has arisen to redefine *ex post* the effective rights of all parties. The resolution of conflicts over use under the control of the regulator and subsequently of judges entails the redesign of provisions for managing negative externalities wrested from the incumbent integrated operator. Here we finally find all the main ingredients of the Coasian recipe: "the market, the firm, and the law" (Shirley, 2002; Nyborg & Telle, 2004).

6 The Essence of Network Effects: Positive Externalities

Like negative externalities, positive network externalities result from "non-excludability" in property rights. On the supply side, these are mostly interconnection and interoperability and, on the demand side, club good effects and the impact of an increased variety of complementary goods. In principle, a planned reallocation of property rights can internalize them in new "expanded" rights, such as the rebundling of up- and downstream decision units, of platforms and services, or of basic services and ancillary services, etc. However, this type of redefinition of rights would also change the nature of the positive externality effects and recognize their usefulness to a new supply monopolist. This would defeat the purpose of deliberately opening networks to variety, initiative, and decentralized innovation. Consequently, here again we empirically see that the regime of externalities becomes increasingly complex in network industries having been subjected to pro-competitive reforms (Awerbuch, Crew, & Kleindorfer, 2000; European Commission, 2008; Chao, Oren, & Wilson, 2008).

The opening of standards for network operation (physical or intangible,

equipment or services) is one of the core features of the new economy of these industries. It is the opening of these standards that makes technological innovation and competition possible. We know of their importance to telecoms (terminals and new services) and the Internet. It is similar for air transportation. With the construction of connecting hubs (internal to large air carriers, Air France or British Airways, for example), followed by the obsolescence of the hub principle in the wake of low-cost non-stop flights between secondary airports (e.g. Ryanair). We have also seen this in electricity generation (the appearance of combined-cycle gas power stations, or cogeneration of heat and electricity with micro turbines), in the logistics of the gas supply (proliferation of methane terminals and minimal inventories "Peak shaving"), and in the postal service (variants of high-speed mail delivery). On the minus side, we have also seen this in the loss of correspondence effects between competing railways in British stations.

The opening of networks creates a real tension between the devolution of operating standards and increments to welfare contributed by positive externalities. Initiatives and innovations cannot develop without an open economy and decentralization of the standards regime. These developments lead to a *de facto* privatization of the standards protection regime - with or without a "standards war" - around an open operating standard. They can thus result in greater protection of the operators' investments through an appropriation regime (patents) that can make maintaining the open character of operating standards very difficult.

In this new framework the role of the regulator is to manage tension. She must safeguard the "open" nature of networks by supporting the process of developing open standards, while also controlling the exercise of market power by operators who dominate the dynamics of elaborating standards. In networks of physical infrastructure (transportation and energy), the regulator must maintain open interconnections and interoperability by ensuring that the dominant operators do not deter new entrants by erecting barriers to economies of scale (in particular, access to the best segments of the transmission grid, or access to auxiliary network services - such as storage or energy balancing) (Commission of the European Communities, 2007; Commission of the European Communities, 2005).

In the old network economy, operating standards were determined centrally by negotiation between the integrated operator and its equipment manufacturer, then endorsed by the administration with or without rules for connecting with neighbouring zones or countries. The upshot is that, globally, interconnections and interoperability are strong within each zone of operation, but weak between zones (cf. the technical rules for electrical motors on trains). In this new economy, the creation of standards has been privatized and globalized, while the desire is for greater integration between standards so as to exploit the vast positive externalities (Internet services being the archetype). However, maintaining open standards and

operational consistency has been made increasingly difficult by the proliferation of standards (alternative or complementary) underlying the greater variety of equipment and services. Anti-trust activity by regulators or competition authorities (cf. the European Commission's DG Competition vs. Microsoft) becomes essential for safeguarding the openness of networks and guaranteeing the disclosure of key information on critical points at critical times (early stage and key implementation points) (Twomey et al., 2005; Gilbert & Newbery, 2007).

7 The Holy Grail of Regulation: the Public Good

Even though the role and tools of regulation change, promoting the public good remains at the centre of its functioning. The regulator remains a quintessentially public institution that sets the rules of the game applicable to economic agents and provides the rationale for the credibility of powers detained by all public institutions. Given this context, the activity of the regulator is always constrained by informational asymmetry between her and other economic agents (Smeers, 2005). This asymmetry can motivate the regulator to opt for a close relationship with agents, which may reduce uncertainty, but at the risk of capture by one or the other of the dominant interests (Waddams Price, 2004; Spiller & Liao, 2008; Thomas, 2007). However, all of these agents are also exposed to an irreducible risk created by innovations in technology, business models, or usage (Giannakis, Jasmab, & Pollitt, 2005). None of these networks can develop complete market systems, and all agents must, in turn, make decisions within a framework of information that is inherently incomplete, whether in the choice of technology or capacity, the allocation of past and future costs, or the reaction to negative or positive externalities (Cramton & Stoft, 2008; Butler & Neuhoff, 2008; Vandezande et al., 2011).

If the regulator imputes great importance to independence or neutrality, she can strategically manoeuvre to shore up the central role of arenas and forums. These open spaces of rivalry and cooperation between the various stakeholders allow her to reduce asymmetry in the information and its manipulation by interest groups. By virtue of participating, agents can also reduce their knowledge deficit through the exchange of data and the generation of pooled information.

This potential for the open generation of information that is mutually contestable has an impact on the design of the new regulatory framework. The regulator may learn to create open arenas in which public "postings" create a new type of information and a new way of generating information. This "posting" acts like a public display allowing recurring alterations to be immediately visible to all, in the manner of a collective "post-it" or a blog of the preparation of the regulation. In the traditional lobbying process, especially when the executive power strongly dominated the legislative power -

as in France - the regulator only had access to information that was subject to manipulation by the biggest interest groups (especially, the incumbent operators). The new regulatory framework of an open arena provides an incentive for other, smaller, interest groups to participate, allowing a better reciprocal control of strategic manipulation by one side or the other. Hidden information is now easier to ferret out, since everything that is relevant to the decision process is now on display in a virtual fishbowl (Graham, 2006; European Commission, 2007; Waddams et al., 2007).

It goes without saying that the open forum system is not perfect, either. Uncertainty regarding the future properties of the network system may give rise to dilemmas of false revelation of shared knowledge, as in the case of the "winner's curse". However, the openness of the arena should, in principle, limit this effect, which seems more representative of the process of eliminating stakeholders in rival auction systems. Conversely, this openness could actually facilitate the revision of common knowledge by allowing open, and thus revisable, consensus to emerge. Regulation thus frames a dynamic in which consensus generates achievable outcomes that are less diverse and profuse than the set of all potential equilibria. Regulation by "open arena" leads to focal points in which expectations converge to create a space of common beliefs and consistent behaviour, as in the economic theories of Greif (2005) or Aoki (2001). To maintain the power these arenas have to produce information and behavioural consistency, regulators must nurture their dynamics by accounting for the interests of the various stakeholders. The regulator assumes a central role in recognizing the "constraints on participation" facing the various interests in the regulatory interplay. This notably implies that, typically, regulatory changes will be incremental, so as to avoid violating these constraints. Aside from the issue of a participation constraint, the regulator must also manage the continuity of the openness of the informational arena. This will allow new potential futures and loci to emerge, giving rise to new regulations despite the existence of irreducible uncertainty. Everybody, including the regulator, knows that the open framework is uncertain. An open arena generates a consensus on the need to revise the framework, step by step, as the shared knowledge evolves.

Here new forms of regulation come into their own. On one hand, "soft regulation" becomes an essential component of regulation by allowing new spaces to emerge before they have been fully delineated. Regulation takes shape over the progressive adjustment of behaviour around the production of new, as-of-yet untested, principles. Here regulation functions as the organization of a process of the convergence of beliefs around new benchmarks. On the other hand, it is "reflexive regulation" that transforms the mechanisms of production by striving to surpass unilateral "top down" (discretionary regulator) and "bottom up" (capture of the regulator) actions. This new regulation will frequently be adapted and revised as information and beliefs evolve, or under the influence of the entry of new actors or new prac-

tices into the open arena of the regulation. Of course, the regulator may appear to be structurally captured, in light of her role bringing together assorted interests and beliefs. However, the regulator can also arrange to depend on coalitions that are sufficiently large or adaptable to preclude the danger of capture, while remaining able to detach when necessary using the strategic power of "agenda setter" for the regulatory arena. This new regulator runs the regulatory arena as a "platform", in the sense of the economic theory of two-sided markets (see more in Brousseau & Glachant, 2011). A fundamental role of the new regulator is to align the participation constraints of agents with the functioning of the new markets and the generation of reform for these new markets. Notably, the regulator can organize cross-subsidization between the various stakeholders as a function of their propensity to pay and participate. Thus, the regulator can decide to have the owners of pre-existing infrastructure, or all consumers, finance the construction of new markets, rather than impose the cost directly onto new entrants or on the most mobile consumers (see the case of the construction of retail gas and electricity markets in Great Britain; or the roll-out of energy smart meters in France or Italy). When the need for new reforms arises because of innovations in technology, business, or use, the regulator can establish provisional frameworks to facilitate the extension of new practices. When these practices have stabilized, the regulator can again cut transaction costs while expanding the new shared rules. The actions of a regulator who is favourable to innovation can thus extend beyond orderly management of the two sides of the regulatory "platform" (Helm, 2003; Ajodjia, 2006; Marsden & Whelm, 2007; Rious et al., 2011).

8 Conclusion

The operating framework of the regulatory economy in network industries has recently undergone profound mutation: on one hand, by the lower information costs made possible by NICTs and, on the other hand, by the embedding of knowledge required to understand the challenges associated with innovation and, finally, by the modularity of production and use processes in network industries.

These transformations of the framework have given rise to several major redesigns of regulatory activity. First, there is a renewed interest in the allocation of the monopoly's fixed costs among the various actors and users, between prolonging the decisions of the past and making new decisions to usher in the future. Next, it involves taking into account property rights as the new "essential" institutional infrastructure of decision making in these complex multi-task and multi-agent environments. Thus, in a very Coasian sense, account is taken of all new modalities for managing network externalities: negative externalities, such as congestion, incidents, and harm, and positive externalities for the benefits arising from the interconnection and

interoperability of networks, equipment, and network services. Finally, in contrast to the first three elements, dealing with fixed costs, property rights, and externalities, a last element focusses on producing the "public weal" and public standards arising from regulatory activity (Newbery, 2006).

Among all these new elements, the element that is most innovative and structuring appears to be the role of the regulator in constructing open forums for the revelation of information and knowledge. These arenas organize an active meeting of rival interest groups to define actions and operations with public legitimacy.

In our XXI Century information and knowledge society, this dynamic management of asymmetric information and knowledge has become vital. It can rely on forms of emulation and rivalry between interest groups that leads much further than mere information revelation by incentive contracts applied to infrastructure monopolies. This new special function provides the rationale for the appearance of "hybrid" regulators, which mix a little executive power with some normative power and some judicial power. These new regulators bring about new forms of societal production, in which public debate precedes or accompanies the aggregation of interests by building progressive compromises rather than imposing an asymmetric "collective" standard. In this open process of generating public rules, the various stakeholders also need to organize, whether to promote their own interests or to seek to build coalitions and capture the regulation. To accomplish this, in an arena that will remain open, each stakeholder must develop an expertise, create credible alternative proposals, and attract the attention of the regulator-referee to have the opportunity to exercise influence. The ensuing new "practicable" regulation is very similar to the "workable competition" imagined in the middle of the last century by the most pragmatic economists (Glachant, 1996; Glachant, Meeus, & Belmans, 2006; Politt, 2008).

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