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Série Scientifique
Scientific Series

97s-41

Competition and Access in Electricity Markets: ECPR, Global Price Cap, and Auctions

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Montréal
Décembre 1997

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ISSN 1198-8177

Competition and Acccess in Electricity Markets: ECPR, Global Price Cap, and Auctions*

Marcel Boyer†, Jacques Robert‡

Résumé / Abstract

Dans cet article, nous passons d'abord en revue certains principes, faits et enjeux pertinents aux mouvements de déréglementation, de restructuration et de privatisation dans les industries-réseaux en général et au secteur de l'électricité en particulier. Nous procédons ensuite à la discussion d'un ensemlbe de mécanismes par lesquels la concurrence peut être développée dans les marchés de l'électrcicité, notamment les règles et les prix d'accès. Nous comparons la règle de tarification efficace des composants et la règle de Ramsey-Boiteux et nous discutons la règle des prix plafonds globaux. Nous présentons ensuite quelques éléments importants des réformes vécues au Royaume-Uni et au Canada. Nous abordons enfin la possibilité que des enchères sur les droits d'accès aux réseaux puissent permettre d'accroître la concurrence en ne maintenant qu'une réglementation légère. Nous concluons en rappelant certains enjeux importants mais négligés dans les débats actuels.

In this paper, we first review in this paper some general principles and fundamental facts and issues which remain at the heart of the movement towards deregulation, restructuring and privatization in network industries in general and in the electricity industry in particular. We then proceed with a discussion of a set of basic procedures through which competition can be introduced in electricity markets, that is the access pricing rules. We compare the efficient component pricing rule with the Ramsey-Boiteux pricing rule and we discuss the global price cap rule. We finally discuss some real world experiences (UK and Canada) and we present some recent ideas on network access auctions as a possible approach to increasing competition with soft or light-handed regulation. We conclude by raising some issues which have been relatively neglected but remain nevertheless important.

Mots Clés : Réseaux, électricité, déréglementation, droits d'accès

Keywords : Networks, electricity, deregulation, access pricing

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1 Introduction

Many network industries (telecommunications, electricity, natural gas, postal services, water and sewage services, etc.) are confronted with significant logistic and behavioral problems in their transition towards a (more) competitive environment and structure. In some of those industries, this transition is already more or less achieved while in others, it is still a project rather than a reality even if pressures to achieve such a state of reasonable competition have been mounting for quite a few years by now. It is believed that a competitive structure is the only way to credibly incite firms to provide efforts in minimizing costs and to offer to their different classes of clients and customers, both industrial and residential, the best quality products optimally matched to their specific needs. On the other hand, when different providers of goods and services are intensively engaged in a competitive process, it becomes difficult to ensure that an adequate level of coordination is taking place in order for the industry to benefit from economies of scale and in particular from economies which are external to the firms but internal to the industry. In the network industries, these economies are very important at least on specific well-identified essential links of the network. Those are subject to monopolization: they are essential inputs and would be, at least potentially, inefficiently provided if more than one producer was involved. If there ever existed natural monopoly sectors, these essential network links are thought to be perfect examples.

A recent magazine article claims that 60 per cent of the adult population in the world today has never made a phone call and that for another 15 to 20 per cent, making a phone call remained a difficult enterprise. We may wonder what percentage of the world population are still today consuming electricity in minute negligible amounts if at all. A prudent figure is most probably of the order of 50%. Given the tremendous interest that the revolution in telecommunications and the restructuring of electricity generation, transmission and distribution is creating among and around us and given the significant potential in productivity gains that they promise, it may be useful to keep in mind that this revolution and this restructuring, their characteristics and their consequences are still unknown for a very significant majority of the human population. There is clearly a large part of the world which is still in need of some very basic electricity producing system. Indeed, one of the main challenges confronting the telecommunications industries is and will be for some time to link a vast majority of human population to the international telecommunications network. And similarly for the electricity industry as a whole. It is therefore extremely important that we find new and more efficient (organizational) ways to develop and implement telecommunications networks and electricity generation, transmission and distribution networks in order to achieve the global village which has been announced possibly too quickly as a virtual fact. It is clearly not yet the case.

Increasing competition in such network industries, of which the telecommunications industry and the electricity industry are the front runners, raises important questions. What are the reasonable and workable competition structures ? What are the characteristics of the appropriate coordination mechanisms which would ensure that efficient investment programs are undertaken capable of reaping the potential scale economies and external economies to be realized ? Given the reality of essential facilities subject to important scale economies, how can we achieve the proper competition among networks through the determination of access conditions to the essential links ? What are the characteristics of efficient transition policies, that is, policies which are capable of counteracting the tendencies of the public or regulated monopolies to overestimate the difficulties of creating a manageable competitive framework ? Should the transition be gradual or brutal ? Should it be done through a stage of flexible and incentive regulation ? Can we dispense with the regulatory framework in favor of a more general competition policy and antitrust framework ? These are questions which are confronting the electricity and telecoms industry and their observers today.

The problem of designing an optimal or efficient set of institutions for developing a proper competition level over time among service providers and between networks is a very difficult task. Up till now, the drastically simplifying assumptions under which its analysis has been done make the results difficult to implement and therefore its messages remain rather poorly understood by many producers, regulators and observers. Although the existing systems of regulation was designed in a theoretical context which by now is in disrepute and significantly challenged by the new theoretical developments, it is still very much pervasive in the regular discourse of practitioners. It is very important to explicit the underlying assumptions under which the design of institutions and the characterization of the mechanisms by which the transition towards competition will be implemented. In that sense, there is still a need for basic and theoretical research into both the new regulation of electricity industry and telecommunications industry and the potential effects of relying more and more on the application of competition and antitrust laws.

Moreover, translating the results of theoretical research into a workable set of institutions and procedures which can be well understood by the different parties is both demanding and challenging. Few institutions are designed to tackle such a task which requires a fine equilibrium between managers, researchers and political analysts. This may be one reason why it is so difficult to reduce the time lag between research findings and their implementation: first, the researchers may not value that much the implementation of their ideas and results and second, the practitioners may be too preoccupied to maintain the well known and mastered institutions and procedures by which the control and regulation of network industries is achieved now. We then end up with a set of procedures and institutions (organizations, firms and markets) which may be tractable and manageable but which are not capable of generating the level of static and dynamic efficiency which more adequate procedures and institutions could generate.

Let us recall what are the characteristics which a proper competition-generating institution design should eventually discuss and tackle [Laffont and Tirole (1994), Economides and White (1995), Armstrong, Doyle and Vickers (1995)]: the determination of the final consumer prices; the nature and modes of competition in product and services markets; the level of market power (and mode of competition) over different links in the network; the level of differentiation among the products being sold to consumers over the networks; the potential and real extent of bypass, that is, competition among the networks; the possibility of offering fixed or common conditions of access combined with variable or discriminatory conditions for different network users; the possibility of variable entry and exit by service providers over time; the incomplete (different and private) information structures and the specific incentive system that regulators, network operators and service providers are respectively facing; the dynamic factors and forces present in the industry and generating or dependent on learning-by-doing and innovations. A demanding program by any standards.

Our paper is divided into four parts. In part I, we cover some general principles and fundamental facts and issues which remain at the heart of the movement towards deregulation, restructuring and privatization in network industries. Then we will proceed with a set of basic procedures through which competition can be introduced in electricity markets, that is the access pricing rules. We will compare the efficient component pricing rule with the Ramsey-Boiteux pricing rule. Then we will discuss the global price cap rule, what it is and how it could in fact be an answer to many of the concerns and questions which have been raised for some time in the search for an efficient way to introduce competition in electricity markets without losing the benefits of important economies of scale and scope. We will continue by discussing some real world experiences in the UK and Canada and by presenting some recent ideas on network access auctions as a possible approach to increasing competition with soft or light-handed regulation. We will then conclude by raising some issues which have been relatively neglected but remain nevertheless important.

This paper deals with electricity markets but, as these introductory remarks have stressed, similar concerns and procedures exist, mutatis mutandis, for other network industries.

2 Basic principles and fundamental issues

Let us recall what the general principles and fundamental facts, issues and concerns are. It is important to restate those here so that we can better define and understand the basic problems which underlie the need for further analysis of the electricity sector among other network industries.

First, *institutional and organizational design (coordination and incentives) is a major problem of human societies.* The observed movement of reform towards market-based system economies, outsourcing and downsizing in business and governments, deregulation and incentives-based regulation, and privatization are all parts of a relatively recent realization and increasing consensus that coordination and incentives mechanisms are a major determinant, factor and driver of social efficiency and social well being in human organizations and more generally in human societies.

Second, *inefficiencies in organizations (and more generally inefficient institutions and organizations) may creep up, even if all members and partners are honest, hard working and law abiding citizens.* This is well illustrated by the costs of telecommunications, electricity and water services before high powered incentive mechanisms or competition itself were introduced. Claiming that organizations are inefficient or that costs are too high does not mean that this state of affair is achieved deliberately. It may be done in a very honest way. People and organizations do not know how far they can go in reducing costs, unless they are forced to do it, and this is something which is forgotten in many discussions about the role of incentive regulation or deregulation.

Third, given the difficulty to go after the true cost of an activity, *the role of governments and regulators is basically to set up a proper environment for decision making* rather than to intervene into what may be called micro management. Basically their role is to set up an environment in which decision making can be made efficient.

Fourth, *the development of national electricity generation, transmission and distribution systems and the associated regulatory framework was done in a period where there was a huge need for stability.* Demand was in formation and there were lots of network externalities to be mined. Technology together with our understanding of market creation and organizational behavior didn't offer as much possibilities for introducing competition. This have clearly changed now. In a sense, recent and current academic research in incentive regulation and market creation have cleared the way for the undertaking of bold policy measures in many countries. Substitutes for traditional regulation have been suggested and implemented both in the electricity industry and in related network industries. Early encouraging results are important drivers of global restructuring attempts all over the world.

Fifth, *although many observers think that there is no other way to build, develop and promote efficiency in the electricity industry today than to bring in competition, it is too early to discard at the outset significant reforms of regulatory frameworks and credible implementations of high powered incentive systems in the public sector.* It is not clear at this time how the latter reforms and implementations could be designed as substitutes for competition. Some mix of policies and tools can be considered and could prove quite successful. But how can that be done? The first step would certainly be to design procedures providing equitable and significant access to competitors to essential facilities and markets. This is the basic problem. Access pricing and conditions to essential facilities are the first major procedure or major problem we should tackle. A second, as important and critical, is the design of incentive regulatory framework and of high powered incentive systems in the public sector and in public or government controlled electric utility firms in particular. This could be achieved through an open access policy to public markets. The British experience with compulsory competitive tendering (CCT) is one bold and important real world experience to provide such open access to public markets. It turns out to be quite a powerful source of incentives for the public sector direct service organizations.

One cannot simply put in place organizations or rules without first considering and understanding their implications in terms of coordination patterns and procedures and of incentives for social and economic performance, both static and dynamic. Many of the problems we are facing are basically linked with those coordination and incentives problems, and it is important just to restate again and again what these problems are, where they come from and how they play a crucial role in institutional and organizational design.

Before looking more precisely at the electricity industry, it may be useful to stress at the outset that these problems and issues are not peculiar to the electricity industry. Indeed, the analysis of coordination and incentive mechanisms, both from a normative point of view and a positive one, may be the unifying paradigm underlying microeconomics and the economics of growth, if not of all social, economic and management sciences. Let us simply mention two other problems currently facing all modern societies, the social security and welfare reform and the fundamental dynamic problem of economic growth. In both cases, coordination and incentive mechanisms are the major elements of performance.[1]

[1] In Canada, as well as elsewhere in the developed world, the reform in the social security system is basically a coordination problem and an incentive problem. The social security and welfare systems of the recent past and present have become over time less and less efficient because of organizational malfunctions both internal and external. Social security and welfare personnel in large enough numbers have developed routines and habits which may have been desirable in the past but are now ill-adapted to the current working and needs of the labor markets and of society as a whole. Social security and welfare recipients in large enough numbers have learned to use the system in distorted ways by modifying their behaviors in order to privately profit from the system, not as a security and insurance system but as a regular and predictable source of income and benefits. Although at the beginning of the current reform effort such perceptions and objectives were present in some official documents and public interventions, the emphasis was quickly put on different issues, namely the need to reduce government deficits and the 'vested rights' of people to the traditional comprehensive social protection system. The former is clearly an unrelated problem while the latter is a lack of flexibility (incentives) problem: the tragedy of public deficits is not that they exist but rather that they are incurred for the wrong reasons, namely because of consumption habits, political economy inflexibilities and unprofitable public investments rather than for productive investments capable of generating directly or indirectly the revenues necessary to finance themselves. In so doing, we lost contact with the more fundamental coordination and incentives problems which the social security and welfare system had created. Nevertheless, it is through the theory of coordination and incentives in organizations that we can understand better what this whole reform is or should aim at. Both the economists (as well as other social scientists and management analysts and theorists) and the politicians have a lot of selling effort to make in order to convince the people of such a fact. But surprisingly, those better equipped to do it seem almost totally absent from the public debate on these issues.
As for the problem of growth, it is surprising that economists have for so long looked for mechanistic models of how economies can grow in order to characterize the paths, efficient or not, through which growth occurs. *The recent renewed interest in endogenous growth, with its emphasis on externalities in human capital and knowledge (technological patterns) capital, leaves aside for the most part the institutional and organizational 'capital' of a society. Growth is more a matter of this latter capital than of anything else.* As the recent histories of Eastern Europe, Asia and Africa have demonstrated, the quantity and quality of human capital and/or of technology are not sufficient factors to explain or generate growth although they are clearly useful facilitators, indeed necessary ones, to reach higher growth paths. Moreover, these traditional factors, human capital and technological patterns, are better understood

Incentive constraints come basically from asymmetric information on some characteristics of particular situations. Herbert Simon, the Nobel Prize winner in economic sciences, once said that *the major problem that organizations are facing today is to overcome the fact that information is proprietary.* It is now common among economists to consider two basic objects of this private information, namely the private information on characteristics (for example, on technological characteristics or costs) leading to adverse selection, and the private information on actions (for example, on effort) leading to moral hazard. Both forms are major problems in organizations. For instance, it is quite difficult to observe the economic profits (not the accounting profits) and their sources in an organization. Similarly, it is quite difficult to observe the effort level and structure in generating those profits, in choosing the right investments, in self-protection and self-insurance activities (to avoid damaging accidents and bankruptcy) across the organization. The efficiency and profitability of an organization depend possibly more on its capabilities to overcome these information problems than on any other factor. A society is more (or less) efficient in its use of the scarce resources it controls when its organizations are more (or less) efficient in solving the coordination and incentives problems generated by the asymmetric information structures.

Coordination is a major issue in the electricity industry because of the specificity and design attributes of investments. A proper level of coordination is necessary in particular to determine the proper level and characteristics of investments in electricity generation and transmission. Are competitive markets a sufficient instrument for achieving this coordination? Most probably not, for two reasons. A significant part of those investments are very specific investments and they relate to design attributes. Therefore, there is a significant possibility that they will become stranded and that small errors in synchronization and complementary matching will generate major losses, unless an efficient form of coordination is achieved. Moreover, economies of scale and scope are an important feature of electricity generation and transmission (as well as but to a lesser extent distribution) technologies. In many cases, the market will by necessity remain an oligopolistic market in which too much duplication should be avoided. Again, important gains can be achieved by having an extended form of coordination. It is not clear how this

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as products of institutional and organizational capital, that is, of coordination and incentive mechanisms generally present in the society being considered. It is not clear how formal models of growth incorporating measurement of the quantity and quality of this institutional and organizational capital and of its evolution over time could be developed but one may hope that they will be in the near future so that a better understanding of the determinants of growth can be achieved.

coordination can be obtained in an efficient way without allowing or inducing the firms to put in place procedures and forums which will facilitate collusion. The regulatory process has been one way to more or less make these investments in some form of coordinated way. Market-based investments in developing networks may not be as successful as regulated investments have been in the past unless proper coordination is achieved.

It is useful to see the problem of regulating or reforming regulation of the electricity industry as a coordination and incentive problem. Although for many years, lawyers, managers, regulators and economists have been fighting among themselves over the proper way to generate a normal risk-adjusted rate of return in the traditional regulation framework, we know now that many of the costs which were incurred by electricity companies were not necessary in spite of the fact that we have been mostly convinced for many years that they were indeed part of a cost minimizing strategy. These observed costs were the costs on which the rates of return were computed. Perhaps the best example of this is the recent evolution of the telecommunications industry. When price caps were introduced in Great Britain a little more than 10 years ago, costs decreased rather rapidly. When competition was introduced in Canada in the long distance market, Bell Canada and other Stentor companies found that they were overstaffed and that at least a good chunk of their costs could be avoided. *Before a firm gets into a more incentive system, it seems very difficult if not impossible to find out how much it is overstaffed and how much of its costs can be avoided.* This is the starting point for the analysis of global price caps and auctions in the next sections, as ways through which efficient decision-making could be achieved.

Unless an economy can count on an efficient energy and in particular an efficient electricity generation, transmission and distribution industry, firms in that economy will have problems to compete on the world markets. That may not have been the case up until about 10, 15 or 25 years ago. Because globalization of markets was still in its infancy, low cost energy was important but 'not vital', that is, firms could survive and prosper even if energy costs were 10 or 15 per cent above what they should or could have been. The energy industry, and the electricity industry in particular, was maybe less vital in that sense than it is today. A typical evolution in developed countries is that exports have doubled since 1980; in Canada for instance, exports represents now about 45% of GDP compared to 23% in 1981. For that reason among others, the pressure to get to the lowest possible cost of energy, and electricity, has continuously increased.

3 Access pricing rules

The electricity industry is regulated because of the important economies of scale present in the network activities: it would make little sense to let two similar parallel transmission or distribution networks exist. But if there exist important economies of scale in providing transmission and distribution services of the network itself, the situation may be quite different regarding the activities, goods and services offered over that network. Hence the possibility of separating the network itself from the goods and services 'travelling' over it or surrounding it (generating or producing, contracting, metering and billing for instance). Moreover, it is possible and quite likely that the network economies of scale are quite important over some links but not over all links. For the latter links, market forces should lead to an efficient number of parallel links insuring that a proper level of competition will emerge. Those links over which the economies of scale are important are the essential facilities and duplication is either not feasible or not economically meaningful.

Hence, access to the essential facilities must be regulated in some way to prevent the owner from exercising market power and predatory self-dealings in cases where the essential facility provider is also active on the competitive links and/or in the provision of goods and services travelling over the network. How should the access pricing and conditions to the essential facility be regulated ? The objective of regulation here is two-fold: to make sure first that the proper goods and services are produced and offered at a proper price to the consumers and second that the firms allowed to use the essential facility be those firms which are the most efficient in using it. Ideally, it should be in the best interest of the owner of the essential facility, when it is also present in the complementary competitive markets, to allow these more efficient firms to have access to the essential facility even if this means allowing the entry of more competitors in previously monopolistic or oligopolistic markets. Finally, the regulation rules should discourage the entry of firms which would be less efficient in using the essential facility. What are those rules ?

The efficient component pricing rule [The ECPR: Willig (1979), Baumol (1983), Baumol and Sidak (1994)] and the Ramsey pricing rule [Laffont and Tirole (1994)] are two approaches to determine the proper regulation rules to attain an efficient allocation of resources and an efficient access to the essential facility in particular. They have been more or less opposed to each other in the literature. However, some authors [Armstrong, Doyle and Vickers (1995)] have advocated recently that the two approaches are in fact two sides of the same coin even if for some time, the ECPR was considered as suffering mainly from very restrictive assumptions and the Ramsey pricing rule was considered as suffering mainly from very demanding information gathering. In spite of their internal consistency and powerful theoretical propositions, the translation of either approaches into real and operational institutions and procedures has been less than satisfactory at this time. One reason may be that the suggested procedures and rules to make their results operational has been too closely related to the formal models themselves. We may need here a new approach in which the institution design stage of the research program is given more importance and follows a kind of stand alone development. It is most likely that the institutions by which theoretically efficient allocations are achieved will have little resemblance with their theoretical representations.

Let us just recall briefly what those access pricing rules are. To make the presentation and discussion more specific, let us concentrate on the transmission network(s) which correspond here to the essential facility. The objective of the Laffont-Tirole Ramsey pricing is global efficiency. It is not an entry issue. It aims at making sure that in the presence of significant economies of scale, the proper goods are produced and that the pricing of goods and services creates as small distortions as possible from the first best allocations. It says that the margin over marginal cost should be proportionate to the inverse of the superelasticities in the different markets of the different goods. To apply Ramsey prices, you have to know or have an evaluation of those superelasticities which is something requiring a lot of information on demand systems.

The Baumol-Willig ECPR has the objective of allowing efficient entry under 'given', possibly regulated, final prices which rule out monopoly rents. If it is not the case, the rule itself would not generate a fully efficient allocation of access to the essential facility because the pricing of final products and services might be monopolistic rather than competitive or efficient. This final prices issue is an important one in practice because of the difficulty for the regulator to fix unilaterally those prices. Baumol and Sidak (1994) advocated for fixing final price ceilings according to some measure of stand alone costs, more precisely of stand alone cost of a hypothetical entrant. This may be difficult to assess in practice. To prevent predation, the incumbent would also be required to satisfy price floors determined by marginal (incremental) costs. The objective of the ECPR is to make sure that the access rules to the essential facility do not allow inefficient or less efficient firms to enter the market for goods and services using the essential link of the network as an input but at the same time do not prevent the entry of any firm which may have the capability to be more efficient than the incumbent in using the essential facility itself. It is important to control the power of the incumbent to block systematically the entry of those more efficient firms. In that sense, it is a cost based rule. But as we will see, its validity as a normative rule is limited when a budget balance constraint is imposed on the incumbent and its apparent simplicity and therefore superiority over Ramsey pricing rules can be challenged when more realistic cases are considered.

According to the ECPR, the access charge (and other conditions) should be the direct cost of access plus the incumbent's opportunity cost of giving access to competitors, that is, in the notation of Armstrong, Doyle and Vickers (1995),

$$a = C_2 + [P - C_1],$$

where a is the cost of a unit of access, C_2 is the marginal (incremental) cost incurred by the incumbent for giving access to a firm, P is the given price of the final (homogeneous) product, and C_1 is the incumbent's marginal cost of production. This opportunity cost $P - C_1$ is basically the displacement of the incumbent's market plus possibly a contribution to the cost of the social obligations to serve, if this is considered as being a social responsibility of the incumbent firm. The displacement of the incumbent's market translates into a loss of variable profits for the incumbent. Given the final prices optimally set (by the regulator) to eliminate monopoly rents, the reduction of the incumbent's variable profits (revenues minus variable costs) implies that the incumbent's fixed costs would not be covered anymore. Hence, the new entrant should be able to cover this loss in variable profits, not as a tribute to the incumbent but as an efficiency condition. Regarding the contribution to the cost of social obligations (a form of differentiated product sold at a loss by the incumbent who has to recuperate the loss from the profitable sectors of the market) imposed on the incumbent, again the reduction in variable profits would make the incumbent unable to fully cover the cost of those obligations. Hence the requirement that the entrant contributes to those social obligations unless the contribution can be considered as part of the loss in variable profits. The rule has two important properties: first, it sends the right signal to potential entrants since only the more efficient entrants will find it profitable to enter and second, the incumbent being fully compensated does not object to the entrant's use of the essential facility (at least in the static non strategic context considered).

The opportunity cost or displaced market for the incumbent can be evaluated in different contexts, from the relatively simple case above, which was the original case in which the ECPR was proposed, to more and more complex and realistic cases. As we go from the simple case to the more realistic case of product differentiation, bypass, uncertainty in demand, input substitution, multiproduct firms and multiaccess (entry in the network at different points or nodes), the evaluation of the incumbent's opportunity cost becomes more and more complex. Those factors will in general reduce the opportunity cost of access for the incumbent.

Consider product differentiation. If the entrant offers a new product different from the products offered by the incumbent, the displacement of the incumbent's market becomes more difficult to evaluate because the new sales of the entrant are not necessarily lost sales by the incumbent. Hence, an entrant producing a differentiated product may increase welfare by generating diversity even if it is less efficient than the incumbent. In the extreme case of independent products, the entrant has no impact on the incumbent's market (absent income effects) and therefore, the ECPR would fix the access price at the direct cost of access only. More generally, substitution factors must be evaluated in order to determine the level of access charge, making necessary a rather detailed knowledge of demand conditions.

Armstrong, Doyle and Vickers (1995), following an approach proposed by Laffont and Tirole (1994), have shown that in such a general context, the proper evaluation of the opportunity cost for the incumbent of providing access is a rather complex issue. For instance, in a context where a competitive fringe of entrants with each one supplying a similar product but differentiated from (and substitute to) the incumbent's product, where some bypass possibilities exist and where there are input substitution possibilities, the equilibrium fringe final price will be increasing with the incumbent's final price and the cost of access. In fact, the output x and price p of the fringe and therefore its demand for access z and its impact on the incumbent's variable profits are all directly determined by the incumbent's final product price P and access price a thanks to the assumption of a purely competitive fringe (if the entrants have market power, the problem is somewhat more difficult). The incumbent's output increases with the access charge ($\hat{X}_a > 0$) and decreases with its own product price ($\hat{X}_P < 0$) while the fringe's output and demand for access decrease with the access charge ($\hat{x}_a < 0$, $\hat{z}_a < 0$) and increase with the incumbent's final product price ($\hat{x}_P > 0$, $\hat{z}_P > 0$). When the budget balance constraint of the incumbent is not binding, the optimal access charge is based on the opportunity cost obtained as the product of the incumbent's marginal profit per unit sold and of the ratio of the marginal impact of an increase in access charge on the incumbent's output and the marginal impact of this increase on the demand for access by the fringe, that is,

$$a = C_2 + \sigma[P - C_1],$$

with

$$\sigma = \frac{\hat{X}_a}{-\hat{z}_a}.$$

When the budget balance condition is binding, the optimal access charge should be increased by a third term (besides the two terms of the simple ECPR), namely the price elasticity of the fringe's expenditure on access times the multiplier factor of the budget balance condition $\theta = (\frac{\lambda}{1+\lambda})$, that is,

$$a = C_2 + \sigma[P - C_1] + \frac{\theta \hat{z}}{-\hat{z}_a}.$$

The last term is of course due to the possibility of relaxing the budget balance constraint of the incumbent by taxing access. More generally, for the multiproduct and multiaccess case of an incumbent producing N final products and supplying M access services (or nodes), the access pricing formula for the m-th access service is, with straightforward notation,

$$a_m = \frac{\partial C}{\partial z_m} + \sum_{n=1}^{N} \sigma_{mn} \left(P_n - \frac{\partial C}{\partial q_n} \right) + \sum_{i \neq m} \rho_{mi} \left(a_i - \frac{\partial C}{\partial z_i} \right) + \frac{\theta \hat{z}_m}{-\partial \hat{z}_m / \partial a_m},$$

where the sum of the second and third terms represent the loss in variable profits by the incumbent when it supplies a marginal unit of access of type m. The last term is added because of the budget balance condition imposed by the regulatory procedure. It constitutes in a sense the difference between the Ramsey pricing (the four terms above) and the direct application of the ECPR (the first three terms above). Clearly, a proper evaluation of all these terms and formulas would require a lot of informations on demand and cost conditions.

It turns out that both the ECPR and Ramsey pricing have been proposed and sometimes used as tools aimed at obtaining in the electricity industry an efficient allocation of resources, efficient entry, and efficient production of the right goods and services for the consumers. Both of them are informationally very demanding. They are very complex in realistic cases and they are open to manipulation, to regulatory capture and to predatory behavior because of this complexity and because of the fact that there is so much uncertainty or imprecision in the estimates of the basic parameters or basic variables you have to obtain and know to apply them and because of the fact that generically, the information structure on costs and demands is incomplete. The latter factor creates an incentive problem which is sidestepped by the analysis. In fact, they may be more open to manipulation, regulatory capture and predatory behavior than we have thought before. This is a major drawback. Hence the need for a more information-efficient approach.

4 Price caps and global price caps

Such an approach may be the Laffont-Tirole global price cap (GPC) designed to consider explicitly those information requirements. As expressed by Laffont and Tirole, the two main advantages of GPC is first to follow theoretical precepts and second to require no more information than the other schemes such as ECPR, the Ramsey pricing rule, or the long-run incremental costs of access with or without proportional markups à la Allais. The global price cap considers both the final products and services prices and the access charges in one single price cap formula. Once the price cap is determined, the incumbent firm is free to choose its prices, including the access charges, as long as the global price cap is satisfied. The firm implements the Ramsey price structure if it knows its demand and cost functions. There is no need for the regulator to find and measure as before those demand and cost conditions and elasticities.

The role of 'regular' price caps has been basically to introduce high powered incentive mechanisms in regulation. A price cap rule allows the regulated firm to vary its prices as long as some index of those prices is satisfied, that is, is not higher than some benchmark. Given that the regulator controls only an index of prices, it is believed that the benefits of letting the firm choose an adequate price structure and adequate cost reduction activities would then remain with the firm itself, at least in the short or medium run. Hence, the firm is incited to adopt efficient production technologies and to provide the efficient effort levels to reduce costs and increase efficiency.

The notion of global price caps brings access in the basket of goods sold by the firm. So selling access to the transmission network would be one of the goods in the basket on which the regulator would define the price cap. The firm is then free to determine the price of access and the price of the other goods and services it sells, as long as the index of those prices is below the cap which is imposed by the benchmark. One of the interesting characteristics of these global price caps is that they would implement Ramsey pricing in a decentralized fashion. The profit maximizing prices chosen by the regulated incumbent within the global price cap constraint are the Ramsey prices.

The argument goes as follows [Laffont and Tirole (1995)]. Let $\pi(\mathbf{p})$ and $S^n(\mathbf{p})$ denote the firm's profit and the consumers' net welfare for price vector $\mathbf{p}$. A social welfare maximizing firm subject to a budget constraint would maximize $\pi(\mathbf{p})+S^n(\mathbf{p})$ subject to the constraint $\pi(\mathbf{p}) \geq 0$. That is, it would maximize $\pi(\mathbf{p}) + \alpha S^n(\mathbf{p})$ for some $\alpha \in (0, 1]$. When increasing price p_i by one unit, a profit maximizing firm ignores the impact $(-q_i)$ on the net consumer surplus, where q_i is the demand for good i. On the other hand, a profit maximizing firm subject to price cap $\sum w_i p_i = \mathbf{w} \cdot \mathbf{p} \leq \overline{p}$ maximizes $\pi(\mathbf{p}) + \beta(\overline{p} - \mathbf{w} \cdot \mathbf{p})$ and therefore chooses the proper relative prices if the weights are exogenous and proportional to the realized outputs. So the regulator does not have to find those prices. The firm does it and it indeed will find in its best interest to apply Ramsey pricing to its different products including access. The simple but important condition for the procedure to achieve this remarkable result is that the weights on this global price cap be properly selected by the regulator, that is, be set equal or proportional to the expected amount or quantity of those different goods and services, including access, sold by the firm. In a dynamic setting, the proper weights may be achieved by using the previous period observed quantities. The procedure would then converge to the optimal weights and the global price cap would achieve its objective.

Therefore, the regulatory scheme would let the incumbent owner of the essential facility compete also in the competitive markets or sectors and select the prices as long as the price cap is satisfied. The firm would have the incentive to be efficient in terms of cost reduction and to price the different goods at their Ramsey level and, therefore, assure minimum distortions from the first best rule. This is a characteristic which is quite interesting. We now have a little bit of experience with price caps so this would just extend somewhat the role of those price caps in creating the right environment, particularly in the electricity industry. The problems with implementing this procedure are the usual price cap problems: first, the valuation of the technological progress factor (the X factor) and the regular revision of price caps, and second, the possibility of predatory behavior by the incumbent or the owner of the essential facility.

The solution to these problems could be to define and base the global price cap on an index of prices in the electricity business outside the area of the firm itself. For Canada or Québec, for instance, you would need some kind of index of deregulated prices in other countries, prices over which the Québec electricity industry or the Canadian incumbents have no power. These outside prices would be used basically to reflect the X factor. Global price caps could allow the firm to exert predatory behavior by raising the cost of access and lowering the cost of final goods to satisfy the price cap and at the same time to prevent entry. There is here a clear role for the competition and antitrust laws and the Competition Bureau. Their specific role would be in fact to prevent this predatory behavior through the usual antitrust tools.

5 Market based regulation or managed competition

In this section, we report on a bold new approach to regulation. Under the old paradigm, regulation was necessary whenever markets and laissez-faire would fail to allocate resourn=ces efficiently. In the case of electrci utilities, regulation took the form of specific pricing rules imposed on the (often state-owned) utility monopolies. The new paradigm seeks not to regulate firms directly but rather to regulate the markets on which firms operate. The weaker form of such regulation, or light hand regulation, relies on antitrust rules imposed on all industries. Stronger versions may include ownership restrictions limiting vertical integration, the creation of a trading mechanism with specific price discovery rules, etc. The objective of these stronger forms remain the engineering of a market structure and a set of trading rules to foster competition and let competition provides the incnetives to the firms. Coordination of the firms' activities, in particular investments, may still be necessary but this can also be achieved by the markets provided that they be properly designed.

In the first part of this section, we will illustrate how this new paradigm has been applied in the UK electric industries, the most advanced economy in that matter. The latest trends in electrcicity regulation in Canada are also presented. In the second part, we discuss what would be the basic elements of a regulated market for electrcicity transmission.

5.1 Historical Background

THE SEPARATION OF ACTIVITIES

Ownership structures have been advocated as one way to reach a proper level of competition. The UK 1989-90 split between electricity generation (to be made more competitive through an oligopoly structure, while keeping the nuclear plants under public ownership), electricity transmission (kept as a natural monopoly structure) and distribution (made a multiple local monopoly structure), and finally electricity supply (made competitive) involving contracting for the delivery of electricity to consumers and industry was an attempt to control the ownership structure in order to generate enough competition.

THE UK EXPERIENCE[2]

The British government undertook the privatization and restructuring of the electricity industry in 1990 through a strategy of introducing competition in the generation sector of the industry. The key ingredient of the reform was the set up of a spot market for wholesale power in which generating companies compete to sell their power and from which all wholesale customers buy power. There is an auction mechanism that everyday determine the spot market prices for the next day. There are 48 such spot prices, one price for each half-hour.

The Power Pool in England and Wales is operated by NGC, the National Grid Company. All generating stations operators are required to participate in bidding in a price and conditions of availability for each of their generating units (there could be many such units in each of every producer's plant[3]) each day for the following day. Each operator must transmit to the NGC before 10:00AM, the "offer prices" for its different units [a start up price in $ per start, a fixed price or no-load (standby) price in $ per hour and at most three incremental prices in $ per MWh with their respective ranges of application], the conditions of availability and flexibility (to be started up and turned off repeatedly) of the different units, and a few other characteristics. All those factors are used by NGC to determine the optimal use of each producing unit in order to minimize the total cost for the day and therefore optimally ranking the different units for each of the forty-eight pricing periods of the following day. This ranking then give rise to an economic supply schedule which together with the demand estimated by the NGC and the demand forecasted by large users will serve to determine which units in which plant of which company will be required and what will be the System Marginal Price (SMP) for each half hour of the following day. The SMP is typically the generator price computed by NGC form the bid or offer prices of the marginal unit called by NGC in that period to satisfy demand.

To this SMP is added a capacity element C given by

$$C = LOLP(VOLL - SMP)$$

where $LOLP$ is the loss of load probability, that is the probability that capacity will be unable to satisfy the demand in that particular time period either because demand is higher than expected or because some

[2]This account of the UK experience relies basically on Wolak and Patrick (1996), Wolfram (1997) and a WEB source (http://www.energyonline.com).

[3]According to Wolfram (1997), units vary between 20 and 600 MW and plants may have from 2 to 11 generating units.

failure occurred in the producing system. This $LOLP$ is determined by NGC. As to $VOLL$, the value of lost load, it measures the willingness of customers to pay to avoid a power shortage.[4] The prices paid to the generators in each of the forty-eight periods t, the pool input price (PIP) for t is then:

$$PIP_t = SMP + C.$$

The role of this capacity element, which varies from period to period, is basically to induce the proper incentives for developing proper additional capacity. In the long run, this capacity element is expected to represent the opportunity cost of building new capacity in order to meet peak demand.

Together with the operation of the pool itself, the NGC is responsible for a whole set of supporting systems of services including commercial arrangements for the payment system governing the transfer of funds from suppliers to producers. The ancillary services (system reserve, frequency response, reactive power, black start capability) are themselves contracted for by the NGC and their costs, together with some other costs which must be paid to the producers because of forecasting errors (loss of revenues), transmission constraints (units bumped out or constrained-on because of those constraints) and marginal plant adjustments, are added to PIP to determine the "pool output price" POP.[5] Those arrangements, referred to as "pooling and settlement arrangements," must make sure that basic constraints of an interconnected system: first, the power demanded must be covered at any time by the power generated at the different stations (generating capacity available in reserve is paid for, even if not used: the price will typically be a function of $LOLP$, $VOLL$ and the unit bid price BP through the formula

[4]According to Wolfram (1997), the value of $VOLL$ was set at the time of restructuring at 2 000 *\$* per MWh (compared to an average pool price of about 25 *\$* per MWh in 1990) and has since increased at the rate of inflation. As for $LOLP$, it is set by NGC and can be zero in many half hour periods.

[5]Wolfram (1997): "If a unit that was not originally scheduled to operate, that is a unit whose bid price exceeds the SMP, is needed in order to alleviate transmission congestion (is "constrained-on"), pool rules require that it be paid its bid price. As a result, the suppliers have an incentive to submit high bids for plants that are likely to be constrained-on. Adjustments due to transmission limitations are captured by a fee called Uplift, and the price that the pool customers pay, the Pool Selling Price (PSP *or* POP) is equal to Uplift plus the PPP *or* PIP. The PPP is also calculated using forecasted demand. After demand is realized, adjustments are made to both generators' revenues and to Uplift to reflect differences between the actual and forecasted demand. Last, generators receive payments for what are called "ancillary services" which involve, for instance, providing spinning reserves or reactive power capacity. Payments for ancillary services are also collected through the Uplift charge." (italics added)

$LOLP(VOLL - BP)$); second, identifying the electricity generated by a given station is impossible once that electricity has entered the system; third, the transmission constraints; and finally the system stability (reserve and reactive power). Both PIP and POP vary over time and over the different half hour periods within a given day as demand, production and availability of units and plants fluctuate.

On the producing side of the electricity equation, there are five major players: National Power and PowerGen, private companies having respectively about 20.5 and 17.5 GW of fossil fuels burning plants; Nuclear Electric, a public company having about 10 GW of nuclear capacity; Scotland and France exporting about 4 MW altogether of hydroelectric and nuclear capacity respectively; and finally smaller producers operating CCGT (combined-cycle gas turbines) for about 5 MW of capacity. Because of the operating characteristics of the two large private producers' plants [high variable cost fossil fuels burning plants versus the low variable cost hydroelectric, nuclear and CCGT plants of the other producers], they have been, according to Wolfram (1997), the marginal producers about 90% of the time since privatization.

On the consuming side of the electricity equation, one finds the individual consumers who are in general subject to constant prices (the typical contract is an annual fixed price contract offered by their respective local monopoly Regional Electric Company – REC), and whose demand is therefore generally not sensitive to the pool selling price of electricity, and the large consumers who are allowed to have their needs satisfied by anyone of the twelve RECs, the generators themselves or a host of independent electricity brokers, and are in general paying prices closely linked to the pool selling price.

The Canadian Experience

In Canada, the regulation of the electricity industry is a provincial responsibility (except for electricity exports which is in part a federal responsibility) and therefore, the industry has been organized and fragmented according to provincial boundaries. We will review here briefly three provinces, namely Ontario, Alberta and Québec.

The MacDonald commission recent report on the restructuring of the electricity in the the province of Ontario contains recommendations,[6] somewhat based on the UK experience, with the clear objective of making sure that the competitiveness of the Ontario electricity industry would be maintained in the future: for the commission, the best

[6] See Doucet and Heyes (1997) for an overview of the Ontario proposals.

way to remain competitive is to introduce competition in key sectors of the industry, namely the generation sector and the supply sector. The commissioners advocated that we should split the transmission network operator (a natural monopoly and essential facility sector) from the producers (generators) and the providers of services (suppliers) over the transmission and distribution networks. In this way, the different generation technologies and systems could compete with each other and the service providers at the other end would also compete with each other. By splitting the ownership structure, it is hoped that a proper level of competition will likely emerge: extensive competition at the generation level, mild competition at the customer level and regulated monopolies at the transmission and distribution levels. Here, the way to bring in competition would be through restricting ownership structures and opening the transmission and distribution networks to all producers and service providers on level playing field conditions. The basic problem left for the regulators to overcome is the determination of access pricing and conditions over the different national and regional transmission and distribution networks. More fundamentally, it is our rather poor understanding of the competition forces which would be at work in such a context that constitute the major stumbling block to the adoption of such an approach.

The province of Alberta has made early progress in restructuring its electricity industry (a law to that effect was voted in 1995) and it is by now the North American jurisdiction with the most advanced competitive electricity system based on a separation of transmission, generation and distribution. The pool operates along similar lines to that of the UK since January 1996; one notable difference is that offer bids and demand bids are expressed each day for the next seven days although only the bids for the following day are binding. Three major vertically integrated utilities compete in Alberta (TransAlta, Alberta Power and Edmonton Power) with IPPs and with producers from outside Alberta (importers) who can also place bids. The basic features of the reorganization concern the pool price, the stranded investments, the bilateral contracts, the transmission authority and the separation of pre-deregulation existing utilities into separate transmission, generation and distribution subentities. The pool clearing price for wholesale power is determined from competitive bids submitted daily by the participants: hence, the Alberta utilities must offer competitive prices if they are to be included in the effective producers.[7] Stranded investments are taken into account

[7] Alberta is 90% coal and gas generated and the system marginal price will therefore reflect that cost strucuture.

through a legislated "tax" on end use customers which spread the (fixed) cost of pre-deregulation existing generation capacity over the total KWhs consumed. Bilateral contracts for difference are allowed between producers and distributors.[8] The system operates with a single transmission authority or administrator, the Grid Company of Alberta [regrouping through a shareholders' agreement the utilities owning transmission facilities], to be operated independently from producers and distributors and supervised by the Electrci Transmission Council regrouping distributors, generators, IPPs, consumer groups and representative of the shareholders of the Grid Company. All owners of transmission assets lease their facilities to that authority and the transmission rates are set as postage stamp transmission charges independent of the location of production and loads within Alberta. The determination of the transmission charges is an access pricing problem and the major stumbling block here resides with the charges to be set on producers from outside Alberta. Finally, each of the major Alberta utilities are expected to participate fully in the new electicity industry system by separating into different entities their production, transmission and distribution divisions.

In the province of Qubec, the recent law (Bill 50, December 1996) creating the "Rgie de l'nergie" remains much more traditional in its restructuring attempts and is far from introducing competition in the electricity industry. The Rgie is given wide approval powers over tariffs, investments and overall operations, including the handling of customers' complaints, of Hydro-Qubec (as the electricity producing, distributing and supplying public monopoly[9]) and the natural gas industry which is for all practical purposes controlled now by Hydro-Québec.[10] The basic regulatory framework put (or kept) in place is basically a rate of return framework together with a cost allocation framework for the determination of tariffs of both electricity and natural gas. However, some provisions of Bill 50 suggests that more important reforms *might* be forthcoming: one such provision requires the Rgie to take account of the evolution of commercial practices; another requires the Rgie to advise the government, if and when the latter calls for such advice, regarding the relevance, conditions and modalities of liberalizing the electricity markets; finally, a third provision requires the Rgie, when it determines or modify prices, to design incentive measures and mechanisms to en-

[8] Besides the three major utilities, there are several municipality based or controlled distributors.

[9] Except for minor local distribution rights owners.

[10] The Rgie has also limited powers in the distribution of petroleum products, in particular in the determination every year of the operating cost per liter that a service station operator must support or incur, possibly on a regional basis.

hance performance and to make sure that consumers' needs are met. No specific mechanisms or timetable are mentioned.

5.2 Designing Transmission Price Markets

The UK experience demonstrates that it is possible to create competition between the generators of electricity, but can we create similar competition in the market for electricity transmission ? One answer is that we cannot: (1) the allocation of tension across a unified grid requires extensive coordination, a market-based mechanism (i.e. decentralization contracting system) does not allow a full optimization of the grid system; (2) electricity transmission is a text-book example of a natural monopoly with huge fixed costs and small variable costs, and it would be inefficient to construct redundant power lines. Not too long ago, regulators were pointing out the same arguments against the possible deregulation of the telecommunications industry; yet, the telecommunications industry is a living testimony that competition can be introduced in a network industry.

Something in the telecommunications industry has changed to allow for more competition, can this occur also in the electricity transmission industry ? The demand for telecommunications (voice, data or video) has risen very rapidly. This has made it possible for small long-distance firms to emerge and prosper. Small resellers can buy and sell connectivity, making profits simply by exercising arbitrage or by using new information compression technologies. Thanks to the fluidity of routing, one single long-distance call may use the services of three or more different companies. This has reduced the importance of economies of scale in the telecommunications industry. The same transformations have not occurred in the electricity transmission industry: the fixed cost of building new telecommunications line is far less than a high-tension transmission line; there has been no drastic cost reducing technological innovation in the transmission of electricity; and the demand for electricity is not rising. This limit our ability to reproduce the kind of large scale deregulation seen in the telecommunications industry. Nevertheless, some institutional changes can make the electricity allocation more market-based. We discuss below the institutional designs proposed in the literature.

There are three main challenges we need to address. First, the *access prices must reflect at any moment in time the real scarcity of transmission resources.* In particular, the owner (or owners) of the network should not be allowed to exploit its market power to increase transmission prices. Second, although the grid may be owned by many, and although it is used by many sellers and buyers of electricity, *management of the grid must be fully optimized.* Grid management is a difficult engineering task, the integrity of the grid should not be jeopardized by lack of coordination. Third, *rents accruing to the owners of the grid must provide the proper incentives for long-term investment in the grid.* The first two challenges can be addressed using a so-called smart market. The third challenge is more difficult and proposals to address it are discussed below.

The smart market

One may argue that the allocation of tension across a unified grid requires extensive coordination, and that a market-based mechanism (i.e. a decentralization bilateral contracting system) does not allow a full optimization of the grid system. This argument presumes that a market system can only take the form of a decentralized nexus of bilateral contracts. However, one can design a centralized market which optimize the electricity flow on the network. This type of market institutions are often referred to as smart markets. A smart market is a centralized computer-based trading system. It specifies explicitly the participation rules, the price discovery mechanism, and often optimize explicitly the allocation of resources. In the electricity market, such a system is in use in the UK, and similar systems are being developed in the USA.

The natural way to calculate the efficient access price is to use an explicit competitive double-auction. In order to illustrate this, consider a simple electricity market with a single transmission line, many electricity producers at one end of the line, and many buyers at the other end. The line is constructed to transport a given amount of electricity, say k. We shall assume first that transmission is loss free. An efficient market can be organized as follows: buyers submit their willingness to pay while sellers submit their asked price schedule, and the market maker set the prices to clear the market. If the equilibrium quantities are less than k, transmission is free; otherwise, a spread will be set between the buyer's price and the seller's price, the difference being the congestion rent accruing to the line owners. (see Figure 1)

The market clearing system presented above is multilateral, a trade must include simultaneously three distinct parties: sellers, buyers and the owners of the transmission lines. The limited capacity of the transmission line implies that not all profitable trades can be carried through. Here the congestion price serves has the efficient rationing mechanism. The market information requirements are such that a centralized market-clearing system is needed. For more complex transmission networks, it is even more so. Note that this market equilibrium can be interpreted as the solution of some maximization problem. Given the announced demand and supply functions, we can maximize consumers' surplus minus producers' costs subject to the transmission capacity constraint. From this solution, we can calculate the market-clearing price using the second theorem of welfare. [11]

For a more complex grid, the same idea can be applied. We can take into account the engineering structure of the grid, the capacity and synchronization constraints, transmission loss functions, and all other constraints and specifications provided by the engineers. The smart market maximizes welfare given these constraints and provide both the optimal allocation (electricity generation, transmission flows, etc.) and the market clearing-prices (prices to the generators, to the local electricity distributors, and the transmission prices calculated as the differences between the nodal prices).

Backerman, Denton, Rassenti and Smith (1997), Backerman, Rassenti and Smith (1997), and Denton, Rassenti and Smith (1997) have experimented with various trading designs. Wilson (1997) and Plott (1997) have reported similar investigations to the California Trust for Power Industry Restructuring. The former authors consider computer-based trading systems where all transactions are simultaneous and prices are such that each user bears the marginal transmission costs imposed by the user's activity. The market-clearing system includes a grid optimizer. They show that "network externalities" associated with transmission losses are effectively resolved. Although these trading systems do not solve all the inefficiency problems (particularly when there are minimum load capacity and other non-convexities), they seem far more preferable to heavy regulation.

Investment incentives

In the simple example above where the transmission capacity is limited, the average congestion rents will be high. Hopefully, this will provide incentives for some to expand the line capacity up to the point where the average congestion rents equals the incremental cost of adding more capacity. However, this need not be the case. It depends on (i) how large and costly are the minimal capacity increments, and (ii) who is entitled to build and own new transmission lines.

If the minimal capacity increment are large relative to the size of the market, it will be difficult to adjust smoothly transmission capacities to

[11] If there are non-convexities, one must be more careful about the pricing rule.

their socially optimal level. This has little to do with institutional design and a lot to do with the nature of the technology. However, some institutional design issues matter. The owners of the transmission line extract profit only when the capacity constraint is binding. Naturally, if the line is owned by a monopolist, it would be in its interest to provide less than the socially optimal capacity in order to extract more congestion rents. Safeguards must be introduced in order to prevent such opportunistic behavior. Boyer, Lasserre and Moreaux (1997) have considered investment dynamics with large minimal capacity increments. They compare the socially optimal investment path with that of a monopolist and of a duopoly. Not surprisingly, when more than one firm can invest in new capacity, the investments are undertaken earlier (in some extreme cases, even earlier and faster than what would be socially optimal). Hence, the key is to allow free entry into the provision of additional transmission capacity.

Entry can be further facilitated by allowing various cost sharing rules. In order to illustrate this, consider the example of trains. If a firm wishes to send cargo, it may have to freight a complete new train (locomotive, wagon and all): the minimal increment is large. But the same firm may simply have to attach an extra wagon to an existing train. If the latter is possible, the minimal increment cost can be much lower. In the context of electricity transmission, competition can be facilitated if entrants are allowed to use (at a reasonable cost) incumbents' infrastructures to increase capacity. We are back to some form of access pricing rule.

Some articles have examined more precisely what form of contractual arrangements can induce long-run efficiency in a competitive electric power industry (see Bushnell and Stoft (1995), and Hogan (1992)). Their proposals include the use of "transmission congestion contract (TCC)". The TCC act like ownership rights of the grid and are designed to reward investment in transmission infrastructure. The allocation rule of the TCC must take into consideration the complex externalities associated with grid modifications.

Regulation and Managed Competition

Based on the above literature and our own market design experience, we can summarize the main characteristics of the type of market-based regulations which can be used for electricity transmission:

(1) The production of electricity by competing generators and the allocation of power within a grid is determined by a competitive spot market. The spot market must allocate power production and transmission for

very short periods of time (typically each half-hour). The trading system must be computer-based and attached to a sophisticated optimization system to allocate efficiently power in the grid.

(2) Contract for differences (analogous to buy and/or sell options) can be used to reduce the risk associated with excessive spot market volatility or risk. Under a contract for difference, the demander pays to the seller the difference between the contract price and the spot market price time the contracted quantity. Since these contracts only affect financial compensations, they preserve the efficiency of the spot market allocation.

(3) Firms making long-term investments into the grid infrastructure receive transmission congestion contracts. These contracts pays the owner the price difference between two nodes times the directed power flow specified by the contracts. These contracts can be freely traded up to the conventional anti-trust restrictions.

(4) Both contracts for difference and transmission congestion contracts can help limit long-term uncertainty by increasing flexibility and liquidity (bankability), i.e. the ability of firms to obtain financing for their investment in generation and transmission.

(5) In order to limit market manipulations through the exercise of market power, ownership of generation plants and transmission lines should be largely distributed. Preferably, participation into the spot market should be compulsory so that all network externalities accruing to the large firms be shared by the small firms.

(6) There remains room for regulatory policy. In order to protect the integrity of the system, the trading system must not be under the control of any one agent, and its working and activity rules must be carefully designed, regulated and updated. Moreover, the allocation rules of the transmission congestion contracts must be designed so as to induce efficient investment into the grid. These rules must be overseen by the regulator.

6 Conclusion: Some neglected issues

Some neglected issues should be raises in conclusion. The standard procedure of introducing competition in network industries has been to give some advantages to entrants. This has been quite often advocated to raise competition because of learning effects and brand name effects. How long should those last and how to make this duration credible ?

New competition is redefining risks and affect investments and network developments and maintenance, reliability and integrity. From our discussions with executives in telecommunications, electricity and natural gas, this is something which preoccupies them very much. We are not sure if this is a proper preoccupation but they are afraid that at least the maintenance, reliability and integrity of networks might be affected by some of the new competition rules which are brought in.

Transition towards more competition seems to imply increases in game rules and litigation. Deregulation becomes synonymous with increased transaction costs. In some cases, these higher transaction costs may destroy the advantages competition was suppose to generate; the importance of those transaction costs depends very much on the way the competition rules have been introduced. The transition toward more competition has been and remains a difficult undertaking but lots of the transition costs could be avoided by a well planned course and better, sharper and more efficient announced procedures such as global price caps or smart market auctions.

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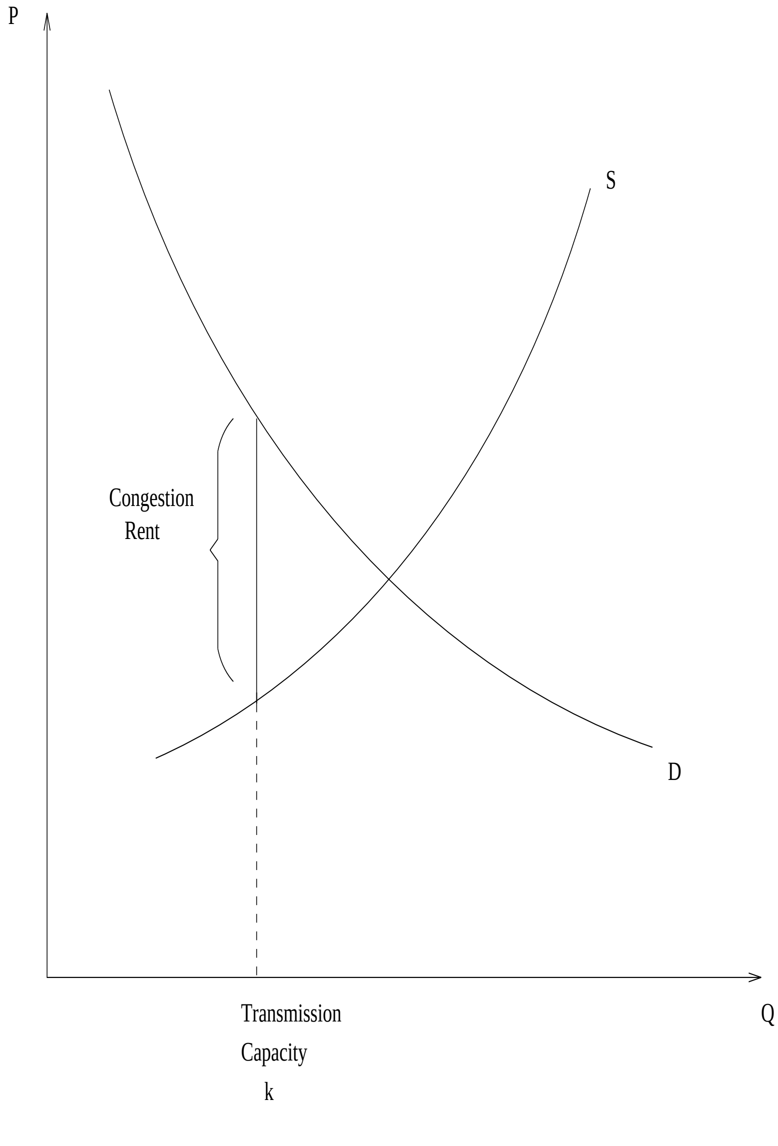
Figure 1



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