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WHAT PLACE FOR COMPETITION TO DEVELOP THE POWER TRANSMISSION NETWORK?

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Competition is an efficient alternative to regulation for the power transmission network only for peculiar investments in peculiar conditions. The competitive network investments are generally radial and/or create new commercial links in Direct Current between big markets with high and lasting difference in zonal prices. In these conditions, the impact of the inefficiencies due to economies of scale, lumpiness and externalities of network investments is small enough for an efficient transmission market.

To leap to these conclusions about competition to develop the power transmission network, we will analyse the hypotheses which pros (Hogan [2003], Littlechild [2003, 2004]) and cons (Pérez-Arriaga *et al.* [1995], Joskow-Tirole [2003, 2005]) ground on thanks to a survey of the network revenue and of the network cost structure. Thanks to the same criteria, we also analyse the heterogeneity of the practices of competitive power transmission network investment.

1. Introduction

Economists debate the introduction of competition to develop the power transmission network as an alternative to the regulation of the power transmission network monopoly. The competition to develop the power transmission network might avoid the challenges associated to the monopoly regulation. It seems that in theory the power transmission network must widely remain a natural monopoly, in particular because of the externalities of the network investments. However, anecdotic experiences of competitive network investments in the USA, in Australia or in Argentina lead to contradictory conclusions about the efficiency of competition to develop the power transmission network.

The heterogeneity of models and experiences of competitive network development questions the orthodoxy of the natural transmission monopoly as well as the competitive transmission market. We answer the question: is the competitive development of the power transmission network always efficient, efficient only in some situations or is it clearly inefficient?

The competition for transmission can be introduced in two ways. The first way is the classical one. Transmission investments are market driven as are the other competitive activities that a price signal coordinates in a nodal energy market. We study market driven transmission network investments in sections 2 and 3. The second way considers that the decision to develop the network must stay centralised and that the transmission ownership remains a monopoly; but the development, ownership and maintenance of new assets is allocated by an *ex ante* competition similar to "Demsetz [1968] competition". We study this second kind of competition in section 4.

For each kind of competition, we analyse the hypotheses which they ground on thanks to a survey of the network revenue and of the network cost structure. Thanks to the same criteria, we also analyse the heterogeneity of the practices of competitive power transmission network investment.

In section 2, we show that the theoretical efficiency of market driven transmission investment is based on the hypotheses about the cost structure of power line. The economies of scale and lumpiness[1] in transmission investment define the network cost structure. Market driven transmission investment is efficient as soon as the economies of scale and lumpiness in transmission investment are neglectable (Bushnell-Stoft [1996a, b et 1997] and Hogan [2003]). Property rights called "Financial Transmission Rights" are the ground of market driven transmission investments and transmission market (Hogan [1992, 2003]). An independent investor is called a "merchant (line) investor" that builds a "merchant (transmission) line". However, market driven transmission investments are undersized if the hypotheses about the network cost structure are more realistic (Pérez-Arriaga *et al.* [1995], Joskow-Tirole [2005]). Besides, FTRs do not always internalise some power transmission network externalities (Bushnell-Stoft [1996a, b et 1997], Lesieutre-Hiskens [2005], Stoft [2002]).

In section 3, we see that the merchant lines can be relevant solutions in some niches of network investments. Some regulations constrain the technological choice of the merchant investor to Direct Current lines by the requirement of dispatchability. Merchant lines are then possible when the conventional network investments in Alternative Current are not technically and economically relevant. Besides, lumpiness in transmission investment is relative to the capacity of the markets connected (Joskow [2005]). It explains for a part the heterogeneity of experiences of merchant lines. Lastly, the difference in nodal prices on both sides of the merchant line must be lastingly high to ensure a sufficient rent to the merchant investor. We see two conditions in which the differences in nodal prices stay lastingly high.

In section 4, we show that even if the Argentine experience of Demsetz [1968] competition can put a competitive pressure on the network investment cost, its transposition seems however difficult in a meshed network (Joskow-Tirole [2003]). Nonetheless, Demsetz competition can be interesting for radial network assets, as it is proposed in the last law of French energy orientations (Loi 2005-781).

2. Merchant lines: transmission rights and network cost structure

In the following sections (2 and 3), we wonder if transmission investments can be market driven as are the other competitive activities (generation for instance) in a nodal energy market.

A nodal energy market is a market in which the energy price depends on the node where energy is injected to or withdrawn from, taking into account physical constraints on power flows (Schweppe *et al.* [1988]). The congested lines create differences in nodal prices.

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[1] In economics, lumpiness means that discrete and non continuous quantities of a commodity can be produced. In our case, it is generally impossible to increase the capacity of a power line by a megawatt; the network development is done by the addition of several hundreds megawatts of power lines.

Transmission rights complete the nodal energy market. They hedge against the volatility of differences in nodal prices. They are also property rights for merchant lines.

If transmission investments are market driven, an investor can independently decide to build a line from the observed and expected differences in nodal prices. Such an investor is a "merchant investor" and such an investment is a "merchant line". The merchant investor earns money either from the differences in nodal prices, or from the sale of its transmission rights to other actors (generators, consumers, traders) for them to hedge against the volatility of differences in nodal prices.

However market driven investments in a nodal energy market are not possible for technological reasons. Transmission network remains a monopoly because of the network cost structure. Economies of scale and lumpiness in transmission investment frame the network cost structure. These features are incompatible with market driven transmission investments.

Besides, some externalities are not always fully internalised in the transmission rights market and in the energy market. A transmission rights market cannot fully internalise the externalities linked to loop flows. The energy market does not fully internalise reliability on a meshed network.

2.1. Transmission rights and transmission market

The nodal energy pricing is a prerequisite to market driven transmission investments. The nodal pricing internalises power transmission network externality thanks to differences in nodal energy prices. Market participants need transmission rights to hedge against locational price fluctuations. If a merchant line makes the transmission network capacity grow, it receives some of these transmission rights. The merchant investors can so be remunerated either directly thanks to the differences in nodal prices, or thanks to the sale of their transmission rights as hedging products to network users.

The efficient sharing of a network as a scarce resource is a well-known and addressed issue in the restructured electricity industry. Schweppe *et al.* [1988] demonstrate that an efficient constrained dispatch could be computed thanks to a nodal pricing system considering network externality as constraints of the market clearing. One generally considers only congestion and losses because of implementation issues and seldom includes voltage constraints (Caramanis *et al*. [1982]). A nodal pricing gives an energy price per node indicating where it is preferable to generate or to consume one more megawatt taking into account both network losses and network limitations. The differences in nodal prices linked to externality generate a merchandise surplus for the merchant line investor, also called congestion rent in the DC lossless approximation[2] (see Figure 1).

[2] The more used approximation, namely DC approximation consists in considering only the real power and in approximating the behaviour of the network to be linear. In this case, only congestion constrains the nodal pricing.

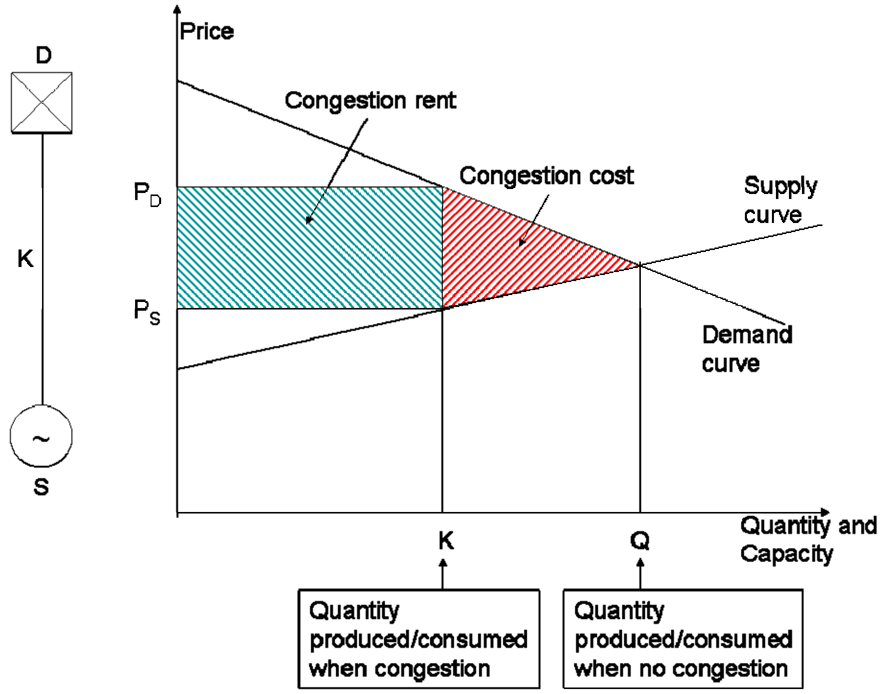

Figure 1 Graphical representation of nodal pricing on a congested two-node network

Nodal prices are very volatile and are a too dubious revenue source for the merchant lines investors as well as for the merchant plant investors. Some financial tools complete the market for the market participants to hedge against the risk of locational price fluctuations.

Hogan [1992] defines such hedging tools as point-to-point transmission rights between a sink node and a source node. These rights, the "Financial Transmission Rights" (FTR) are long term financial rights that allow their owner to hedge against nodal price volatility. FTRs are not physical rights. They do not give a right to flow energy between two nodes. FTRs allow their owners to earn the differences in prices between a sink node and a source node for the contracted quantity of FTR between these two nodes. These rights are allocated thanks to an Optimal Power Flow (OPF), as is the energy in a nodal market, to take into account the long term transmission network externality such as congestion and sometimes losses (Hogan [2002]). As the nodal prices are to the merchant line investors what the energy price is to the merchant plant investors, the transmission rights FTRs are to the merchant line investors what the forward contracts are to the merchant plant investors.

To conclude, depending on their aversion to locational price fluctuations, the merchant line investors choose to earn money either by receiving the congestion rent either by selling their transmission rights (FTR) to other market participants as hedging tools against the differences in nodal prices.

2.2. Transmission rights unfitted to the network cost structure

The "merchant model" (transmission rights and market driven investments) is efficient only under some stringent hypotheses about the network cost structure. Hogan [1992] notices this weakness of transmission rights FTR without studying it. Pérez-Arriaga *et al.* [1995] and Joskow-Tirole [2005] focus on the incompatibility of these property rights with the network cost structure. Pérez-Arriaga *et al.* [1995] numerically evaluates the part of network cost that the congestion rent can cover. Joskow-Tirole [2005] relaxes the implicit Hogan [1992]'s hypotheses about the network cost structure. Beside the exercise of market power that flaws the evaluation of the need of network investment (Joskow-Tirole [2005]), the main obstacle to efficient market driven transmission investments in a nodal energy market is the network cost structure. Economies of scale, lumpiness and exogenous variations of lines capacity are features of the power transmission network that make market driven investments inefficient.

Pérez-Arriaga *et al.* [1995] show from numerical simulations that the congestion rent covers only 20 to 30% of the network cost. The hedging financial products equal in average the economic value of their underlying assets, without taking into account any risk premium. Therefore, except any risk premium, FTRs are normally valuated to the average of differences in nodal prices. As a consequence, FTRs cover in average only 20 to 30% of network investments costs.

Various features and management rules of the power transmission network cause this lack of revenue. Economies of scale of network assets (see Figure 1) induce an "overinvestment" that lumpiness in transmission investment highlights. Even if Fuldner [1998] only provides average costs ($/MW.mile) of Alternative Current (AC) transmission lines, economies of scale are present until 750 MW. When network capacity is needed under this threshold, an optimal capacity investment generates a too weak congestion rent compared to the investment cost.

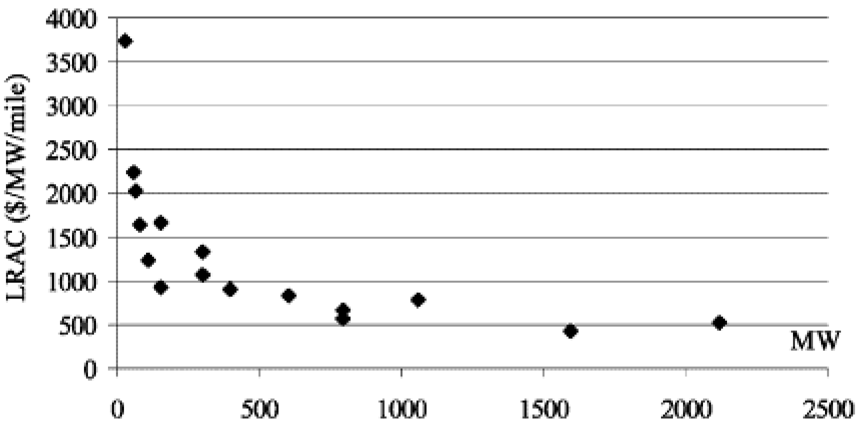

Figure 2 Economies of scales of AC transmission assets (Brunekreeft [2004], Fuldner [1998])

Joskow-Tirole [2005] shows that incorporating more realistic attributes of the power transmission network in the "merchant model", in particular these concerning the network cost structure, induce market failures. FTRs (or the congestion rent) do not ensure the efficiency of merchant lines.

The physical attributes of the network that are mainly lumpiness in transmission investment and the stochastic attributes of transmission networks do not allow the merchant line to be incited proportionally to the social welfare that it creates. Lumpiness in transmission investment means that the capacity of transmission line is not continuous but discrete. Lumpiness in transmission investment induces an underinvestment vis-à-vis the optimal capacity since the merchant investor does not earn rent proportionally to the social surplus that he creates. Besides, lumpiness and scarcity of *rights of way* to accommodate transmission lines also lead to an underinvestment in order to pre-empt the available corridors.

FTRs are long term rights that do not take into account the variation of line capacity during its operation. The capacity of a transmission line varies with the external conditions (temperatures, wind, extreme conditions, curative or preventive measures taken by the System Operator, etc…). These variations of capacity can induce an inadequacy between the real congestion rent and what the investor must receive from its FTR. Heuristics so complete the FTR markets (PJM's one, NYISO's one, etc...) to deal with this flaw of the FTR.

This attribute of transmission lines makes the exercise of market power by a merchant line[3] possible, in the framework of already undersized investments because of economies of scale and lumpiness. Since the capacity of lines varies with the external conditions, the definition of congestion is a home-made convention before being a real fact (Glachant-Pignon [2005]). The merchant lines can so set their capacities in order to maximise the rent. Besides, in the case of complementary merchant line investments, there may be a war of attrition in order to be the only line to be congested and to earn the whole congestion rent.

To conclude, market driven transmission investment cannot be efficient because of the network cost structure. The network cost structure induces an underinvestment. The exogenous variation of line capacities allows the merchant to exercise market power and to decrease dramatically the transmission capacity if merchant lines are complementary.

2.3. Badly internalised externality in transmission rights

The transmission rights market and the energy market do not always suitably internalise some externalities. The transmission rights market cannot suitably internalise some externalities of investments because of loop flows. The energy market does not always suitably internalise reliability. These market failures induce an inadequacy between the real congestion rent and what the FTR owners must receive. First, even in the framework of Hogan [1992]'s hypotheses about network investments, only the simultaneously feasible set of FTRs can be allocated to guarantee the efficiency of investments (Bushnell-Stoft [1996a, b, 1997]). Besides, even if network reliability is a notion which must still be specified on an economic point of view, reliability being not well internalised generates a lack of revenue to the merchant line investors.

Bushnell and Stoft [1996a, b and 1997] show that the method to allocate transmission rights to merchant investors is determinant for the efficiency of market driven transmission investment. The allocation of FTRs only between the two nodes that the merchant line newly connects allows profitable investments whereas they are inefficient. In other words, allocated FTR does not allow to internalise loop flows in transmission investments. Not only does a new network investment create these FTRs but it can also make the transmission capacity vary (increase or decrease) from the point of view of another couple of nodes and so make the quantity of associated feasible FTR vary too. It is the modification of the set of FTRs that reflects the value of network investment in term of social surplus. Attributing to an investor a portfolio of FTR that contains the modification of the whole set of FTRs that its investment induces can correct this market failure due to loop flows.

[3] Joskow and Tirole [2003] also show that the revenue of the merchant lines creates a disincentive interaction with the maintenance scheduling. The merchant investor can increase the congestion rent with inefficient maintenance scheduling.

The adequacy between the congestion rent and the revenue from the FTRs is ensured if the set of feasible injections and withdrawals are convex (Hogan [1992]). For a network with a given topology, the set of feasible injections and withdrawals is convex in the case of the DC approximation but it is not convex in the conditions of operation with an active and reactive dispatching (Lesieutre-Hiskens [2005]). Besides, during the network operation, the dispatchers modify the network topology if needed by the fusion or the separation of nodes. Therefore, the adequacy between the congestion rent and the revenue from the FTRs is not self-ensured because of the physical properties of the network, of the hypotheses about the network topology during the FTR allocation and of the stochastic properties of line capacities.

Various network investments (maybe most) are motivated by system reliability rationale more than by physical constraints that some locational price differences make apparent; even if these two causes of network investments are narrowly interdependent (Joskow [2005]). The resolution of reliability issue generally implies a decrease of congestion and inversely. The network reliability is a notion that still needs to be specified in an economic term (Brunekreeft-McDaniel [2005]). Energy non-supplied (ENS) is generally associated to reliability. However, reliability and ENS being public goods makes the measure of the cost of ENS and its internalisation difficult (Stoft [2002]). A lack of demand response to energy price implies a free-riding of market participants and a lack of revenue for the merchant line investor that could receive an important part of their rent during tight periods. Even when the cost of ENS is known, the probability of loss of load and so the probability for the energy price to reach the cost of ENS is quite low. It would be risky for a merchant investor to ground its investment on this criterion.

Without any demand response, more administrated market mechanisms can be implemented to internalise reliability. The capacity markets implemented by the ISO/RTOs in the United States are an example of such mechanisms. Consumers must so cover their peak consumption over 100% to a defined rate of generation capacity (for instance 118% in the PJM area). A merchant line can then earn part of its rent from the arbitrage between the capacity markets or zones of a single capacity markets that it connects. However, remarks previously formulated about the impact of the network cost structure and about the internalisation of loop flows remain valid.

To conclude, FTRs does not internalise or badly internalise some externalities of merchant network investments otherwise internalised by horizontal integration in a regulated Transmission and System Operators. These flaws of FTR and energy market induce a lack of revenue for the merchant lines.

2.4. Conclusion: transmission rights unffited to transmission investment

Transmission rights that are thought as the ground of transmission market in a nodal energy market are unfitted to the features of network. Economies of scale, lumpiness, loop flows and system reliability cause inefficiencies of market driven transmission investments otherwise internalised in the transmission network monopoly.

Even if the solution of a transmission monopoly is not optimal, there exists an asymmetry of costs and benefits between network over- and under-investment (Brunekreeft - McDaniel [2005]) that leads to prefer transmission monopoly and over-investment compared to market driven transmission investments and under-investment.

3. Merchant lines projects: mistakes or specific conditions?

So in theory, market driven investments are not efficient. However, merchant lines exist, others are planned and they do not seem so inefficient, which contradicts our previous idea.

The study of merchant lines projects in Australia or in United States allows to moderate our theoretical view and to formulate specific conditions of existence and efficiency of merchant lines. The dispatchability imposed on the merchant lines constrains the merchant investors that must only consider Direct Current lines. Then merchant lines are valid only when specific conditions of investments increase the cost of classical Alternative Current network investments such that it is prohibitive. If merchant lines are undersized, it is only inefficient compared to the size of the markets hence linked. However, the profitability of a merchant line is linked to the duration of the high difference in nodal prices. High and lasting differences in nodal prices are very rare. Lastly, even if there are risks of hold-up by regulated transmission owners, the institutional compatibilities between zones are some entry barriers harder to overcome for regulated Transmission Owners than for merchant investors.

3.1. Technological choices of merchant lines

Regulations (as in Europe or in Australia) constrain the technological choice of merchant investors. So merchant lines are generally Direct Current lines (HVDC – High Voltage Direct Current). Therefore, Merchant lines are only possible when the cost of installing alternative current lines is prohibitive.

The regulations of the power transmission network (in Europe – the CE [2003], article 7 – and in Australia – ACCC [2001]) generally impose the merchant lines to be dispatchable. The dispatchability is the physical attribute to control the power injected to or withdrawn from the network. The dispatchability of a merchant line consists in controlling the quantity that flows through this merchant line. The classical electrical lines, so-called Alternative Current (AC) lines, are not dispatchable. However, new technologies of network assets are dispatchable. The investor[4] can choose among various solutions but he generally elects the Direct Current line solution (HVDC).

This technological constraint limits the investment opportunities of the merchant investors. The investment costs of DC lines are generally superior to those of AC lines, in particular because of the conversion station from AC to DC and inversely. However, when the conditions surrounding the investments make the cost increase, the DC lines are cheaper than the AC lines. In particular, it is more advantageous to choose a DC line rather than an AC line when its length increases (Hartley [2004], Rudervall *et al.* [2000]). Besides, when burying lines is necessary over distances greater than some kilometres, a DC line is the unique technical solution. In particular, this is the case of most of the undersea cables. This advantage can be a double-one when the hiding of the lines eases the public acceptability of the lines. This decreases the costs of capital by decreasing the risk of delaying the project. The DC lines globally have some advantages as for thermal losses, for land needs and for hiding and burying costs (Rudervall *et al.* [2000]).

The dispatchability of a merchant line eases the work of Transmission and System Operator by creating an analogy between the merchant lines and the dispatchable generators and

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[4] See Marinescu-Coulondre [2004] for a paper about “merchant phase shifters”.

consumers. Therefore, the merchant lines are more like traders arbitrating between an import zone and an export zone than like classical AC lines. We saw previously that loop flows create externalities on the AC network that are hard to internalise in transmission rights (FTR). When the merchant line is dispatchable and so controls its flow, it is less exposed to these externalities. The constraint of dispatchability ensures less risky revenue to the investor and a line with an optimal capacity (Brunekreeft [2004]).

To conclude, the DC lines and so the merchant lines are limited to investment conditions where the AC lines are not a technologically and economically acceptable solution, that is to say for long distance lines and cables that must be hidden or buried (for instance undersea).

3.2. Lumpiness: notion related to the size of the markets

We saw in section II that the economies of scale and lumpiness prompt the merchant investor to undersize its investment. However, Brunekreeft [2004] moderates this issue that the merchant model faces up against. The inefficient underinvestment of the merchant lines must be compared to the size of the markets that the merchant lines connect.

The capacities of investments in the electrical system are generally lumpy. It means that it is impossible to add only one megawatt of capacity to a generator or to a line. As for the generation investments, lumpiness interferes little with the power market. Of course, lumpiness in generation investment prevents the optimal capacity of production from being reached and so creates inefficiency. However, if the power market is big enough, inefficiency stands for less than 1% of the cost to the end-users (Stoft [2002]). Lumpiness in transmission investment must similarly be compared to the size of the markets hence linked (Joskow [2005]). One must also consider the impact of lumpiness on the difference in zonal prices. Besides, a new technology of HVDC lines so-called “light”, the “HVDC light” allows to imagine the use of HVDC lines for smaller capacities, about 200 to 300MW (Rotger-Felder [2001]), capacities that are similar to those of CCGT plants, decreasing so the impact of lumpiness.

Therefore, even if the capacity of interconnectors between unconnected markets can be important in some cases (up to thousands MW), it is small compared to the size of these markets. Examples of regional markets hence connected are numerous: interconnectors between regional markets in Australia[5] (Basslink, Directlink, Murraylink), between France and England, or some projects of interconnectors between the Netherlands and Norway (the NorNed), between The Netherlands and Great Britain (the BritNed), between New-York City and close areas (New Jersey, New England).

The capacity of lines between the nodes of a nodal market is generally of the same order of magnitude as the capacity of the generators and the consumers connected to these nodes. To keep on the analogy with market areas, each node in a nodal market is a market area in itself. Therefore, even network investments of small capacity greatly impact the difference in nodal prices and so the revenue of these investments (Joskow [2005]). Besides, market driven investments are not efficient in the core of the network because they require important transactions costs to avoid “moral hazards in team” (see Joskow-Tirole [2005] for more details).

Therefore, it is not surprising if the PJM [2004] “Market Window” for network investments gains only a limited success. During this market window, PJM lets one year for the market participants to take the initiative to build a market driven transmission investment. After

[5] The Australian market NEM is organised similarly to the Nordpool market splitting.

that one-year delay, PJM as a TSO imposes a last resort regulated network investment. There are only two small merchant investments in the PJM area.

To conclude, if market driven investments can be efficient in some situations, the distinction between merchant lines and regulated lines must be based on the capacity of investments compared to the size of the market areas hence connected; one must also consider the impact of investments on the evolution of difference in nodal prices.

3.3. Lasting differences in nodal prices and congestion rent

A merchant investor must consider a third parameter beside the technological choice and the size of the connected markets. The source of revenue of a merchant investor comes from the arbitrage between a zone where the energy price is high and a zone where the energy price is low. The difference in nodal prices on both sides of the merchant lines must so last. In a competitive environment, the difference in nodal prices may not last. Specific conditions of supply of primary energy may be at the origin of the differences in nodal prices. The merchant lines in Australia illustrate weak and unsteady differences in prices between zones. On the contrary, the merchant lines that are operated or planned around New York City illustrate lasting differences in zonal prices that some difficulties of supply in primary energy maintain. We draw general conditions for lasting differences in zonal prices from these two examples.

Merchant lines in Australia: non lasting difference in zonal prices

TransEnergie, subsidiary of HydroQuébec for power transmission, built two merchant lines in Australia to collect the congestion rent between market areas. The first one called Directlink connects the states of Queensland and New South Wales and the second one called Murraylink connects the states of South Australia and New South Wales. These two merchant lines grounded their revenue on a deficit of production in the states of South Australia and Queensland that was expected to last. This assumption has not concretised with disastrous consequences on the revenue of these merchant lines.

For a reasonable rate of return on Murraylink, a difference in zonal prices between 12 and 15A$/MWh between the states of New South Wales and South Australia was needed at full utilisation. Similarly, to ensure the profitability of Directlink at full utilisation, a lasting difference in zonal prices between the states of Queensland and New South Wales of at least 11A$/MWh was needed (Booth [2003]).

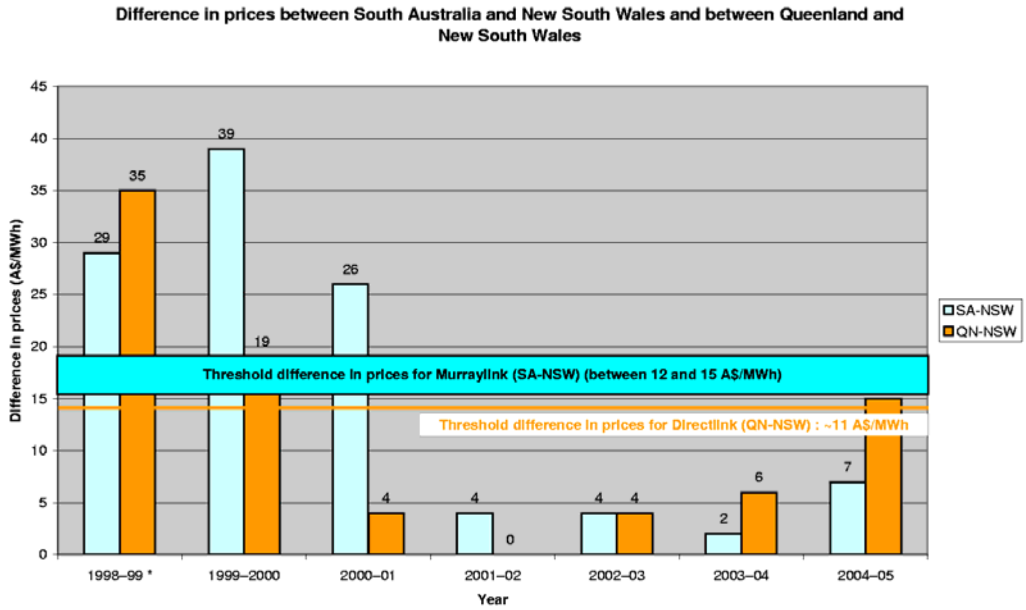

Figure 3 Difference in prices[6] (A$) between the states of South Australia (SA) and New South Wales (NSW) and between Queenland (QN) and New South Wales (NSW) (own calculus – data from www.aer.gov.au)

Required differences in zonal prices are huge and seem hard to maintain in a competitive environment. The differences in zonal prices between on the one hand the states of South Australia (the more expensive area) and New South Wales and on the other hand the states of New South Wales and Queensland (see Figure 3) show that it is difficult to maintain durably high differences in zonal prices between close areas, unless there is a political willingness to resort on power import. There are indeed few differences between the marginal generation technologies from a region to another if these regions have access to the same primary energy resources and if the public powers do not want specific energy mixes. Therefore, during investments periods/cycles, it is probable that the prices of two close areas tend to balance.

To conclude, the investments of Murraylink and of Directlink were profitable in static (1999-2000) but not in the competitive dynamic. These two interconnectors were indeed involved in a boom of investments as well in South Australia as in Queensland that led the market to an excess margin of generation of 34% in South Australia. Merchant lines are such risky investments unless finding a huge and lasting difference in zonal prices.

Merchant lines around New York City: lasting difference in zonal prices

Several merchant lines are planned or operated in the USA. Most of them are around New York City (NYC). Their number and the diversity of interested or involved investors indicate that NYC presents some peculiar conditions that make these investments far less risky

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[6] The difference in zonal prices is overestimated because of the prices that are available on the AER web site are volume weighted.

than what we noticed before. The urban density makes the building of new generation capacity in NYC or of new classical transmission capacity quite impossible. Merchant lines are a solution to the energy supply issue of NYC.

The Cross Sound Cable that was developed for the distributor LIPA connects Long Island (in the control area of NYISO) with Connecticut (in the control area of ISO-NE). The Neptune Cable that is also developed for the distributor LIPA will connect Long Island to New-Jersey (in the control area of PJM); the planned Empire Connection was thought to connect New York City with the region of Albany; the planned Harbor Cable was thought to connect PJM to the Queens district. These projects benefit from the impossibility to install new generation capacity to supply NYC or to build new overhead AC lines to NYC. Therefore, NYC undergoes a shortage of cheap power that allows to maintain local high prices without local solutions. And merchant lines can be then attractive supply solutions.

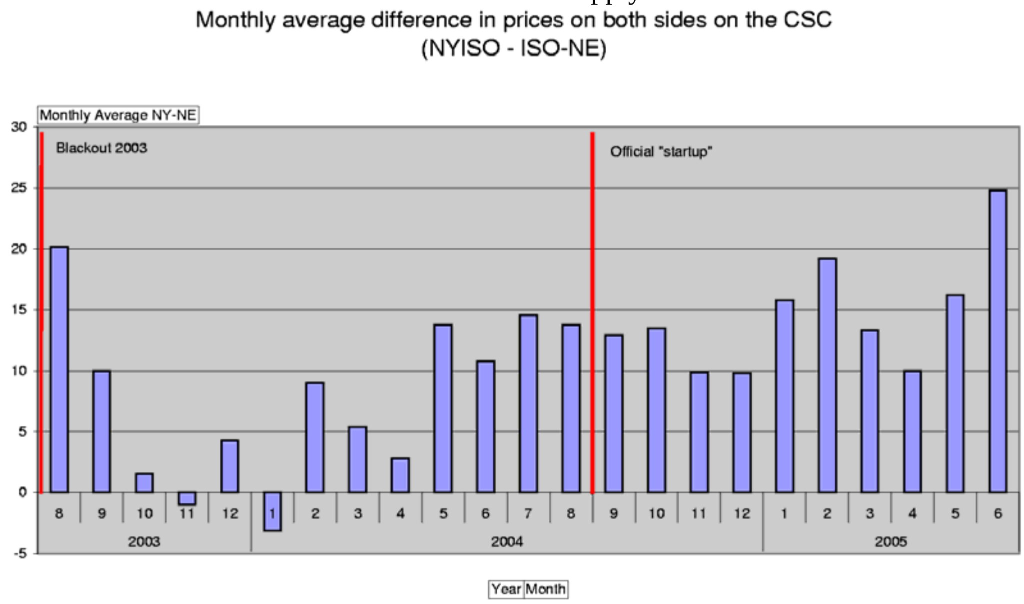

Figure 4 Monthly average of the difference in prices on both sides of the Cross Sound Cable

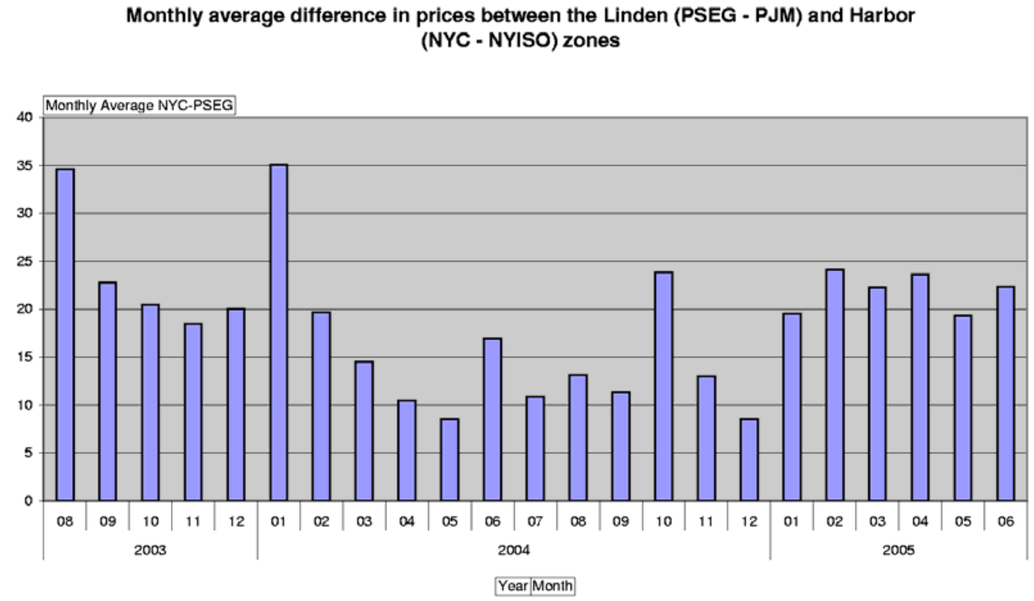

Figure 5 Monthly average of the difference in prices between the PSEG zone (PJM) and the NYC zone (NYISO), both sides of the thought Harbor Cable

We notice indeed that there exist high and lasting[7] differences in prices between NYC and the close areas, such as ISO-NE or PJM, or even areas inside NYISO. Besides, merchant lines earn money not only thanks to differences in energy prices but also thanks to capacity prices. Capacity prices are an important source of revenue for generators in NYC. They can earn 30% of their revenue thanks to the capacity market (FERC [2005]). So, it can also be an important source of revenue for the merchant lines that can then arbitrate between the capacity markets hence connected. It is a way to internalise reliability that a merchant line provides to the power system.

We can also notice that these investors are not independent ones but only one distributor that want to decrease the cost of energy to end-users. Therefore, he does not have the same incentives as an independent merchant investor to set the capacity of the merchant line. However, even in this case, the merchant investors would earn a noticeable rate of return.

To conclude, from the study of operated or planned merchant lines projects, we see some common denominators essential to the relevance of these investments emerge. Financing these investments requires a high and lasting difference in zonal prices on both sides of the merchant lines. The Australian experiences show that lasting differences in zonal prices are seldom. The American experiences show that it is nevertheless possible to find particular conditions where high differences in zonal prices can last.

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[7] The energy price in NYC has stayed high and volatile since the beginning of the nodal market in 2000 with an average price of 57$/MWh between March 2000 and July 2005 and a volatility (variance) around 30$/MWh.

Conditions for a lasting difference in zonal prices

The model recalled in section II informs quite well about the general conditions of profitability and efficiency of a merchant line. But there exist peculiar cases where a merchant line can be a relevant solution. Some supply constraints or some technological choices enforced by the public power of a market area can ensure a lasting difference in zonal prices and so a sufficient revenue to merchant investors.

Topological constraints can induce an energy insularity of a market area. Supply difficulties can be linked to difficulties in installing new generation capacities as well as to difficulties in creating new interconnectors with close areas. NYC is an example of an impossibility to build new generation capacities or to expand interconnectors with the rest of the NYISO area through classical terrestrial ways because of the urban density. Therefore, energy and capacity are expensive in this area. A merchant investor can benefit from this isolation to connect this isolated area to a close one thanks to non conventional means such as HVDC lines. Such a merchant line can then benefit from a high and lasting difference in zonal prices.

Another possibility to ensure that the difference in zonal prices lasts consists in connecting close areas with different energy mixes. For instance, the NorNed (the future cable between Norway and the Netherlands) exemplifies that a merchant line can benefit from the complementarity between a hydroelectric power system and a thermal energy system [Bugten 2004]. The cables that connect West Denmark to Norway and Sweden allow to limit the effects of wind power volatility by compensation thanks to the flexibility of hydrological power system (Nordel [2004]). It is also possible if there is a missing power technology in an energy mix. This situation is a common one when nuclear programs have been suspended.

Let's be careful because the differences in zonal prices in this case are subject to political decisions. Therefore, investing in a merchant line in such a case implies an important risk all the more this risk is not quantifiable. The Australian experience is an example where the regulatory uncertainty maintained then decreased the difference in zonal prices. In Australia, the states indeed lead the deregulation process and so the deregulation process follows different dynamics and application speeds from one state to another with a noticeable impact on the price formation (Littlechild [2003]).

To conclude, the merchant lines seem to be limited to some very specific investments where the huge difference in zonal prices can exist lastingly because of some constraints of energy isolation.

3.4. Hold-up of a merchant line

If a merchant line cohabits with a transmission owner, there is a risk of hold-up of the merchant line. The incentives of the two investors are indeed different. The objective of capacity of regulated lines tends to be greater than the objective of capacity of merchant lines. However, regulated transmission owners faces up against more issues of institutional compatibilities in building interconnectors. And long term contracts can hedge the merchant investor against uncertainty.

A merchant investor maximises the congestion rent by maximising its benefit. This objective makes the capacity of the merchant lines suboptimal.

A regulated transmission owner maximises its profit under regulatory constraints (with or without incentives). The regulator tries to make the objective of maximisation of social welfare coincide with the transmission owner's objective. In this case, the investments of a regulated transmission owner are near to the optimum.

Therefore, an efficient investment by a regulated transmission owner in parallel of a merchant line automatically induce the loss of an important part of the congestion rent that is needed to the merchant line's profitability (see Figure 6). Reliability criteria that motivate most of the regulated investments highlight this effect (Joskow [2005], see 2.3).

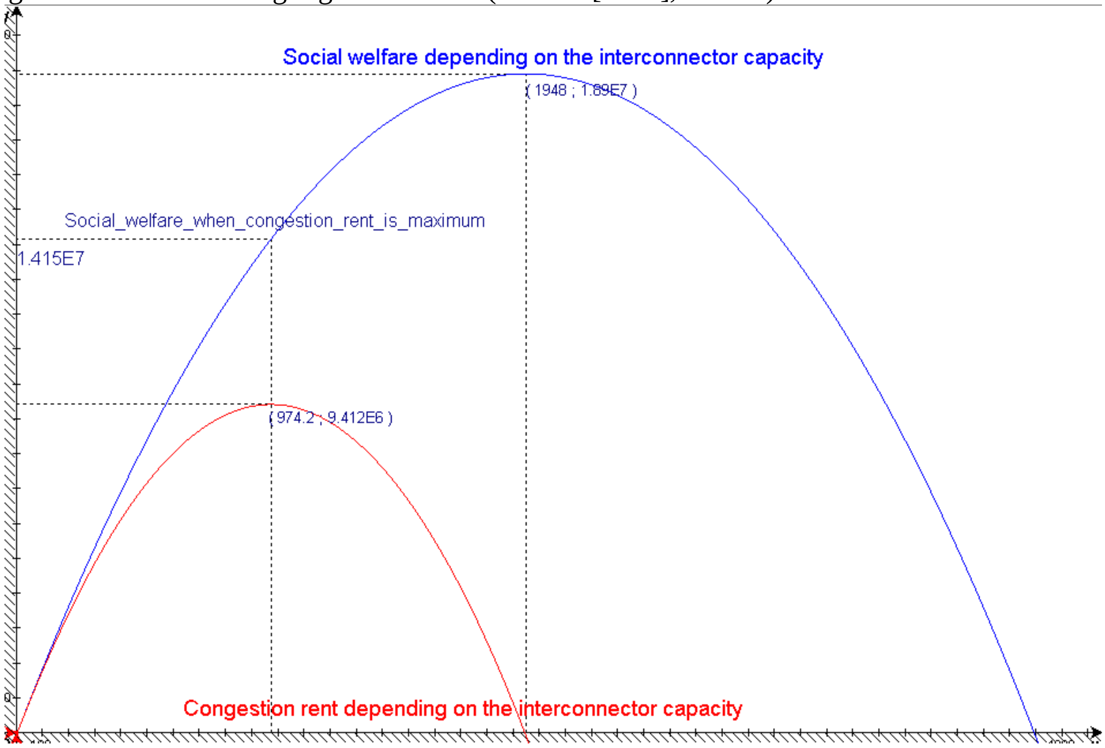

Figure 6 An example of variation in congestion rent and social welfare vis-a-vis the interconnector capacity between two zones for linear demand and supply curves

However, sitting on an institutional border, that is to say between two market areas, the merchant investors increase the transaction costs of the transmission owners in their negotiation process to justify such an interconnector (Joskow [2005]). Transmission owners must so not only justify their interconnector to their regulator but also involve the transmission owner of the second market area and so the regulator of the second market area. Since the merchant investor is the only to bear the investment risk, he does not have to justify its investment to the regulators.

The example of the merchant line Murraylink in Australia is eloquent. The time between the investment decision and the operation of the line was only 18 months. The regulated investment SNI between the two same market areas failed to proceed although it was submitted to the regulator before the investment decision of Murraylink.

Besides, a merchant investor can protect itself against market risks and the risks of hold-up by building its merchant line in the framework of a long-term contract with other market participants such as producers or consumers that would like to use the transmission capacity. This formula was adopted by the two merchant lines projects connecting Long Island with 20-year contracts. These contracts are not FTRs in themselves but they are quite similar. The merchant lines Murraylink and Directlink also tempted to adopt similar strategies before the fall of the difference in zonal prices, without any success. The Empire Connection was not built because not enough long term contracts were signed.

To conclude, the independent merchant investors face up against a risk of hold-up from the regulated transmission owners. However, sitting between two market areas, the merchant investors raise some kind of entry barrier for the transmission owners that must deal with a four-player negotiation, that is to say the transmission owners and the regulators of each area. Besides, the merchant investors can protect themselves against the risk of hold-up thanks to long-term supply contracts.

3.5. Conclusion: Where merchant lines are possible

The constraint of dispatchability that most of the regulations impose set the merchant investors more like traders that arbitrate between two markets rather than like classical transmission owners. Besides, the technological choice of merchant lines limits the investments conditions to cases where lumpiness and economies of scale are less present. Some constraints linked to the cost structure of merchant lines are all the less important that the connected markets are big. Some supply conditions or some choices of public powers can ensure a high and lasting rent to the merchant investors. The risks of hold-up of a merchant line are limited because the regulation exposes more the regulated transmission owners to institutional incompatibilities than the merchant investors. In brief, the power transmission network globally remains a natural monopoly. If the conditions previously mentioned are gathered, the merchant investors can build some relevant investments.

4. Demsetz competition limitéd to radial network investments

The competition to develop the power transmission network can be introduced in the “market of the transmission network monopoly” thanks to the Demsetz competition rather than in the energy market that we previously studied. The Argentine power industry applies the Demsetz competition to reduce the network investment costs. The regulatory evolution in Europe let us foresee similar approaches for some kinds of network investments.

4.1. Demsetz competition and power transmission network

The power transmission network globally remains a natural monopoly because of the economies of scale and the externalities that are hard to internalise otherwise than by horizontal integration. Even under this assumption, the competition to develop the network can be introduced in the “market to be the transmission monopoly”. The right to develop new power lines is granted by the Demsetz competition or « franchise bidding ». However, the interdependences between the network assets might require an adaptation of the Demsetz competition to radial or little meshed networks.

The economies of scale dictate the resort to monopoly rather than a market but do not have obvious effects on the practiced price level. It is the potential exercise of market power by the monopoly that creates the social welfare loss. Regulation allows to limit the informational rent that monopoly can extract, to obtain a price near to the competitive level and so to limit the social welfare losses.

Rather than resorting on monopoly regulation to limit the monopoly market power, Demsetz [1968] proposes to organise an *ex ante* market to grant the right to be a monopoly. The company that offers the lowest price for the monopoly services receives a franchise to ensure these public services. It is an efficient mechanism since the ex post price will be near of the competitive price without any public resort. The public power is so an auctioneer rather than a regulator. The competition for the right to be the monopoly dissipates the monopoly rent because it decreases the price and increases the produced quantities.

We previously saw that some attributes make the power transmission network a monopoly: the economies of scale whose effects are amplified by lumpiness, the difficulties in internalising all the externalities and the interdependences between the network elements otherwise than with horizontal integration.

Only a variant of the Demsetz competition has been applied on the power transmission network. The Demsetz competition is applied on the new investments whose owners are then regulated; the whole network is not auctioned off. Nevertheless, as we previously mentioned, in the framework of a meshed network, the balkanisation of transmission ownership whereas there are strong interdependences between each network element might increase transaction costs (Joskow-Tirole [2005]). In the case of franchise bidding, it is mainly the decentralisation of maintenance that might raise some issues. If maintenance scheduling is let to the transmission owners' discretion, the maintenance timetables might interfere because of the interdependences between network elements, create congestion and decrease the network reliability.

To conclude, replacing the regulation of the power transmission monopoly by Demsetz competition is easier and known to be possible, investment by investment, on radial or little meshed networks, because the interdependences between network elements can then be quite clearly identified and quantified.

4.2. Argentine as a model of franchise bidding for the power transmission network

In Argentina, since the power deregulation in 1992, the development of a power transmission line follows an accurate process. This process ends with a Demsetz competition to grant the right to build and maintain a transmission line. The investments criteria were criticised. However, the franchise bidding to develop the power transmission network seems satisfactory to reduce the network cost.

In the Argentine power industry, the System and Market Operator CAMMESA is unbundled from the transmission owners that are themselves unbundled from the generators[8]. CAMMESA is an Independent System Operator (ISO); the Transmission Owners are not "merchant investors" as we previously defined this term since they are regulated. Transener is the Transmission Owner that owns and maintains the network that existed before the reform. New network investments can be developed by other Transmission Owners than Transener.

Network developments follow the process presented hereafter. After:

1. the TSO CAMMESA identifying[9] the need for a network investment following a demand from network users,

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[8] Even if generators generally create subsidiaries or joint ventures to develop network in the Argentine system.

[9] Whatever the criterion. For more details about the investment criterion and the voting rules see Chisari *et al.* [2001]

2. the regulator ENRE validating the economic interest of the investment from the data provided by the ISO,
3. and the network users voting,

the project is auctioned to grant the right to build and maintain this asset. The line owner is paid to build the line and undergoes a RPI-X regulation to maintain the line. The line owner is regulated and remunerated by a network tariff as a common transmission monopoly is.

Even if the method to evaluate and validate the investments was criticised (Chisari *et al.* [2001]), the Demsetz competition to grant the right to build and maintain new lines is satisfactory since it allows to reduce the cost of some lines by 30% (Littlechild [2004]).

To conclude, this kind of franchise bidding to control the network development cost is satisfactory in the Argentine system.

4.3. Feasibility of the franchise bidding to develop a meshed network

The franchise bidding could not be applied to develop a meshed network. However, the possibility given to generators to choose the builder of their connection assets is similar to the kind of franchise bidding applied on the Argentine transmission network.

There are peculiar conditions in Argentina that have allowed to auction the network investments. The Argentine transmission network is indeed almost radial or little meshed.

Radial investments are seldom on the meshed core of the network in Continental Europe or in the USA. But, the network users are not generally connected directly to the core of the network but through a so-called “connection line”. This line is generally dedicated to the need and use of one network user. Therefore, the Argentine experience can be repeated for these network elements. The article 63 of the French law [2005-781] that sets the energy policy orientations henceforth allows the generators to do by themselves the building work of their connection assets. Two conditions are nevertheless required: the generator must obtain the agreement from the French TSO RTE and follow the schedule of conditions set by RTE.

In brief, the Argentine experience may be repeated at least for the connection assets. Besides, the Argentine example might also inform us about the feasibility of franchise bidding to develop a meshed network when the Argentine network would be looped southward and westward (Littlechild [2004]).

5. Conclusion

What place for competition to develop the power transmission network?

Some drastic views envision competition as a remedy to the regulatory failures to “regulate” the power transmission network (Hogan [2003], Littlechild [2003, 2004]). However, competition is efficient only in some niches of investment. We studied two kinds of competition to develop the power transmission network. In the first case, transmission investments are market driven as are the other competitive activities such as generation on a nodal energy market. In the second case, the transmission network remains monopolistic but an ex ante competition called Demsetz competition grants the right to be a monopoly.

Market driven transmission investments in the framework of a nodal energy market completed by transmission rights (FTR) are not efficient. Market driven transmission investments are undersized because of the network cost structure that economies of scale and lumpiness feature. The transmission rights as property rights for market driven investments does not well internalise loop flows and exogenous variations of line capacity. The energy market does not properly internalise reliability because of a lack of demand response, which decreases the merchant investor rent.

However, these inefficiencies can be small in some particular cases. The constraint of dispatchability imposed to the merchant lines reduces the exposure of merchant lines to loop flows. The underinvestment caused by economies of scale and lumpiness may be quite small compared to the size of the connected markets. Nevertheless, the conditions to develop merchant lines are still peculiar ones since they require a high and lasting (around 10 to 20 years) difference in nodal prices. These conditions are seldom and unsteady. The risk of hold-up by a regulated transmission owner is not that important since the regulated transmission owners may face up against more issues of institutional compatibilities between two market areas. Besides, the merchant investors can hedge against uncertainty while the merchant lines are "asset-specific" thanks to long term supply contracts.

It is hard to say if the Demsetz [1968] competition can be applied on a meshed network because of the interdependences between the network elements. However, one knows that it can reduce costs of connection lines or of radial lines.

Eventually, in the absence of appropriated property rights and methods to allocate the network cost, the competitive network investments are generally radial and/or create new commercial links between big markets. Competition to develop the network remains limited to where the inefficiencies due to economies of scale, lumpiness and externalities of transmission investments are small enough.

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