

Bier, Christoph

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Network Access in the Deregulated European Electricity Market: Negotiated Third-Party Access vs. Single Buyer

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**Network Access in the Deregulated
European Electricity Market:
Negotiated Third-Party Access vs.
Single Buyer**

by
Christoph Bier*

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Abstract:

The question of third-party access to the networks has become central to the debate around the liberalisation of the European electricity markets due to the natural monopoly characteristic of the transmission network. The European Union's electricity directive provides three institutional options for the organisation of network access: the single buyer procedure, the negotiated third-party access and the regulated third-party access.

This paper analyses these regimes in a framework of an imperfect decision-making regulation authority which can commit errors when supervising the transmission tariffs. It will be shown that the equivalence of the systems required in the directive is usually not achieved. In addition, conditions for deciding between the three systems are derived under social welfare considerations.

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* Center for the Study of Law and Economics, University of Saarland, Department of Economics, Bldg. 31, PO Box 151 150, 66041 Saarbrücken, Germany, Phone +49-(0)-681-3023172, Fax +49-(0)-681-3023591, email:c.bier@rz.uni-sb.de, homepage: <http://www.uni-sb.de/rewi/fb2/csle>.

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1. Introduction

After a long debate, the European Union's electricity directive of December 1996¹ has finally initiated the process of liberalisation of the European electricity markets. It contains regulations concerning generation, transmission and distribution of electricity, unbundling of these activities, and access to the network.² The latter is regarded as the key question in liberalisation both in public discussion and economic literature.³ Because the transmission network is generally considered to be a natural monopoly, economic efficiency requires that the grid as transport system be supplied by a single firm.⁴ Since the natural monopoly character of the grid prohibits the construction of parallel networks, the possibility for new competitors to use the network of the incumbent monopolist is a necessary prerequisite for competition.⁵

The directive provides three alternative institutional arrangements for the organisation of the access to the network: the so-called single buyer system, the system of regulated third-party access and the system of negotiated third-party access. All three systems are intended to lead to equivalent market results.

This paper compares these three systems in the context of an imperfect decision-making regulation authority and examines them with regard to the question as to the extent they do justice to the equivalence requirement. In addition, criteria for deciding between these systems under efficiency considerations are proposed.

¹ Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity, Official Journal of the European Commission, L27 (30. 1. 97), henceforth cited as EU (1997).

² Cf. KUMKAR/NEU (1997, 78 ff. and 108 ff.) for an overview of the process leading to the adoption of the directive and a detailed description of its provisions. See also JOHNSTON (1999).

³ Cf. e.g. ARMSTRONG/COWAN/VICKERS (1994, 135 ff.) or FARNUNG (1998).

⁴ The existence of almost 1000 power supply firms alone in Germany each operating their own networks doesn't contradict the natural monopoly characteristic. The crucial fact is that no competing networks exist in any supply area. Different ownership in different subnetworks is not relevant for the natural monopoly characteristic. For more on the notion of natural monopoly see SHARKEY (1982) and KRUSE (1985, esp. 19 ff. and 35 f.) with reference to the electricity supply industry.

⁵ The directive permits the construction of so-called direct lines (EU 1997, Art.21). However, this does not include the building of complete parallel networks. Direct lines are to be regarded rather as additions to the network. Their construction is expected only in special cases (cf. EWI 1995, 7, 56). For reasons of simplification direct lines are therefore omitted in the following analysis.

In the following chapter, the problems with unregulated access arising from the strategic incentives of the incumbent network owner are outlined. The third chapter presents the three systems of network access. In chapter four the imperfect decision-making agency is introduced. Chapter five analyses the different access systems and examines their effects on the market results. It will be shown that they lead to equivalent results only in exceptional cases. Chapter six addresses the question of which alternative is preferable from a welfare point of view. The last chapter summarises the results.

2. Unregulated network access

The pre-liberalisation situation of the electricity market was characterised by area monopolies: A single power producer who also controlled the grid supplied all customers in its area with electricity.⁶ After the opening-up of the market, a new competitor also may supply customers of the area monopolist. To reach these customers he must be able to use the grid of the incumbent monopolist.⁷ Thus the transportation service of the network constitutes an essential input to the production of the service "electricity supply", which must be bought from the network carrier. However, from the perspective of the incumbent monopolist, the new power supplier is not only a customer, who purchases transportation capacity, but also a competitor since he wants to lure the incumbent's customers. From this a situation arises in which the incumbent has an incentive to block the entry of the new competitor by refusing him access to the grid.

Although the directive expressly forbids the refusal of network access except in the case of capacity constraints,⁸ a competitor could be deterred by the incumbent's demanding a prohibitively high access price or delaying negotiations. The former can be illustrated using a simple model:

Let there be two players, the incumbent area monopolist (I) controlling the grid and a representative market entrant (E). Prior to liberalisation, the incumbent supplies all customers in her supply area with electricity at price \bar{p} and makes a positive profit. The demand for electricity is assumed to be perfectly price-inelastic and normalised to one.

To supply the customers, costs arising from generating and transporting electricity must be incurred: The constant marginal generation costs of the incumbent are denoted g_I . Fixed production costs are not considered. In addition, there are costs associated with the maintenance and the operation of the grid, which I has to incur in any case, regardless

⁶ These areas could comprise a whole country (e.g. in France) or only parts of it (e.g. in Germany, where almost 1000 electricity suppliers were active in their respective monopoly area). Exceptions include England and Wales and Scandinavia, where the industry already was (at least partially) liberalised prior to the adoption of the directive. For an account of the organisational structure of the industry in different European countries prior to liberalisation see CROSS (1996), GILBERT/KAHN (1996) or KUMKAR (1996).

⁷ The procedure of feeding electricity into the grid of an area monopolist while simultaneously extracting an appropriate quantity further down the line is called "wheeling".

⁸ EU (1997, Art. 17(5) and 18(4)).

whether she uses the grid itself or sells transmission capacity to the entrant E. It is assumed that there are two possible levels of grid costs, expressed by the average costs $c=h$ (abbreviated c_h) or $c=l$ (c_l), with $c_h > c_l$. Correspondingly, two types of incumbent grid operators exist, the l-type with low grid costs and the h-type with high costs. The probability of type l is denoted by $0 < q < 1$.

The potential competitor E has constant marginal generation costs g_E lower than those of I: $g_E < g_I$. In addition he has to pay I a transmission charge per kWh denoted by t . I and E negotiate the transmission payment, both having perfect knowledge about the two possible grid cost levels and the network operator's actual grid costs. The following relation is assumed: $\Delta c > \Delta g$, with $\Delta c := c_h - c_l$ and $\Delta g := g_I - g_E$. The resulting cost structure is illustrated in figure 1.

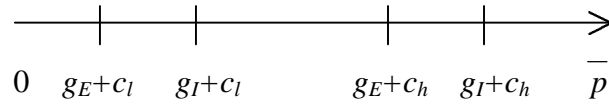


Fig. 1: cost structure

A typical wheeling interaction then has the following structure: The incumbent demands a constant transmission price per kWh. The level of her demand d can correspond either to c_h ($d=h$) or c_l ($d=l$). The variable s indicates the status of the demand, i.e. whether the amount of the demand corresponds to the actual costs ($s=true$) or not ($s=false$).

The potential entrant can agree to this demand and enter the market (*in*) or not (*out*).⁹ If he agrees, he pays a transmission price $t=d$ when he supplies the customers. If he enters the market, the player reflecting the lower costs will supply all customers in the area with electricity at a price marginally below the costs of its rival.

If the new competitor offers the electricity at a lower price than the incumbent, all customers switch to the entrant who can completely satisfy demand. If the entrant stays out of the market, the customers are supplied by the incumbent at the old price \bar{p} .

Table 1 summarises the profits of the two firms for all possible constellations. $G_c^t(\mathbf{p}_c^t)$ denotes the profit of E (I), with transmission price t and grid costs c . G_c^0 and \mathbf{p}_c^0 are the profits if E stays out of the market.

If the transmission price equals the actual low grid costs ($t=c=l$), then the entrant has generation costs of g_E and transmission costs of $t=c_l$, thus in total g_E+c_l . The old monopolist's costs amount to g_I+c_l . Since $g_I+c_l > g_E+c_l$ (see fig. 1), the entrant will assume the supply of the customers. He sets his price at the same level as the old monopolist's cost, so that the incumbent cannot undercut him, thus $p = g_I+c_l$. Hence he makes a profit of $G_l^l = g_I+c_l - (g_E+c_l) = \Delta g$. The incumbent incurs the grid operation costs of c_l , which are

⁹ These "negotiations" between the players, modelled as ultimatum game, will not be costless. Nevertheless negotiation costs are not considered in this case, since the players have to negotiate about the transmission price in any case. Thus they are insignificant to the concrete decision during the negotiation process.

exactly covered by the transmission payment of the entrant, giving I a profit of $\mathbf{p}_l^l = c_l - c_l = 0$. The profits in the remaining cases can be derived similarly.

		Entrant E		Incumbent I	
Grid costs c	Transmission price t	Costs	Profit	Cost	Profit
$c=l$	$t=l$	g_E+c_l	$G_l^l = g_I+c_l - (g_E+c_l)$ $= \Delta g$	g_I+c_l	$\mathbf{p}_l^l = c_l - c_l = 0$
$c=h$	$t=h$	g_E+c_h	$G_h^h = g_I+c_h - (g_E+c_h)$ $= \Delta g$	g_I+c_h	$\mathbf{p}_h^h = c_h - c_h = 0$
$c=l$	$t=h$	g_E+c_h	$G_l^h = 0$	g_I+c_l	$\mathbf{p}_l^h = g_E+c_h - (g_I+c_l)$ $= \Delta c - \Delta g$
$c=h$	$t=l$	g_E+c_h	$G_h^l = g_I+c_h - (g_E+c_h)$ $= \Delta g$	g_I+c_h	$\mathbf{p}_h^l = 0$
$c=l$	No wheeling	0	$G_l^0 = 0$	g_I+c_l	$\mathbf{p}_l^0 = \bar{p} - (g_I+c_l)$
$c=h$	No wheeling	0	$G_h^0 = 0$	g_I+c_h	$\mathbf{p}_h^0 = \bar{p} - (g_I+c_h)$

Table 1: Profits

The case of high grid costs and low transmission price deserves closer attention: The network operator cannot cover her costs and would make a loss, if she had to further maintain and operate the grid. It is assumed for now that the control over the grid is transferred to E.¹⁰ His total costs then equal g_E+c_h , the old monopolist's g_I+c_h , from which profits $G_h^l = \Delta e$ and $\mathbf{p}_h^l = 0$ result.

Thus the following relations apply to the profits:

- (1) $\mathbf{p}_l^h > 0$ and $\mathbf{p}_l^0 > \mathbf{p}_h^0 > 0 = \mathbf{p}_h^h = \mathbf{p}_l^l = \mathbf{p}_h^l$.
- (2) $G_h^l = G_l^l = G_h^h > 0 = G_l^h = G_l^0 = G_h^0$.¹¹

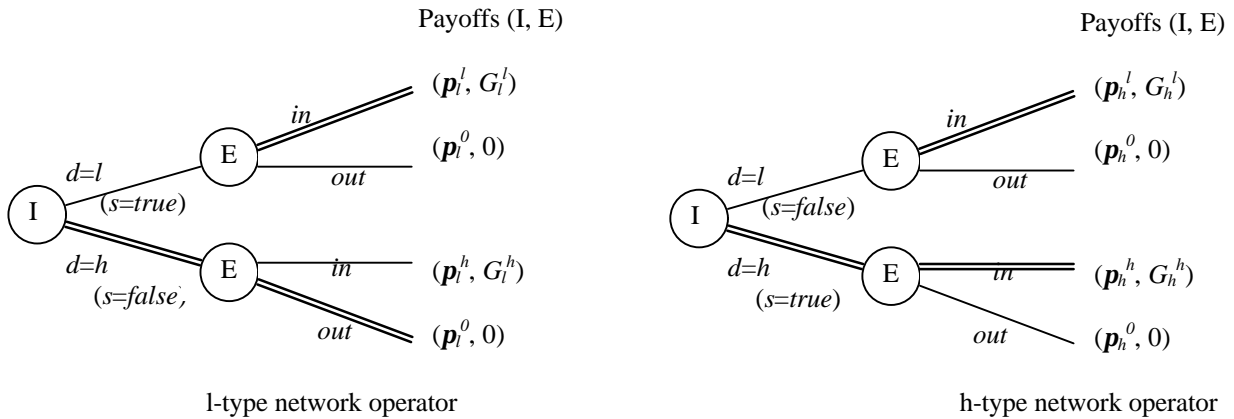


Fig. 2: Unregulated network access

¹⁰ Other possibilities include e.g. subsidising the network operator. While this slightly changes the decisions of the entrant, it does not affect the basic results of the analysis.

¹¹ In the remainder it is assumed that the network carrier demands a high price and the potential entrant stays out of the market whenever they are indifferent among two actions, respectively.

Figure 2 shows the game trees in the case of unregulated network access. With regard to (1) and (2) it can easily be verified that an l-type network operator will demand a high transmission charge despite low grid costs and E will not enter the market.¹² I thus can effectively deter the market entry of the new competitor by not revealing her true costs but instead demanding an exaggeratedly high transmission price. She can offset E's cost advantage in generation by charging an inflated transmission fee to the effect that her total costs are lower than those of the potential entrant. However, since E can generate the electricity at lower costs ($g_E < g_I$), supply by the entrant would be desirable from the point of view of technical efficiency which means accruing the lowest possible total costs.¹³ Hence, in this case, unregulated negotiation over network access leads to inefficient market entry deterrence. Thus a welfare loss is incurred to the extent that the cost reduction Δg is not achieved.

Should the network carrier be of the h-type, then she demands a transmission price equal to her true costs, and the new competitor enters the market and supplies the customers with electricity. So in this case, the efficient result is reached for a true transmission fee, which covers the costs, is demanded and the cheaper generator enters the market.

Summarising, it can be stated that the unregulated market interaction between the two power suppliers involved cannot guarantee an efficient outcome. Inefficient market entry deterrence will result whenever the incumbent is of the l-type, thus with probability q . The expected efficiency loss of this unregulated solution in contrast to an ideal outcome, where the efficient entrant always enters and pays a transmission price equal to the grid costs, then amounts to

$$(3) EL_{un} = q\Delta g + B > 0,$$

where B denotes the sum of the negotiation costs of both firms.

Since unregulated network access cannot guarantee the supply of electricity by the efficient producer, it seems reasonable to submit the grid access to some form of control. The next chapters turn to the organisation of this control.

3. The Network access procedures of the EU-directive

The European Union's directive provides three alternative access regimes between which the member states can select when enacting national laws to comply with the directive: Negotiated access to the grid, regulated access to the grid and the single buyer procedure.

1. Art. 17 (1-3) of the directive defines the negotiated third-party access to the grid (NTPA). All electricity producers and suppliers and all eligible customers can sign supply contracts with each other. The modalities of grid access – in particular the transmission price – are

¹² The actions which are actually selected are marked by double lines.

¹³ Cf. KRUSE (1985, 97), BERG/TSCHIRHART (1988, 9 f.)

to be negotiated between the parties to the contract and the network operator.¹⁴ This negotiation with the grid operator is the defining feature of this system of network access. Negotiations are necessary in each individual case, perhaps leading to different transmission prices for different wheeling transactions, so that this system could be characterised as one of specific rights to grid access.¹⁵

2. The system of regulated access to the grid (RTPA) gives actors a right of access based on fixed pre-published tariffs (EU 1997, Art. 17(4))
3. The single buyer procedure (SB) as third option is defined in Art. 18. Within the area covered by the network a so-called single buyer is designated by the member states. This single buyer is responsible for the electricity supply of all customers within the area concerned. Nevertheless, eligible customers within the area covered by the single buyer can conclude supply contracts with producers inside and outside the system. The single buyer is then obliged to purchase the quantities of electricity which are agreed upon in such contracts at a price calculated as the difference between the price at which the single buyer has been supplying the customer thus far and thereafter and a tariff for the use of the transmission system that has been made public (so-called triangle contracts).¹⁶

The price difference between the single buyer's and the new supplier's price is passed on to the customer through this mechanism. The contractual relationship between the customer and the single buyer is maintained, the latter continuing in the role of the electricity supplier of the former.¹⁷

According to the intention of the directive, these three options are to lead to equivalent economic results – in fact this is the reason why the member states are allowed to choose between different systems at all.¹⁸ According to the European Commission, 10 member states opted for a RTPA system, 2 for the single buyer, 2 for an NTPA system.¹⁹

Taking into account the need for a regulatory supervision of grid access outlined above, the single buyer procedure and the regulated access system can be classified as access regimes with mandatory ex ante adjustment of transmission fees, for the tariffs must be approved by

¹⁴ EU 1997, Art. 17(1). If networks owned by different operators should be needed to carry out the wheeling transaction, access must be negotiated with each single operator.

¹⁵ Cf. KUMKAR/NEU (1997, 96 f.)

¹⁶ It should be noted that member states can decide not to obligate the single buyer to buy the contracted electricity. But since, in this case, a mechanism either according to NTPA or RTPA comes into effect (EU 1997, Art. 18(3)) this paper considers only the single buyer system where there is an obligation to purchase.

¹⁷ From the construction of these triangle businesses, it becomes clear that the net payments under the single buyer procedure are the same as under RTPA or NTPA, provided the transmission prices are equal. For a more detailed description of the mechanism of such triangle businesses see SCHMIDTCHEN/BIER (1997, 27 ff) or EWI (1995, 25 f.).

¹⁸ Cf. EU (1996, 1997 (12))

¹⁹ Cf. EC(1999a, b). The fifteenth state, Denmark, was still indecisive (as of December 1998). Particularly interesting is the case of Germany, where NTPA and single buyer co-exist at the distribution level.

the responsible supervision agency and published before the first wheeling transaction takes place.²⁰

In contrast to this, the NTPA system can be understood as an arrangement under which no adjustment takes place in the first instance, but instead the actors negotiate autonomously. After the negotiations have established a transmission price, control must still be possible, if not obligatory, e.g. by the competition authority.²¹

Taking into consideration the fact that single buyer and RTPA not only feature identical regulatory structures (first a uniform transmission tariff is approved by the regulator and published, and only after that wheeling transactions take place) but also lead to the same net payment flows it becomes clear that RTPA and single buyer are virtually identical. Therefore, in what follows the RTPA system is omitted from the analysis and only the single buyer procedure and NTPA are considered.

In the remainder of this paper these typical institutional options with regard to organising network access are examined in the light of their efficiency, and the question as to whether, or to what extent the choice of the access system influences the success of the liberalisation will be addressed. Technical efficiency serves as yardstick, i.e. supplying the electricity customers is to be the preserve of the cost-efficient generator.

4. An imperfect decision-making regulation agency

The comparison between both regimes of network access needs to be viewed in a framework of a regulation agency which does not decide perfectly. The risk of making errors arises from the complexity of the subject as well as from the fact that the opening-up of electricity networks is a relatively new development for which there is, as yet, little experience on which to fall back on. In addition, a supervising body might be less well informed about the grid costs than the enterprises involved.

The task of the regulator consists in setting the transmission charge equal to the actual grid costs of the network operator, i.e. to determine the true line costs. When a tariff is submitted to the authority, it has to decide whether to accept the demand (a) or to reject it ($-a$). Since, in this model, only two grid cost levels are possible, the refusal of a demand automatically means that the fee is set at the other possible level. Thus the task of the authority consists of approving a demand in accordance with the true grid costs and rejecting one that incorrectly cites an exaggeratedly high or exaggeratedly low cost level.

²⁰ The directive requires member states, when setting up a single buyer system, to “take the necessary measures for ... the publication of a non-discriminatory tariff for the use of the transmission and distribution system” (EU 1997, Art. 18 (1)). This tariff then has to be applied to all wheeling requests. The logic of the system suggests that a network operator designs a tariff scheme and submits it to a control instance for permission. If the controlling authority agrees, then the transmission charge is fixed for each following wheeling transaction.

²¹ Cf. EU (1997, Art. 22).

This authority is modelled as a decision automaton characterised by two probabilities which are conditioned on the state of the demand. This mode of representation reflects the fact that the authority can commit two kinds of errors: it can reject a justified (true) demand, or it can approve an unjustified (too high or too low) one.²² These probabilities are defined as follows (see also table 2): The probability of approving a demand given that the state of this demand is actually true is $\text{prob} \{a \mid s=true\} = r$, and the probability of accepting a demand which doesn't equal the costs is denoted $\text{prob} \{a \mid s=false\} = w$. Let $0 < r, w < 1$. The probability that the authority will commit an error is thus strictly positive.

The conditional probabilities r and w are called decision parameters of the regulator. In fact, in this model, the agency does not make an actual decision; on the contrary its action is determined in accordance with a probability distribution.²³ However, it is only important that the firms perceive the authority in such a way that its decision is made in accordance with parameters r and w .²⁴ It is assumed that both the incumbent and the potential entrant are informed about the values r and w .

State of I's demand	$d=c$ ($s=true$)	d^1c ($s=false$)
Agency's decision		
Acceptance (a)	r	w
Refusal ($\neg a$)	$1-r$	$1-w$

Table 2: Decision probabilities

The regulation agency accrues two kinds of costs: Those necessary to set up the agency, denoted by S , and the costs which are caused every time the agency is called into action, denoted by A . These costs mean real consumption of resources.

The firms only take into account expenses they have to incur themselves when the agency's services are required, e.g. costs resulting from the preparation of documents but perhaps also specified fees for calling the authority into action. These expenses are denoted A_I and A_E , respectively.

²² The basic idea of modelling imperfect decision-making using two types of error probabilities is adapted from HEINER (1983).

²³ It can be shown that the representation of the authority as probability automaton serves as a simplified model of the agency as a player who is only capable of imperfect decision-making, cf. KIRSTEIN (1998).

²⁴ It has to be borne in mind that the focus of this paper is not on the decision-making process of the agency itself, but its impact on the underlying behaviour of incumbent and entrant.

5. The access systems

5.1. The single buyer procedure

On the basis of the above considerations, the effects of the single buyer system - perceived as an access regime with mandatory ex ante control of the transmission tariff - are to be examined.

5.1.1. l-type network operator

First the case of an incumbent network operator with low costs is analysed. The game structure is as follows (see fig. 3):

- First the network operator decides on her transmission demand $d=l$ or $d=h$.
- After that, the regulation agency has the possibility to accept this demand (a), leading to a transmission price $t=d$, or to reject ($\neg a$) and to set the payment equal to the other possible level. In the case at hand of the l-type network operator, a high demand ($d=h$) is exaggerated ($s=false$). Thus the agency rejects it with probability $1-w$ setting $t=l$, but it commits an error with probability w and accepts the high demand, resulting in $t=d=h$. Accordingly a low demand is justified and the regulator accepts it with probability r but rejects it wrongly with $1-r$ and determines a high transmission price.
- Finally the entrant decides whether to enter the market (in) or not (out).

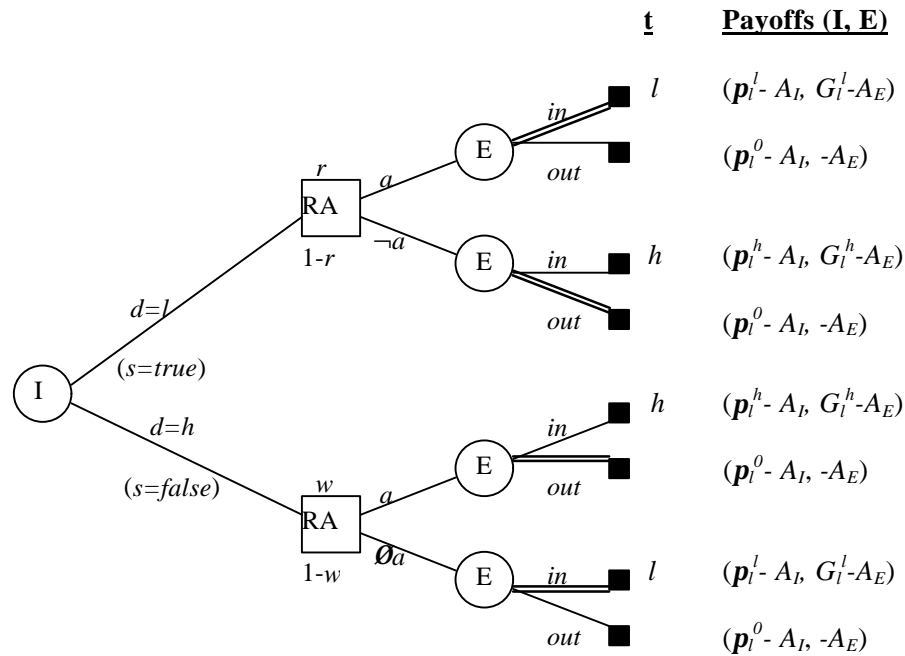


Fig . 3: Single buyer system and l-type network operator

The game can be solved using backward induction. E makes his decision either to enter the market or not to enter the market knowing the transmission price specified by the authority, either by approving or rejecting and changing I's demand. The decision of the incumbent to

demand a high or low transmission charge depends on E's decision and the agency's decision parameters r and w . $E(d=l)$ denotes the expected profit of I if she claims a low demand, $E(d=h)$ the expected profit if she pretends her costs are high.

$$(4) E(d=l) = r p_l^l + (1-r) p_l^0 - A_I = (1-r) p_l^0 - A_I$$

$$(5) E(d=h) = w p_l^0 + (1-w) p_l^l - A_I = w p_l^0 - A_I$$

She opts for a true demand ($d=l$), if:

$$(6) E(d=l) > E(d=h)$$

$$\Leftrightarrow r < 1-w$$

In contrast, if $r \geq 1-w$, then I demands a high price. Her decision is thus ultimately influenced by the decision parameters of the regulation authority. If one could assume that the specific (r,w) combination by which the authority is characterised from I's point of view complies with condition (6), then one could be certain that an l-type network operator's demand in each case is true.

5.1.2. h-type network operator

An analogous analysis can be applied for the case of a high-cost network operator. The situation is depicted in figure 4.

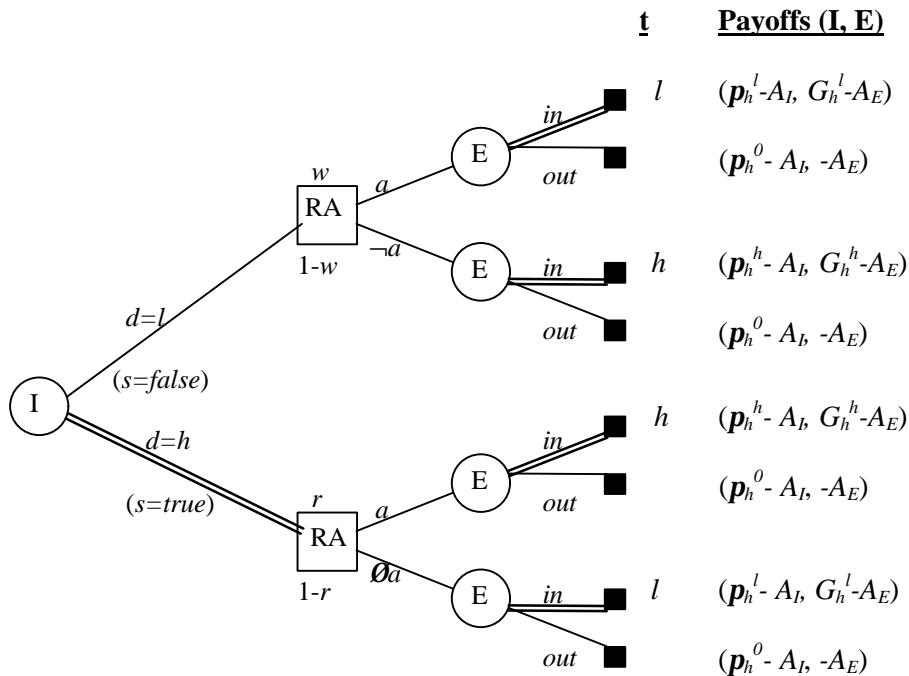


Fig. 4: Single buyer system and h-type network operator

The difference from the case concerning the l-type network operator consists in the fact that, for the h-type monopolist, the action $d=h$ is an accurate reflection of actual costs and $d=l$ is an

inaccurate and misleading one. In the depiction of the game tree therefore besides the payoffs only the status variable s and the allocation of the conditional probabilities r and w , which are conditioned on the status of the demand, change with regard to figure 3.

I's expected profits are:

$$(7) E(d=l) = w\mathbf{p}_h^l + (1-w)\mathbf{p}_h^h - A_I = -w(\mathbf{p}_h^h - \mathbf{p}_h^l) + \mathbf{p}_h^h - A_I = -A_I$$

$$(8) E(d=h) = r\mathbf{p}_h^h + (1-r)\mathbf{p}_h^l - A_I = r(\mathbf{p}_h^h - \mathbf{p}_h^l) + \mathbf{p}_h^l - A_I = -A_I$$

Hence, h-type operators will always demand a high transmission price based on a truthful appraisal of the cost structure.

5.1.3. Effects of the single buyer procedure

The results of the two preceding sections can be graphically illustrated (see figure 5). Each point within the square represents a possible (r,w) combination of the regulator's decision parameters. The darkly-shaded triangle covers all (r,w) combinations for which condition (6) holds: $r < 1-w$. Here an l-type network operator will reveal her true costs and request a low fee. An h-type-network operator will request a high fee in this area, thus likewise revealing her true costs. In the brightly-marked upper triangle condition (6) does not apply: Here an l-type-network carrier will claim an inflated demand and an h-type-network carrier one that is based on an honest assessment of her costs. Both types will thus request a high fee.

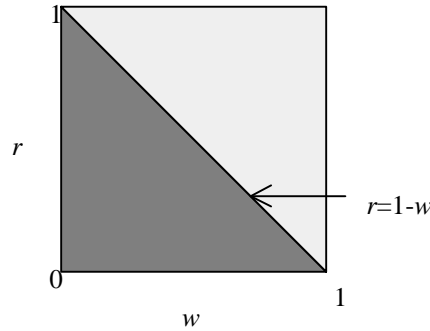


Fig. 5: (r,w) combinations under the single buyer procedure

In this model a regulation agency is always characterised by a specific (r,w) combination. If $r \geq 1-w$ it cannot induce both types simultaneously to reveal their true costs. Such an agency would not change the behaviour of the incumbent with regard to the unregulated situation (see ch. 2) since every network operator would demand a high price.

In contrast to the scenario just outlined, the behaviour of both types would differ in the dark triangle: h-types would still request a high fee, but l-types would now demand a low price.

The agency is always active due to the mandatory ex ante duty of obtaining permission for the tariff, i.e. apart from the set-up costs S the costs of the agency's activity A are continually accruing.

In addition, due to the possibility of a wrong decision by the regulator, the probability exists that the transmission price does not equal the actual grid costs. If $r < 1-w$ an l-type network carrier will place a low demand. This is rejected by the regulator with probability $(1-r)$ and entry is prevented. If the network operator is of h-type, her high demand is accepted with r and rejected with $1-r$. E always enters the market. It must be borne in mind that q denotes the portion of l-type network operators. Then the expected efficiency loss compared with an ideal solution in the case $r < 1-w$ equals $q(1-r)\Delta g$. Similarly for $r \geq 1-w$, when all network carriers request a high fee, the loss is $qw\Delta g$.

Thus the overall expected efficiency loss of the single buyer system amounts to

$$(9) \quad EL_{SB} = \frac{1}{2} q\Delta g(1-r+w)+A+S > 0.$$

The single buyer system thus leads to a strictly positive expected welfare loss in relation to a hypothetical ideal solution, in which the two enterprises agree on a transmission price which would cover the price.

5.2. Negotiated third-party access

In this section, the second regime, negotiated third-party access, is examined in the light of whether it is able to induce the network operators to demand a price just covering their costs and thus to guarantee efficient market entry.

5.2.1. l-type network operator

First the structure of the interaction is represented (see fig. 6):

- First the incumbent I decides on her demand $d=h$ or $d=l$. However, she does not submit this demand to the agency, but to the new supplier E, who wants to wheel his electricity through I's grid.
- E has now three options: as in the unregulated case he can agree to the demand and enter the market (*in*), paying a transmission price $t=f$. Alternatively, he can dispense with the wheeling and stay out of the market (*out*), and the status quo prevails. Moreover he has the option of turning to the regulation authority and having I's demand examined (*ra*). This possibility is independent of whether I's demand is justified ($s=true$) or not ($s=false$).²⁵
- If the authority is to make a move, it decides to accept or to reject the request according to its decision parameters r and w . The activity of the authority is connected with positive

²⁵ This "negotiations" cause bargaining costs. Since negotiations are compulsory they don't influence the decision of the players. Therefore bargaining costs B are neglected in this section.

costs for the two firms, which are denoted A_E for the prospective entrant and A_I for the monopolist.

After the agency's decision, E decides whether to enter the market (*in*) or not (*out*). E's decision, after the agency has ruled on the demand, can be derived by looking at his payoffs (see (1) and (2)) and is designated in fig. 6 by double lines. His decision at node E_1 , after I has demanded a truthful low fee, will always be agreement (*in*): His payoff amounts to G_I^l which is greater than zero, his payoff if he doesn't enter (*out*), and likewise greater than his expected profit from appealing to the agency, $E(ra)$:

$$(10) \quad E(in) > E(ra)$$

$$\Leftrightarrow G_I^l > r(G_I^l - A_E) + (1-r)(-A_E)$$

$$\Leftrightarrow -A_E < (1-r)G_I^l$$

This is always fulfilled, since G_I^l , $(1-r)$ and $A_E > 0$.

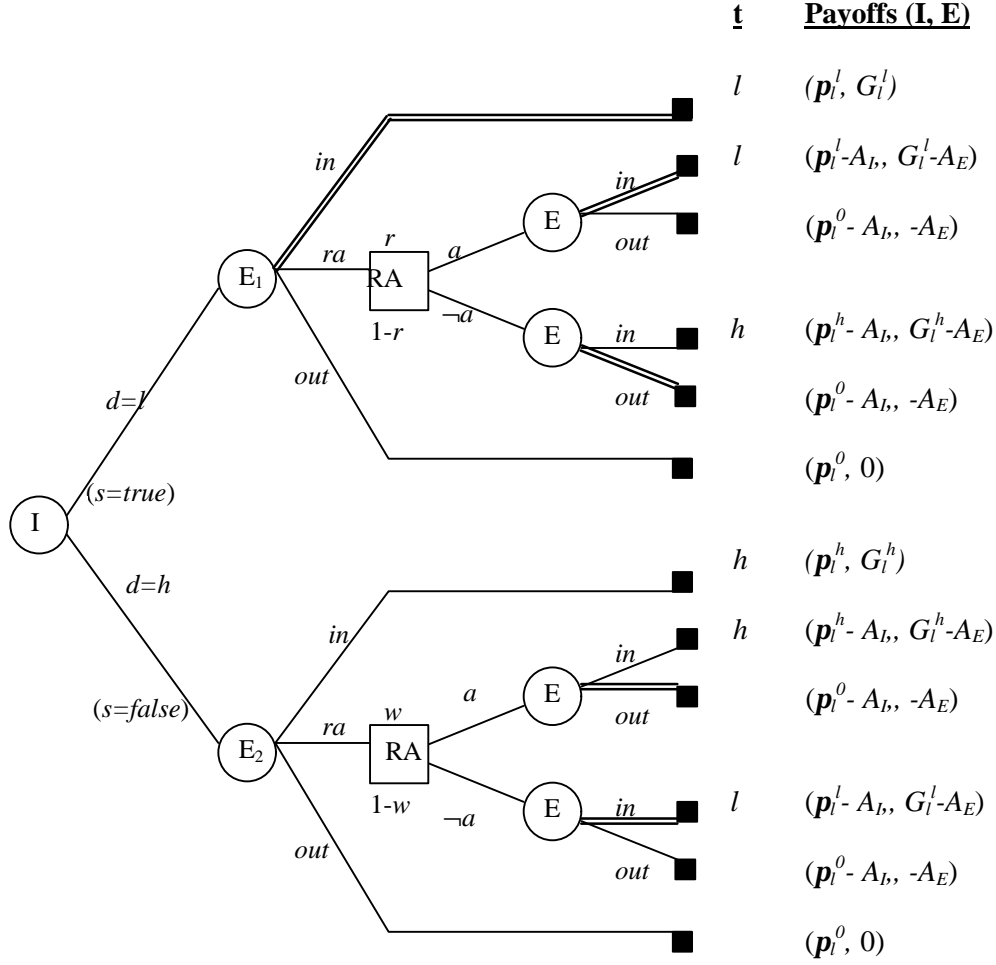


Fig. 6: Negotiated third-party access and l-type network operator

At node E_2 E's problem is as follows: Direct agreement (*in*) to I's exaggeratedly high demand is always less favourable than staying out of the market since $G_l^h = 0$. His selection problem is reduced, thereby, to a comparison between the payoffs from appealing to the regulator and staying out of the market. His expected profit from turning to the authority equals:

$$(11) \quad E(ra) = w(-A_E) + (1-w)(G_l^l - A_E) = (1-w)G_l^l - A_E$$

Turning to the agency is the best action, if

$$(12) \quad E(ra) > E(out)$$

$$\Leftrightarrow (1-w)G_l^l - A_E > 0$$

$$\Leftrightarrow w < 1 - \frac{A_E}{G_l^l} = 1 - \frac{A_E}{\Delta g} := w_1$$

If this inequality holds, E will turn to the authority. I then has the choice between a honestly low demand, which is accepted by E and results in a payoff of π_1^l for I, and an exaggeratedly

high demand, which will induce E to appeal to the authority. The latter yields an expected payoff $E(d=h)$:

$$(13) \quad E(d=h) = w(\mathbf{p}_I^0 - A_I) + (1-w)(\mathbf{p}_I^l - A_I) = w(\mathbf{p}_I^0 - \mathbf{p}_I^l) + \mathbf{p}_I^l - A_I$$

A low demand is the better choice, if:

$$(14) \quad E(d=l) > E(d=h)$$

$$\Leftrightarrow \quad \mathbf{p}_I^l > w(\mathbf{p}_I^0 - \mathbf{p}_I^l) + \mathbf{p}_I^l - A_I \quad | \quad (\mathbf{p}_I^0 - \mathbf{p}_I^l) > 0$$

$$\Leftrightarrow \quad w < \frac{A_I}{\mathbf{p}_I^0 - \mathbf{p}_I^l} = \frac{A_I}{\mathbf{p}_I^0} := w_2$$

If condition (12) does not hold E will not enter the market in E_2 , since turning to the authority results in a negative expected profit. I thus could effectively deter E by demanding a high price. This is her best choice, since

$$(15) \quad E(d=h) > E(d=l)$$

$$\Leftrightarrow \quad \mathbf{p}_I^0 > \mathbf{p}_I^l.$$

The results are summarised in table 3.²⁶ It can be seen that the situations in the right column are inefficient: The incumbent effectively bars the entry of the cost-efficient generator by demanding an excessive transmission charge.

	(12) holds: $w < 1 - \frac{A_E}{\Delta g} = w_1$ (E chooses <i>ra</i> at E_2)	(12) doesn't hold: $w > 1 - \frac{A_E}{\Delta g} = w_1$ (E chooses <i>out</i> at E_2)
(14) holds: $w < \frac{A_I}{\mathbf{p}_I^0} = w_2$	I chooses $d=l$, E chooses <i>in</i>	I chooses $d=h$, E chooses <i>out</i>
(14) doesn't hold hold $w > \frac{A_I}{\mathbf{p}_I^0} = w_2$	I chooses $d=h$, E chooses <i>ra</i>	I chooses $d=h$, E chooses <i>out</i>

Table 3: Negotiated third-party access and l-type network operator

The result in the left lower box likewise is similarly unsatisfactory: Here E cannot immediately be deterred by a high demand. Instead he turns to the authority. E's efficient market entry occurs with probability $(1-w)$; with probability w inefficient deterrence occurs, when the authority approves I's high demand. Due to the action of the regulation authority, costs A result. On the other hand, if the parameter constellation of the upper left box is

²⁶ Situations of indifference are not considered for reasons of simplicity.

fulfilled, then the network operator is induced to state a true (low) demand, after which E efficiently enters the market. As a result, the authority is not active.

5.2.2. h-type network operator

Fig. 7 depicts the interaction in the case of an h-type operator.

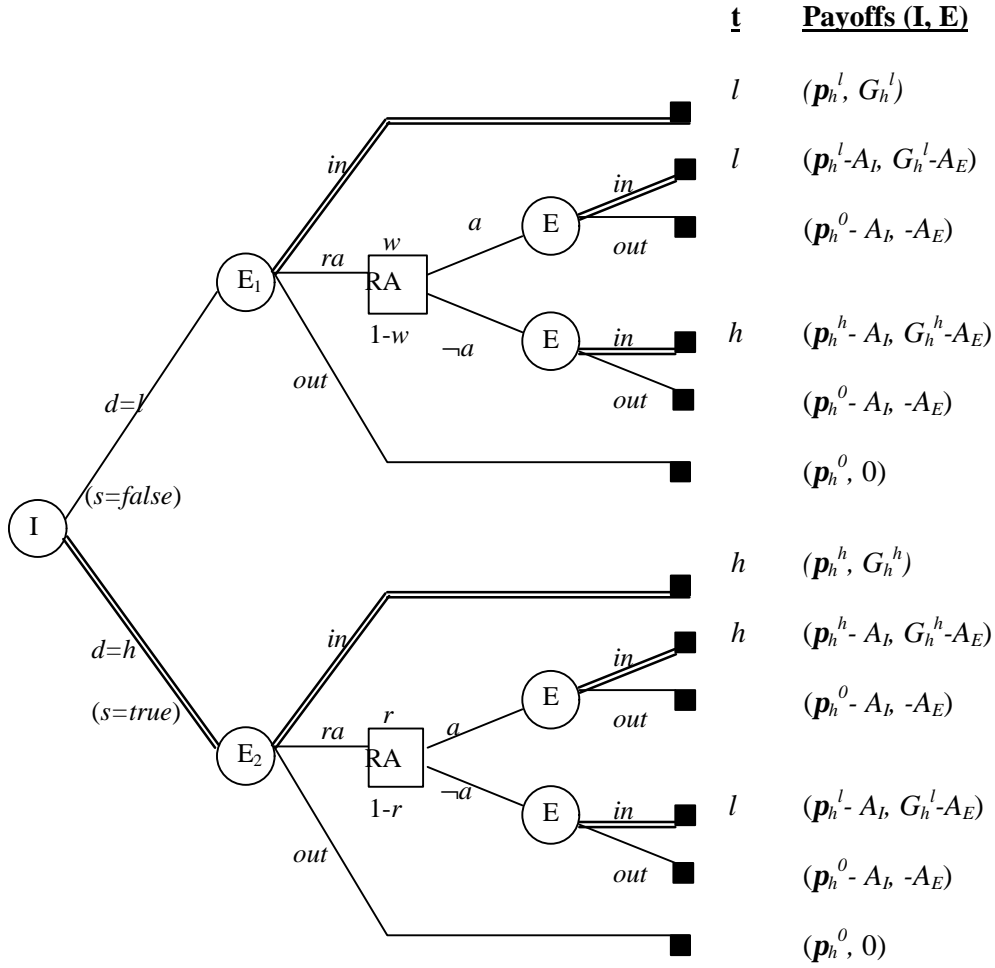


Fig. 7: Negotiated third-party access and h-type network operator

At node E_1 the following holds: in dominates out , since $G_h^l > 0$. Moreover, $E(ra) = w(G_h^l - A_E) + (1-w)(G_h^h - A_E)$. Thus in is preferable to ra , since:

$$(16) \quad E(in) > E(ra)$$

$$\Leftrightarrow G_h^l > w(G_h^l - A_E) + (1-w)(G_h^h - A_E)$$

$$\Leftrightarrow (1-w) G_h^l > (1-w)G_h^h - A_E \quad | \quad G_h^l = G_h^h$$

$$\Leftrightarrow 0 > -A_E$$

In this case too, E's best reaction to a low demand by I is to agree and to enter the market. If, on the other hand, I demands a truly high transmission fee, E's expected payoff from turning to the authority (ra) amounts to:

$$(17) \quad E(ra) = r(G_h^h - A_E) + (1-r)(G_h^l - A_E) = r(G_h^h - G_h^l) + G_h^l - A_E$$

E prefers *in* over *out*, since $G_h^h > 0$. He chooses *in* if:

$$(18) \quad E(in) > E(ra)$$

$$\Leftrightarrow G_h^h > r(G_h^h - G_h^l) + G_h^l - A_E$$

$$\Leftrightarrow 0 > -A_E \quad | \quad G_h^h = G_h^l$$

Since this is always fulfilled, E will agree without appealing to the regulator independently of I's demand. Thus I will opt for $d=h$, since $p_h^h = p_h^l$.

5.2.3. Effects of the NTPA system

A summary of the analysis of both possible network operator types shows that it is possible to induce an efficient solution to the wheeling problem, even if the actual grid costs of the network operator in question are unknown: The efficient solution comprises the choice of a true transmission price demand on the part of I ($s=true$) and E's decision for *in* without appealing to the agency. In the case of the l-type network operator, this equilibrium has been achieved if conditions (12) and (14) both are fulfilled, in other words if the following inequality applies:

$$(19) \quad w < w_m := \min \left\{ 1 - \frac{A_E}{\Delta g}, \frac{A_I}{p_l^0} \right\}$$

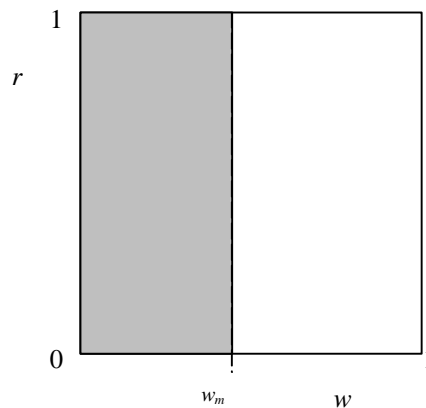


Fig.8: (r,w) combinations
under NTPA

In the case of the h-type network operator entry always occurs at the appropriately high fee, without the authority becoming active. This is represented in fig. 8. The grey area marks those (r,w) combinations for which condition (19) is fulfilled. An authority characterised by

appropriate parameters induces each network operator and each potential entrant to agree upon a transmission price reflecting the true costs without appealing to the authority at all.

Such a field always exists if $w_m > 0$, thus if $A_I > 0$ and $A_E < \Delta g$. In this case, the welfare loss in relation to the ideal situation is zero. The legislator can adjust parameters A_E and A_I by charging agency user fees or by defining requirements for the documents which must be submitted to the agency in case it is called into action. So the size of the field of efficient solutions determined by (19) can be affected by the government. An efficiently negotiated solution can always be achieved in the NTPA system independently of the actual location of parameters r and w , as long as it is guaranteed that $w < w_m$. This is always fulfilled for $w_m = 1$. From condition (19) it follows that this is the case whenever $A_E = 0$ and $A_I \geq p_I^0$: The costs associated with involving the authority thus must be set at zero for the entrant. Then he can credibly threaten to appeal to the authority. If the incumbent's authority usage costs are sufficiently high, then she will want to avoid an authority decision and demand a price appropriate to her true costs.

This solution can be reached by appropriately arranging the user fees for engaging the authority or by setting the requirements to the demand documentations which must be submitted by each individual company. Concretely this could mean that the burden of proof is imposed upon the network operator: if the entrant turns to the authority and alleges that the incumbent has overstated his actual grid costs, then it is not up to the entrant to prove this allegation, but to the network operator, which increases A_I . Under an NTPA system arranged in such a manner an efficient solution can always be brought about. The agency will never be active, but must nevertheless exist, in order to make the threat of turning to the authority credible. Thus set-up costs (S) and negotiation costs (B) result. The consumption of resources in relation to the hypothetical ideal situation amounts to

$$(20) \quad EL_{NTPA} = B + S.$$

5.3. Comparison of the systems

After having analysed the effects of the alternative access regimes both systems can now be compared with regard to the question whether they fulfil the demand of the European Union directive and lead to " equivalent economic results " (EU 1997, 12):

1. In the case of a regulation authority which is prone to making mistakes and accrues costs when called into action, the systems lead to different results: whereas in the case of the NTPA system the firms autonomously negotiate a transmission price that covers the grid costs, resulting in efficient market entry, this cannot be guaranteed in the single buyer system because of the flawed authority decision-making process. Bringing about an efficient solution depends on the decision probabilities r and w of the agency. In particular, it is even conceivable that a network carrier stating his true costs might not receive an official authorisation for that tariff.

2. If the authority were flawed but non cost-accruing, both systems could possibly achieve the same results: With $A_E = A_I = 0$ all 1-type network operators under NTPA would demand high fees and the entrant would call the authority (see table 3). This is the same result as under the single buyer system if $r > 1-w$ holds. Only in this case do both systems generate the same results. If $r < 1-w$ equivalent results are no longer ensured.
3. An authority whose decision-making is perfect obviously always brings about the same efficient market results, since it is able to recognise the true grid costs with certainty.

Thus it can be stated that the outcome equivalence of both systems is generally not ensured. Negotiated third-party access and single buyer procedure can be regarded as equivalent only in two special cases: on the one hand, this is the case for an agency which always decides correctly. On the other hand, even an imperfect authority can lead to equivalent results if it first works without accruing costs and secondly its error probabilities meet a certain condition ($r > 1-w$). In the more realistic case of an authority which makes wrong decisions with positive probability in addition to operating costly, one cannot support the view that both systems are equivalent.

6. Legislator's decision

If both systems lead to different results, then the question arises as to which system the legislators of the European Union member states should implement when they enact the national laws required to comply with the directive. The model just proposed suggests that the NTPA system could be superior since an efficient solution to the grid access problem is always ensured. It must be remembered, however, that this applies only to the individual wheeling transaction. When many wheeling transactions involving several potential market entrants are considered, it is not clear that NTPA is superior to the single buyer. With n wheeling transactions and only one network carrier, the ramifications with regard to efficiency of the access regimes are as follows:

For the single buyer procedure:

$$(21) \quad EL_{SB} = \frac{1}{2}nq\Delta g(1-r+w) + A + S,$$

since the expected efficiency loss dependent on the error probabilities of the authority results n times but the authority decides only once, thus only once resulting in costs A . In addition, set-up costs S have to be taken into account.

The efficiency losses of the NTPA system are (cf. eq. (9))

$$(22) \quad EL_{NTPA} = nB + S,$$

since the authority must be set up (S) but never decides. However, in each concrete wheeling transaction, both parties are forced to negotiate an efficient transmission price (nB). Thus the NTPA system is preferable to the single buyer system if:

$$(23) \quad EL_{NTPA} < EL_{SB}$$

$$\Leftrightarrow \quad nB+S < \frac{1}{2}nq\Delta g(1-r+w)+A+S$$

$$\Leftrightarrow \quad B < \frac{1}{2}q\Delta g(1-r+w) + \frac{A}{n}$$

Thus no unequivocal statement is possible. It can, however, be said that NTPA is preferable to the single buyer if:

- the probability of an I-type network operator, and thus the possibility of entry deterrence, is relatively high;
- the possible cost saving by a technically efficient generator is significantly large,
- the number of expected wheeling transactions is low.
- the costs of the agency's decision-making process are large,
- the authority's decision-making abilities are unsatisfactory (small r and large w),
- the negotiation costs are kept low.

In contrast to this, if many wheeling transactions are expected within the area of the same network operator (n sufficiently large), then it can be quite reasonable to opt for a single buyer system and to accept the associated efficiency loss, since it is outweighed by the savings in negotiation costs resulting in each transaction under NTPA, while the authority under the single buyer system becomes active only once and the transmission tariff is then set for all further cases.

7. Summary

This paper has been an attempt to analyse the problem of the optimal institutional arrangement to regulate network access in a liberalised electricity market. It has been shown that the systems provided by the European electricity directive, negotiated third-party access on the one hand, and the single buyer procedure (and regulated third-party access) on the other, usually do not lead to equivalent economic results, as alleged in the directive.

Additionally, conditions for the choice between the two alternatives were deduced from the model. It was found that neither of the systems is clearly superior. Large potential technical efficiency gains, high probability of entry deterrence on the part of the established monopolist, low negotiation and high regulatory costs and unreliable authority decision-making mechanisms put the NTPA at a distinct advantage. A sufficiently large number of potential wheeling transactions may make the single buyer the better alternative.

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