The NOME law: implications for the French electricity market

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Abstract  In December 2010, France approved the law “Nouvelle Organisation du Marché de l’Electricité” (or NOME law) to promote competition in the retail electricity market. In practice, the law allows retailers to buy nuclear production from the incumbent, at a regulated access price. This mechanism works up to a ceiling of 100 terawatt hours, which represents one quarter of the incumbent’s production from nuclear plants. Each retailer is assigned a share of that amount proportionally to its portfolio of clients. We contribute to the debate raised by the NOME law regarding the evolution of retail market prices. We show that a price decrease results if the ceiling is sufficiently high compared to the market share of the retailers competing with the incumbent. This pro-competitive effect is stronger when the incumbent’s rivals take into account the impact of their market strategy on the redistribution rule. Finally, we find that, if the regulated price of the NOME electricity is set above the nuclear cost, the incumbent realizes a gain that may result in strategic withholding, weakening the pro-competitive effects of the law.

Keywords  Electricity markets · Retail competition · NOME law

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1 Introduction

The French ‘Nouvelle Organisation du Marché de l’Electricité’, \(^1\) henceforth referred to as the NOME law, creates withdrawal rights that allow retailers to access low-cost production from nuclear plants that are owned by the incumbent operator at a regulated price. Retailers benefit from these withdrawal rights up to a given threshold that is fixed by law. This law has been in place since January 2011 (and remains in force until 2025). The primary short-term objective of this reform is to enhance competition for price-sensitive industrial electricity consumers; as further price liberalization occurs, competition should also be enhanced for residential electricity consumers. In accordance with this goal, the NOME law also prescribes a gradual removal of all end-user regulated tariffs until complete price liberalization is reached in 2016. In this paper, we analyze whether the NOME law is likely to fulfill its promises. In addition, we study the extent to which the increase in competition depends on the rule that is applied by the regulator for the allocation of withdrawal rights among retailers. To the best of our knowledge, this paper is the first study to model the impact of the NOME law on retail competition. \(^2\)

Although we focus on a reform that has been implemented in the French electricity market, our analysis provides insight into the ongoing debate about the real extent of retail competition in electricity markets (see Defeuilley (2009), and Littlechild (2009), for an overview). In fact, many papers emphasize the difficulty of enhancing this competition at the downstream level. For instance, Joskow and Tirole (2006) demonstrate that retail competition only has attractive welfare properties if real-time consumption can be accurately measured. Green (2003) finds that an electricity retailer facing competition will be limited in its ability to pass on the costs of long-term contracts to its customers if the spot prices for electricity fall below contractually specified prices. This limitation creates a distortion because the optimal level of contracting for retailers is not attained. Von Dehr Fehr and Hansen (2010) report that Norwegian electricity retailers exert market power by exploiting certain customers’ reluctance to switch suppliers. Our paper addresses a new issue: in a scenario in which the technological structure of the upstream electricity market translates into a strong cost advantage for only the incumbent retailer, we study whether and under which conditions providing access to low-cost electricity generation enhances the development of fair downstream competition. Broadly, our paper contributes to the analysis of measures to mitigate market power, such as horizontal divestiture or capacity release programs (Weigt et al. 2009).

We focus on a scenario in which retailers engage in Cournot competition. Prior to the implementation of the NOME law, the incumbent operator possesses a competitive

\(^1\) That is ‘New Organization of the Electricity Market.’

\(^2\) Other papers on the French electricity market reform discuss in factual terms the expected welfare gains from the introduction of regulated access to nuclear electricity (Crampes et al. 2009; Finon 2010), or the legal foundations of the law (Lévêque and Saguan 2010).
advantage. This advantage is likely to be enjoyed by an electricity retailer that is vertically integrated with a nuclear generator (e.g., the historical supplier of nuclear power in France). New entrants have higher sourcing costs if they are vertically integrated with non-nuclear electricity generators or if they buy electricity from the wholesale market, which will typically offer power at a higher price than the sourcing cost of the incumbent retailer. In this benchmark scenario, new entrants cannot expand their market share because the incumbent is the only retailer that can benefit from low-cost electricity generation. This situation harms retail competition.

The choice of a quantity competition model relies on the results of Bushnell et al. (2008), who assert that the behavior of vertically integrated firms competing in retail electricity markets can be most appropriately predicted by a Cournot game.3 We acknowledge that this stylized setting neglects certain dimensions of electricity markets, but we believe that this approach optimally captures several important features for assessing whether the NOME law is likely to succeed in reaching its objective of strengthening competition in the retail business. To conduct this assessment, we modify the benchmark model of asymmetric Cournot competition by assuming that a portion of the incumbent retailer’s low-cost input (i.e., electricity from nuclear plants) is made available to its competitor; this scenario is similar to the situation addressed by Dixit (1980). However, under the NOME law, the access price to low-cost electricity is set by the regulator at the marginal production cost of nuclear plants. Because both the amount and the price of the reassigned NOME production are chosen by the regulator, the incumbent cannot strategically manipulate these factors. These assumptions represent the key differences between Dixit’s model and the analyses of the current study.

We further modify Dixit’s setting by considering different rules for redistributing low-cost electricity generation and the implications of these various rules with respect to competitiveness and welfare. This examination allows us to assess the competitive impact of several different implementation options for the NOME law, which could be amended in the future. We consider two cases: in the first situation, the share of withdrawal rights is fixed, whereas in the second situation, this share is a function of each retailer’s market share. The former case, which we call the ‘exogenous distribution scenario,’ corresponds to the scenario in which withdrawal rights depend on the retailers’ portfolio of consumers in the years preceding the implementation of the NOME law. The second case addresses the fact that the NOME law foresees an ex-post verification process that will ensure that the reassigned production is in accordance with the real demand that is addressed by retailers. In this situation, the retailer that benefits from the redistribution may account for the impact of its market strategy on the distribution outcome. This case is referred to as the ‘endogenous distribution scenario.’

With respect to the computation of the retailer’s shares of low-cost electricity, in both the endogenous and exogenous scenarios, one further remark is required: the regulator may wish to either assign the entirety of the NOME production to the incumbent’s

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3 Similar results can be found in other papers dealing with vertically integrated firms. See, for example, Mansur (2007).
competitors or refrain from assigning production in this manner. The allocation can be accomplished either on the basis of the entrants’ relative market shares (that is, by excluding the incumbent in this computation) or on the basis of their absolute market shares. The first scenario that we address, which involves relative market shares, may be relevant in the long run, as competitors develop to an extent that causes their total supply to exceed the NOME capacity and thereby requires a form of rationing. In the short run, given the current extent of competition in the French retail market, it is likely that not all of the NOME capacity will be redistributed; thus, the scenario involving absolute market shares appears to be more realistic.4

We demonstrate that the total level of withdrawal rights plays a pivotal role in shaping market outcomes. In the case of exogenous redistribution, if the level that is redistributed is low, then the redistribution will not change competitors’ marginal incentive to produce. The equilibrium outcome then coincides with the outcome prior to the redistribution, and the NOME law merely amounts to a financial transfer between the incumbent and the entrants to the electricity market that provides no benefits for end users.

If there is an intermediate level of NOME capacity, the situation improves for the final consumers as competitors that benefit from withdrawal rights replace their high-cost supply with the lower-cost supply they obtain by the implementation of the law. However, entrants simply resell their NOME capacity; thus, the development of competition on the retail market is fully driven by the level of the redistributed electricity generation. Finally, a sufficiently large NOME capacity allows for the leveling of the playing field among all electricity retailers.

The creation of pro-competition effects by the NOME law is also dependent on the rules that define the allocation of these rights; this issue that has been overlooked in debates of French energy policy. Comparing the endogenous redistribution rule with the exogenous rule, we find that the former policy causes entrants to be more aggressive on the retail market because these entrants strategically internalize the fact that a larger market share on the retail market allows them to benefit from a larger proportion of the NOME capacity.

Other implementation rules of the NOME program are also likely to affect the outcome of reforms. The establishment of an access price that is above the marginal cost of low-cost generation may hinder the pro-competitive effect of the NOME law. In particular, if the endogenous distribution rule applies, we demonstrate that a positive access markup causes the incumbent operator to be less aggressive in the retail market.

The paper is organized as follows. In Sect. 2 we describe the context of the French retail market in which the law was introduced and the energy policy discussion regarding the NOME law that has occurred. In Sect. 3 we explain our modeling framework and the benchmark results for standard Cournot competition involving firms with asymmetric sourcing costs. Section 4 is devoted to the analysis of the NOME law under both exogenous and endogenous distribution rules. In Sect. 5, we extend our model to the case of an access price that is higher than the incumbent’s marginal cost and to the scenario involving several competitors. We conclude the paper in Sect. 6.

4 Indeed, in this case, when entrants are small enough so that their combined production remains below the NOME capacity, full redistribution cannot be realized.
2 The context

2.1 The retail electricity market

Since July 2007, almost all electricity consumers in France have been able to choose their electricity supplier. According to the 2010 market outlook that was produced by the French regulatory agency ‘Commission de Régulation de l’Énergie’ (2011), these consumers represent a total annual electricity consumption of 447 TWh.

Industrial consumers are no longer served at regulated tariffs. Residential consumers may have two types of contracts: (i) a contract at the market price or (ii) a contract at a regulated tariff that can only have the historical provider as a counterparty. Beginning in 2016, Article 4 of the NOME law allows retailers to serve residential consumers at a price that is equal to or higher than the ARENH (or “Accès Régulé à l’Électricité Nucléaire Historique”). The incumbent’s competitors only provide approximately 5% of the 141 TWh of electricity sold annually to the residential sector and 13.3% of the 299 TWh sold annually to the industrial sector.

This lack of competition has already prompted several regulatory responses. Since September 2001, a portion of the historical producer’s nuclear capacity is auctioned to competitors through a mechanism known as VPP (which stands for ‘Virtual Power Plant’). VPPs allow competitors to reserve nuclear capacity for a certain period that varies in length between 3 and 48 months. The capacity that is reserved by VPPs (which only represents 16 TWh of electricity per year) may be either used or left untapped, and its price is defined by the market mechanism of an ascending price auction in multiple rounds.

2.2 Changes introduced by the NOME law

The NOME law was approved in December 2010. It was first implemented in January 2011 and will remain in force until 2025. This law provides electricity providers with access to up to 100 TWh of the electricity that is produced each year by the historical supplier’s nuclear plants (with an additional 20 TWh annually beginning in 2013); this quantity of electricity represents approximately one quarter of EdF’s nuclear

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5 That is, all interconnected consumers.
6 The tariff called Tarif Réglementé Transitoire d’Ajustement au Marché (TaRTAM) disappeared in June 2011. See http://www.legifrance.gouv.fr/jopdf.
7 See http://www.cre.fr/fr/marches/marche_de_l_electricite/marche_de_detail for details on the different options regarding this tariff.
8 In English this means “Regulated access to the historical nuclear generation”.
9 For a list of competitors see http://www.cre.fr/fr/marches/observatoire_des_marches/#a1.
10 Auctions take place on average every three months. The price paid by each auctioneer depends both on the reservation’s duration and on whether it concerns a peak or a base load contract. For more details on the way those auctions are organized in France as compared to other countries see Ausubel and Cramton (2010).
11 The complete text of the law is available at http://www.legifrance.gouv.fr.
production\textsuperscript{12} (see Lévêque 2011). The total quantity of electricity at the ARENH that has been sold for 2011 is 61.3 TWh,\textsuperscript{13} whereas for 2012, 60.7 TWh of electricity has been redistributed. Two main features differentiate the NOME mechanism from VPPs. First, there is an obligation to use these withdrawal rights only to supply the French retail market. To achieve this objective, the project includes an ex-post financial penalty that applies if there is evidence that the electricity obtained through the NOME law does not fulfill this requirement; in particular, this penalty will be enforced if this electricity is re-sold on the wholesale market by either the incumbent or other electricity retailers. Second, the access price to NOME-related electricity is determined by the Ministry of Energy and the Ministry of Economics, with advice from the CRE, rather than by a market mechanism. On May 5, 2011, based on the load profiles of both residential and industrial consumers, the CRE recommended the regulated access price (which is known as the ARENH) of 40\(\text{€}/\text{MWh}\) for July 2011.\textsuperscript{14} The quantity of electricity that is reassigned is a function of the market share of the incumbent’s competitors.

Retailers that are competing with the historical suppliers are not able to offer retail prices that are less than or equal to the tariffs that are offered by EdF because these retailers have higher sourcing costs than EdF. With respect to this issue, Solier (2010) demonstrates that the mean price of one-year-ahead future baseload contracts, which make up the bulk of the retailers’ sourcing costs, is always higher than (and can sometimes be double) the EdF’s tariffs. The NOME law reduces these sourcing costs, favoring the development of retail competition. These sourcing cost effects will be accompanied by the removal of all price regulations in this market, which should occur by 2015.\textsuperscript{15}

The law seeks to safeguard French consumers, who paid for the cost of building nuclear plants in the past, from increases in their electricity bill. It also contains additional articles designed to address the European Commission’s observations regarding the lack of competition in the French retail market. In June 2012, the European Commission finally stated that the regulated access prices and the other provisions of the NOME law were compatible with the liberalization of the European electricity market and the rules governing state aid. In this context, it appears unlikely that the NOME law could be suspended, even if the new French president, who was elected in 2012, has expressed doubt regarding this regulation.

Many authors have debated the likely effectiveness of the NOME law. Crampes et al. (2009) conclude that the increase in competition and the innovation incentives that are provided by the law will be insufficient justification for the law’s administrative costs. Similarly, Lévêque and Saguan (2010) examine the impact assessment of the

\textsuperscript{12} EdF stands for “Energie de France” and is the commercial name of the incumbent.
\textsuperscript{13} See CRE Décryptages No. 25 CRE (2010).
\textsuperscript{14} See “Délibération de la Commission de régulation de l’énergie du 5 mai 2011 portant avis sur le projet d’arrêté fixant le prix de l’accès régulé à l’électricité nucléaire historique à 40 €/MWh au 1er juillet 2011”.
\textsuperscript{15} As first suggested by the Champsaur Report (2009), the previously described distribution is accompanied by a gradual liberalization of the retail price for electricity. From January the 1st of 2011 industrial consumers no longer benefit from regulated tariffs. Consumers with an intensity lower than 36 kVA are still charged at the regulated tariffs but the latter will also disappear in 2015.
NOME law that was performed by the French government in April 2010 and argue that this assessment is overly optimistic regarding the competition-enhancing effects of the law. The French Competition Authority shares the same concern.\textsuperscript{16} Finon (2010) emphasizes the difficulty of having a retail price that is aligned to the cost of nuclear generation.

Although there is a great deal of debate regarding the NOME law, there has been no formal analysis of the impact of this law on the retail market. In the present study, we focus on the time period after 2015, when the retail market will be fully de-regulated, and develop a simple model to examine whether the NOME distribution of nuclear production fosters competition. We argue that the effectiveness of the NOME law at meeting its objectives is dependent on the characteristics of its implementation, which have not been discussed in the debate regarding this regulation.

3 The benchmark scenario

The market structure we consider is as follows. One incumbent firm, \( A \), has a technology that allows an input to be supplied at a unit cost \( c_A \). This input is then used on a one-to-one basis with no additional cost to produce an output that is sold on a retail market.

Firm \( A \) faces several identical competitors in the retail market, denoted by \( B_1, \ldots, B_n \). These competitors are less efficient than \( A \): \( c_A < c_{B_i}, i = 1 \ldots n \). This difference in efficiency is a simplification that describes two features of the French electricity market. First, only the incumbent operator has access to the nuclear technology to supply electricity; by contrast, retail competitors use electricity generation technologies that are less efficient. Second, retail competitors may source their input from a wholesale market (either spot or forward) in which the prevailing price is higher than the marginal cost of the most efficient nuclear technology.

The total supply in that market is denoted by \( Q \geq 0 \). Firms engage in Cournot competition in the retail market, and the inverse demand is given by \( p(Q) \), with \( p'(Q) < 0 \) and \( p''(Q) < 0 \).

To emphasize the main forces underlying our results, we shall primarily assume that firm \( A \) faces only one competitor in the retail market. This competitor is called firm \( B \), and its marginal sourcing cost is \( c_B \). For each result, we comment on the ways in which it should be altered if incumbent \( A \) faces multiple competitors.

Firm \( A \) chooses the retail supply \( q_A \) to maximize \( [p(Q) - c_A]q_A \), which yields the following first-order condition\textsuperscript{17} (with \( Q = q_A + q_B \)):

\[
p'(Q)q_A + p(Q) - c_A = 0. \tag{1}
\]

Equation (1) implicitly defines firm \( A \)'s best-response \( BR_A \).

\textsuperscript{16} See http://www.autoritedelaconcurrence.fr/pdf/avis/10a08.pdf.

\textsuperscript{17} The second-order condition is satisfied under our assumptions.
Similarly, firm $B$ chooses $q_B$ so as to maximize its profit $[p(Q) - c_B]q_B$, which yields the following condition:

$$p'(Q)q_B - p(Q) - c_B = 0. \quad (2)$$

The previous expression gives the corresponding best-response of firm $B$ denoted by $BR_B(c_B)$.

Under our assumptions, the best responses are decreasing, as the quantities that are produced are strategic substitutes. We also focus on relevant cases in which the stability condition is satisfied (see Dixit 1986). A standard revealed-preferences argument then demonstrates that the equilibrium production of the efficient firm $A$ is greater than the production of the inefficient firm $B$; in other words, $q_A^b(c_A, c_B) > q_B^b(c_A, c_B)$, where the superscript $b$ refers to this benchmark scenario. The incumbent retailer thus squeezes the market share of its competitors because it is the only producer that can benefit from the cost advantage that is provided by the nuclear electricity generation capacity.

4 The impact of the NOME law on retail market competition

4.1 Possible interpretations of the NOME law

The implementation of the NOME law may be regarded as follows: the regulator chooses the maximal amount $K$ of $A$’s lower-cost production that is redistributed. Firm $B$ receives a fraction of this amount. Incumbent $A$ receives a unit payment $w < c_B$ in compensation for the withdrawal rights. The price $w$ is regulated; for the moment, we assume that this price coincides with the unit cost of the most efficient sourcing technology: $w = c_A$. Moreover, the production distribution does not constrain $A$’s production.

With respect to redistributing nuclear electricity from the incumbent to other retailers, there are several competing interpretations of the NOME law. First, the share of withdrawal rights $K$ that is granted to $A$’s competitors may be either exogenous or endogenous. Second, the share that is granted to an entrant may be computed on either an absolute basis or a relative basis.

To illustrate these possible situations, we assume that the regulator may allocate withdrawal rights on the basis of previous market shares in the retail market. Thus, if firm $B$ had a market share $\alpha$ in the retail market, then it benefits from a distribution of $\alpha K$. If market shares are computed on the basis of past behaviors, then firm $B$ anticipates that its actual supply will have no impact on the amount of electricity that it obtains from the distribution process. In this scenario, the distribution is exogenous and is based on absolute market shares.

Firm $B$ may also recognize that a larger market share at the present time will allow it to be assigned a larger quantity of distributed electricity in the future. To capture this dynamic effect in our static framework, we consider another case in which firm

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18 This is the case if, for instance, $p''(.)$ is sufficiently small.
**B**’s portion of \( K \) is specified by its current retail market share \( q_B \). This rule is referred to as endogenous distribution and is once again computed on the basis of absolute market shares. This interpretation appears to fit the nature of the NOME law. Indeed, at the beginning of each year, competitors are required to provide business plans that describe their forecasted market shares for the upcoming year; the regulator then assigns withdrawal rights based on these prospective plans.

The difference between the cases of absolute and relative market shares relates to the following point. The regulator may wish to assign the entire NOME production to \( A \)’s competitors to strengthen competition in the retail market. In this case, the entire \( K \) is redistributed to \( A \)’s competitors, each of which receives a fraction of \( K \) that coincides with its relative market share, i.e., its market share with respect to all of \( A \)’s competitors:

\[
\sum_{i=1}^{q_B_i} \frac{q_B_i}{\sum q_B_j} \text{ for firm } B_i.
\]

Past or projected market shares may be used for this computation.

From our understanding of the law, the scenario involving absolute market shares is the most relevant situation for the short run. Indeed, the maximum amount that is redistributed exceeds the current production level of the incumbent’s competitors on the retail market. However, in the long run, we can foresee a situation in which competitors will develop such that their joint market share will exceed \( K \). The regulator is then likely to allocate withdrawal rights among \( A \)’s competitors on the basis of their relative market shares.\(^{19}\)

There are a number of similarities and differences among the various possible interpretations of the NOME law. In the following analysis, we first consider the case of absolute market shares under the assumption that firm \( A \) has only one competitor. In this context, we assess the competitive effects of the NOME law under both the exogenous and the endogenous distribution rules. We then extend the analysis to the situation involving relative market shares and multiple competitors in the retail market.

### 4.2 Exogenous distribution

Let us now consider the case in which a fixed amount \( \alpha K \) of \( A \)’s low-cost production is redistributed to its competitor \( B \). Because retailer \( A \) is not constrained, its profits are now expressed as follows:

\[
\Pi_A = [p(Q) - c_A] q_A + (w - c_A) \min[q_B; \alpha K] = [p(Q) - c_A] q_A,
\]

given that \( K \) is sold at the unit cost \( (w = c_A) \). Thus, \( A \)’s profit function is unchanged from the benchmark model, and its best reply is still specified by (1). Firm \( B \)’s profit is expressed as follows:

\[
\Pi_B = \begin{cases} 
[p(Q) - c_A] q_B & \text{if } q_B \leq \alpha K; \\
[p(Q) - c_B] q_B + (c_B - c_A)\alpha K & \text{if } q_B > \alpha K.
\end{cases}
\]

\(^{19}\) This aspect may be relevant for other regulatory discussions. For instance, some proposed American tradable permits markets have included output-based updating. See for instance Quirion (2009).
Firm B’s reaction depends on whether $q_B$ is lower than $\alpha K$. In particular, note that firm B’s profit function is continuous but not differentiable at $q_B = \alpha K$; this trait affects the way in which firm B best responds to the quantity produced by firm A, as discussed by Dixit (1980). More precisely, suppose first that firm B operates in a region such that $q_B \leq \alpha K$. Firm B perceives a marginal cost $c_A$ and thus produces the following $BR_B(c_A)$ solution:

$$p'(Q)q_B + p(Q) - c_A = 0.$$  \hspace{1cm} (5)

The above equation specifies firm B’s best response if the solution of (5) is lower than $\alpha K$ or, equivalently, if $q_A$ is not overly large. If firm B operates in a region such that $q_B > \alpha K$, then it perceives a marginal cost $c_B$ and produces $q_B$, a solution of (2); this solution requires $q_A$ to be sufficiently large. Finally, for values of $q_A$ between the two previously defined thresholds, firm B best responds by supplying the same quantity of $\alpha K$. The best responses of firms A and B are graphically represented below. The equilibrium of the depicted game lies at the intersection of the best responses (Fig. 1).

The interesting feature of this situation is that the equilibrium depends on the quantity of electricity that is redistributed to firm B. If K is large, then the NOME distribution leads the retail market to a symmetric Cournot equilibrium, as the best responses of firms A and B are solutions of (1) and (5), respectively. The equilibrium quantities are then given by $q_A^b(c_A, c_A)$ and $q_B^b(c_A, c_A)$. The NOME law thus increases the retail market competitiveness relative to the benchmark case. For this case to emerge at equilibrium, the distribution must satisfy $\alpha K \geq K_H = q_B^b(c_A, c_A)$. Note that firm B may not choose to use all of its withdrawal rights. If the redistributed quantity of electricity is small, then the firms’ best responses are given by (1) and (2), respectively, and the equilibrium quantities are unchanged from the benchmark case.

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20 Indeed, remember that quantities are strategic substitutes in our setting.
Thus, if $\alpha K \leq K_L = q^B_B(c_A, c_B)$, the NOME law does not change the retail market outcome but simply allows firm $B$ to replace a portion of its inefficient technology with $A$’s efficient technology. Finally, for the intermediate levels of the redistributed amount (that is, for $K_H < \alpha K < K_L$), the equilibrium involves firm $B$ producing exactly the amount of its withdrawal rights. Compared with the benchmark case, this distribution of capacity involves a larger total production and a lower price on the retail market. Consumers are thus better off. However, note that this increase in competition can be deemed somewhat ‘artificial’ because firm $B$ merely resells the production that it purchased from firm $A$.

To summarize, we obtain the following situation:

**Proposition 1**  
*In an exogenous distribution of the incumbent’s production, there are two thresholds $K_L < K_H$:*

- *If $K \leq K_L$, then the equilibrium outcome is given by the benchmark (pre-distribution) case. Only welfare and firm $B$’s profit increase as $K$ increases.*
- *If $K \geq K_H$, the equilibrium outcome coincides with the symmetric Cournot outcome at the most efficient technology. Any distribution in excess of $K_H$ does not improve either welfare or consumer surpluses.*
- *For $K_L < K < K_H$, the least efficient firm’s market share is determined by its level of redistributed withdrawal rights. In this situation, as $K$ increases, welfare and consumer surplus levels increase, but the industry profit decreases.*

**Proof** Immediately follows from previous reasoning. □

If the distribution program is very ambitious ($K \geq K_H$), no other efficiency gains can be realized. Instead, if the redistributed production is below $K_L$, the NOME transfer produces higher profits for $B$ by the amount of $(c_B - c_A)\alpha K$ but does not result in a lower price. For intermediate values of the redistributed supply, larger values of $\alpha K$ will produce lower market prices. Moreover, $B$ benefits from a subsidy that falls below $(c_B - c_A)\alpha K$.

Policy makers may perhaps predict that firm $B$ will use the redistributed granted production to increase its market share in the retail market. The above analysis demonstrates that this argument has certain limitations because firm $B$’s incentives are driven by its marginal opportunity cost of supplying the downstream market; this cost is not always affected by the distribution of $K$. The most striking illustration of this reasoning is that any distribution that is below the production level of firm $B$ in the benchmark situation has no impact on the equilibrium outcome. Finally, Proposition 1 may provide a benchmark to determine the amount of production that should be redistributed: for a distribution to have a positive impact on welfare, withdrawal rights must be at least as high as the production level of firm $B$ in the pre-distribution benchmark scenario.

One final point can be raised. The NOME law has adverse effects on the incentives to invest in cost-efficient production capabilities. The reasoning behind this conclusion is simple: the distribution of withdrawal rights provides firm $B$ with an efficient technology at a low price; therefore, this firm has fewer incentives to make its technology more efficient because this improvement will apply to a smaller level of production.
4.3 Endogenous distribution

The NOME law predicts that the distribution of access rights will be allocated in proportion to the retailers’ portfolios of customers. If the firms that receive low-cost electricity anticipate this effect, then the distribution rule will become endogenous. To capture this mechanism, let us assume that $B$ obtains the amount $\frac{q_B}{q_B + q_A}$ of $K$.

Retailer A’s best response function remains the response specified by (1). Competitor $B$, by contrast, possesses the following profit function:

$$\Pi_B = \begin{cases} 
[p(Q) - c_A] q_B & \text{if } q_B \leq \frac{q_B}{q_B + q_A} K; \\
[p(Q) - c_B] q_B + (c_B - c_A) \frac{q_B}{q_B + q_A} K & \text{if } q_B > \frac{q_B}{q_B + q_A} K.
\end{cases}$$

(6)

Note that the inequality $q_B \leq \frac{q_B}{q_B + q_A} K$ is equivalent to $q_B \leq K - q_A$ or $Q \leq K$. Thus, the nature of the constraint in the endogenous distribution situation is remarkably different from the constraint in the exogenous distribution situation. In particular, for the endogenous distribution, if $Q < K$, firm $B$ best responds to firm $A$ by setting a quantity that is determined by (5). If $Q > K$, then we obtain the following characterization of firm $B$’s best response:

**Lemma 1** Consider $Q > K$. Firm $B$’s best response lies between $BR_B(c_A)$ and $BR_B(c_B)$. Moreover, provided that $K(c_B - c_A)$ is sufficiently small, production quantities are strategic substitutes over the relevant range that is examined.

**Proof** The first-order condition associated to firm $B$’s maximization problem is:

$$p'(Q) q_B + p(Q) - c_B = -K(c_B - c_A) \frac{q_A}{Q^2}. \quad (7)$$

Since the right-hand side is strictly negative, this implies that the best-response lies strictly above $BR_B(c_B)$. Equation (7) can be rewritten as follows:

$$p'(Q) q_B + p(Q) - c_A = \frac{c_B - c_A}{Q^2} \left[ Q^2 - K q_A \right].$$

This implies that for $Q > K$, $B$’s best-response lies above $BR_B(c_A)$. Straightforward manipulations show that firm $B$’s best-response is decreasing in $q_A$ provided that:

21 The condition $K > Q$ does not reflect the industry’s real structure, in which nuclear production comes together with other higher-cost production technologies. However, we analyze this case not only for analytical completeness, but also because we believe that this condition gains prominence if one wants to conjecture on an eventual modification of the law that contemplates the redistribution of the whole nuclear production.

22 The second-order condition is satisfied when $Q > K$. 
Fig. 2 Equilibrium under endogenous distribution

\[
p''(Q)q_B + p'(Q) + K(c_B - c_A) \frac{Q - 2q_A}{Q^3} < 0,
\]
which is negative under our assumptions.

Figure 2 summarizes the analysis. With respect to the endogenous distribution case, firm B’s incentives to supply the retail market are now quite different. In particular, firm B becomes more aggressive in this market. To better illustrate this point, in Fig. 3, we represent the marginal cost of firm B for the exogenous and endogenous distributions.

\[M C_B = \begin{cases} 
   c_A & \text{for } q_B < K - q_A; \\
   c_B - (c_B - c_A) \frac{q_A}{q_B + q_A} & \text{for } q_B = K - q_A; \\
   c_B - (c_B - c_A) \frac{q_A K}{(q_B + q_A)^2} & \text{for } q_B > K - q_A.
\end{cases}\]

Note that marginal costs of B are

\[c_B - (c_B - c_A) \frac{q_A}{(q_B + q_A)^2} K\]

is increasing with \(q_B\) and \(\lim_{q_B \to \infty} \left( c_B - (c_B - c_A) \frac{q_A}{(q_B + q_A)^2} K \right) = c_B.\]
Firm B’s marginal cost is lower for the endogenous distribution than for the exogenous distribution. Indeed, firm B foresees that any increase in its production will be accompanied by an increase in the amount of withdrawal rights distributed, which will generate lower sourcing costs (i.e., lower values of $c_A$). Therefore, firm B’s incentives to produce are strengthened under the endogenous distribution rule.

As illustrated by Figs. 1 and 2, the two rules for governing the distribution of withdrawal rights generate very different incentives for retailers to provide electricity supplies. A general comparison is arbitrary because the equilibrium outcome in the exogenous case is affected not only by the level of $K$ but also by the choice of $\alpha$. In other words, for a given level of withdrawal rights $K$, one can identify values of $\alpha$ such that the equilibrium outcome in the exogenous distribution is more (or less) competitive than it is in the endogenous distribution.

Nevertheless, the comparison can be assessed in the most natural case; in this case, under the exogenous rule, $\alpha$ is determined by firm B’s market share in the benchmark outcome. This analysis produces the following proposition.

**Proposition 2** Assume $\alpha = q_b^b(c_A, c_B)/(q_A^b(c_A, c_B) + q_B^b(c_A, c_B))$.

- If $\alpha K \leq K_L$, the endogenous rule produces a more competitive outcome than the exogenous rule.
- If $\alpha K \geq K_H$, both rules lead to the same outcome.
- If $K_L < \alpha K < K_H$, the comparison between the two situations generates ambiguous results.

**Proof** Consider that $\alpha K = K_L$. This amounts to $K = K_L/\alpha = q_A^b(c_A, c_B) + q_B^b(c_A, c_B)$. This implies that the benchmark equilibrium quantities belong to the constraint $q_A + q_B = K$. Then, Fig. 2 provides evidence that the endogenous distribution leads to a more competitive equilibrium than the exogenous one. This comparison holds for any $K \leq K_L$.

Consider now that $\alpha K = K_H$, which amounts to $K = q_A^b(c_A, c_A)/\alpha$. Since $\alpha < 1/2$, this implies that $K > q_A^b(c_A, c_A) + q_B^b(c_A, c_A)$. This implies in turn that the quantities in the symmetric Cournot equilibrium lie in the area below the constraint $K = q_A + q_B$. Then, one can see from Fig. 2 that the equilibrium under the endogenous rule always coincides with the symmetric Cournot outcome. The same comparison holds when $\alpha K \geq K_H$.

For intermediate values of $\alpha K$, the comparison is ambiguous.

The endogenous rule always increases the marginal efficiency of retailer B. However, in general, this effect is insufficient to ensure that the endogenous rule outperforms the exogenous rule in terms of retail market competitiveness. Our analysis reveals that the details governing the allocation of withdrawal rights play a critical role in shaping the behaviors of competing firms and the market outcomes of the NOME law.
5 Extensions

5.1 An access price that is higher than the marginal production cost

In this subsection, we analyze the case in which firm \( A \) is allowed to sell low-cost electricity at an access price \( w \) that is higher than the sourcing cost \( c_A \).\(^{24}\) If \( q_B < \alpha K \), then firm \( B \)'s best response \( BR_B(w) \) is a downward translation of \( BR_B(c_A) \); in other words, for a given level of supply of firm \( A \), firm \( B \) reduces its supply.

We begin by considering the exogenous situation. The fact that the cession price is \( w > c_A \) does not affect the best response of firm \( A \). The impact of this access price on the equilibrium outcome is immediately inferred from Fig. 1.

For the endogenous distribution, the analysis is more involved. In particular, in this situation, firm \( A \)'s best response is affected by the distribution. In fact, firm \( A \)'s profit function may be written as follows:

\[
\Pi_A = \begin{cases} 
[p(Q) - c_A]q_A + (w - c_A)q_B & \text{if } q_B \leq \frac{q_B}{q_B + q_A}K; \\
[p(Q) - c_A]q_A + (w - c_A)\frac{q_B}{q_B + q_A}K & \text{if } q_B > \frac{q_B}{q_B + q_A}K. 
\end{cases}
\] (8)

As noted above, the inequality \( q_B \leq \frac{q_B}{q_B + q_A}K \) is equivalent to \( q_B \leq K - q_A \) or \( Q \leq K \). If \( q_A \leq K - q_B \), then firm \( A \)'s best response remains given by \( BR_A \). However, if \( q_A > K - q_B \), then the best response of firm \( A \) is specified by the following first-order condition:

\[
p'(Q)q_A + p(Q) - c_A = (w - c_A)\frac{K}{(q_A + q_B)^2} > 0.
\] (9)

By comparing Eqs. (3) and (8), we observe that if \( q_B < K - q_A \), then firm \( A \)'s profit increases by the term \( (w - c_A)q_B \); in other words, the rent over the NOME rights creates a lump sum of revenue. If the regulated price is higher than the nuclear production costs, a further interdependence between firm \( A \)'s and firm \( B \)'s output choice must be considered. In fact, from an examination of the marginal incentives of firm \( A \) when \( q_A > K - q_B \), that is, a comparison of Eqs. (5) to (9), we deduce that the incumbent’s best response shifts upward. Indeed, in a context in which production quantities are strategic substitutes, a less aggressive approach by firm \( A \) (that is, the provision of lower electricity supply) favors an expansion of its rival. In contrast to a standard Cournot model, in this situation, an increase in \( q_B \) is profitable to the incumbent retailer. Each additional retail sale by \( B \) increases \( A \)'s profits by the margin of \( (w - c_A) \). This effect provides firm \( A \) with incentives to withhold its supply. Moreover, an expansion of \( q_B \) makes \( A \)'s rival more aggressive, increasing its share of NOME rights.

To summarize, the endogenous rule causes retailer \( B \) to be more aggressive, whereas the markup of the cession price over the marginal cost causes the incumbent to become

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\(^{24}\) We will always consider the case in which \( w < c_B \), as otherwise firm \( B \) has no incentives to buy withdrawal rights.
less aggressive. The overall outcome in the retail market will thus depend on which of these two forces prevails.

5.2 Relative market shares and several entrants

In this subsection, we discuss how the qualitative results that have been obtained thus far can be used to analyze situations involving more than one competitor.

In the short run, the French retail electricity market is likely to be populated with only a few small entrants. In the exogenous scenario, the quantity of withdrawal rights that are obtained by a given entrant is proportional to its past market share. If the total supply of the entrants remains lower than the maximum quantity of access rights stipulated by the NOME law, then the constraint faced by each entrant can be expressed as

\[ q_{B_i} \leq \alpha_i K, \]

and the best response of each entrant, defined with respect to the total quantity of its competitor \( Q_{-i} = q_A + \sum_{j \neq i, j=1,...,n} q_{B_j}, \) can be represented graphically exactly as in Fig. 1, except that the horizontal axis now represents \( Q_{-i}. \)

The best response of each firm \( B_i \) has the same features as are present in the case of a single entrant, which was developed in Sect. 4.2.

In the endogenous redistribution case, the profit function of \( B_i \) would take the following form:

\[
\Pi_{B_i} = \begin{cases} 
[p(Q) - c_A] q_{B_i} & \text{if } q_{B_i} \leq \frac{q_{B_i}}{\sum_{j=1,...,n} q_{B_j}} K; \\
[p(Q) - c_{B_i}] q_{B_i} + (c_{B_i} - c_A) \frac{q_{B_i}}{\sum_{j=1,...,n} q_{B_j}} K & \text{if } q_{B_i} > \frac{q_{B_i}}{\sum_{j=1,...,n} q_{B_j}} K.
\end{cases}
\]  

(10)

Note that, the condition \( q_{B_i} \leq \frac{q_{B_i}}{\sum_{j=1,...,n} q_{B_j}} K \) is equivalent to the condition \( \sum_{j=1,...,n} q_{B_j} \leq K, \) which constrains entrants’ sales with respect to the redistributed capacity. Once again, the analysis above is very similar to the assessment of the single competitor situation that was detailed in Sect. 4.3.

As competition intensifies in the retail market, entrants enlarge their market shares, and their total supply may exceed the maximum amount of access rights to be distributed. In this situation, rationing must be implemented. One natural way to allocate the scarce resource among the entrants is to consider relative market shares. The constraint that is faced by each competitor of firm \( A \) becomes \( q_{B_i} \leq \frac{q_{B_i}}{\sum_{j=1,...,n} q_{B_j}} K, \) which can be equivalently expressed as \( \sum_{j=1,...,n} q_{B_j} = Q - q_A \leq K. \) Despite the differences between this scenario and the situation that was outlined in Sect. 4.3, it is clear that in the scenario involving multiple competitors, the same effect that was discussed in Sect. 4.3 causes the entrants to be more aggressive because they expect to receive a larger share of the NOME rights.

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25 The higher the access price, the stronger both effects.
26 This condition differs from the inequalities in (6), which represent a comparison between the total market size \( Q = \sum_i q_i, \) i.e. including the incumbent’s production, and the redistributed capacity \( K. \)
6 Conclusion

The NOME law redistributes nuclear electricity from the incumbent to new entrants in the retail market to create fair competitive market conditions. This paper presents an analytical model that focuses on the impact of this reform on retail electricity prices. We note that the main drivers of the pro-competition effects of the NOME mechanism are the quantity of the nuclear production that is made available to retailers, the rules that define the redistribution of this electricity and the access price for the electricity in question. We find that there are two critical thresholds for the production that is redistributed by NOME. The first of these thresholds ensures that the market price is aligned with the marginal cost of nuclear plants and consists of redistributed production levels that are very high relative to the production of the incumbent’s rivals in the pre-reform scenario. The second threshold produces a redistribution that is too low and has no pro-competitive effect. Between these thresholds, retailers supply both their own production and the NOME production, and the market price remains higher than the marginal cost of the nuclear technology.

The way in which the NOME production is allocated to retailers can enhance the previously described pro-competition effects. Because retailers benefit from the NOME nuclear production in proportion to their market share, they may take this consideration into account in their market strategy and become more aggressive, leading to a market equilibrium at a price that is below the price of the pre-reform scenario. Finally, if the access price for retailers is above the marginal cost of nuclear-generated electricity, an additional rent for the incumbent is created. This rent might contract the supply of electricity that the incumbent provides in the retail market, weakening the pro-competition effects of the NOME law. Given the inherent difficulty of precisely measuring the marginal cost of the nuclear technology, this question raises concerns in the regulatory arena. In fact, the CRE states that, given the uncertainty on the investment cost that is required to ensure the safety of nuclear plants, the actual value for the ARENH merits further consideration.27

The present paper could be extended by explicitly modeling a vertically integrated structure to analyze competitive effects in the upstream and downstream markets for electricity. Our framework could also be used to conduct in-depth examinations of the investment incentives that are provided by these types of cession initiatives; however, these extensions are left for future research initiatives.

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27 See page 2 of “Délibération de la Comission de régulation de l’énergie du 5 mai 2011 portant avis sur le projet d’arrêté fixant le prix de l’accès régulé à l’électricité nucléaire historique à 42 € /MWh à compter du 1er janvier 2012.”
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