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Strategic incentives to merge in the energy industry

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> "*There have been attempts by incumbent gas and electricity companies to merge. These mergers can reduce incentives for competitors to build new gas fired plants. The Commission is monitoring these developments carefully and – to the extent applicable – strictly applies its merger rules.*
>
> "**Report on progress in creating the internal gas and electricity market", {SEC(2005) 1448}**
>
> **http://ec.europa.eu/energy/electricity/report_2005/doc/2005_report_en.pdf**

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Summary

The paper is a contribution to the analysis of "conglomerate" mergers. We build an IO model made of four industrial entities that can be merged vertically, horizontally and laterally: i) an importer of natural gas selling to final consumers, ii) an importer of natural gas selling to power turbines, iii) a gas-fired turbine selling power to final consumers and iv) a power producer using a different primary fuel. Final consumers have some imperfect possibility to substitute natural gas for electricity. Therefore, there is a rich family of competition possibilities upstream and downstream in quantities and in linear or non linear prices. The model allows to see how the merger of some segments has an impact on profits, consumers' surplus and total welfare.

JEL Codes

G34, L22, L94, L95

Keywords

natural gas, electricity, merger, imperfect competition

1. Introduction

Since the first Directive on electricity in 1996[3], the European Commission has been repeatedly calling for more competition in the gas and electricity markets. The stance of the EC representatives on first best in energy markets consists of:

i) a complete separation of the network segments (transport and distribution) from the potentially competitive segments (production and sale of electricity, extraction/imports and sale of gas);

ii) entry of new firms in the competitive segments, keeping the natural monopoly parts under the supervision of independent regulators.

As for point *i*), many countries have succeeded in maintaining a vertically integrated structure, and the Commission is contemplating a third Directive that would leave no choice but legal separation. Concerning point *ii*), one can observe that the level of entry has been very low for the ten years since the beginning of the liberalization process. The result is that incumbents are still dominant firms in their home country.

As a second best solution, the EC has hoped that the opening of markets could create cross border competition in the supply of electricity. But this also failed, mainly because green activists have defeated projects to increase the capacity of electricity interconnections.

Actually, there have been changes in the European energy industry. But contrary to the expected increase in competition, one can observe a wave of horizontal and vertical mergers or take-overs, and more recently a new type of integration between gas firms and electricity firms.

As shown in the map of Figure 1, the dominant firms of the energy industry in Western Europe are not symmetrical: in France we have a very large electricity firm (EDF) and a large gas firm (GDF), both publicly owned; in the UK the largest firm is a gas firm (Centrica); the two largest German groups (E.ON and RWE) are main operators in the two industries. And the integration process keeps going on.

[3] Directive 96/92/EC "concerning common rules of the internal market in electricity" was adopted by the Council of Ministers on 19 December 1996. It entered into force two months later on 19 February 1997. The current legal framework for the European Union is defined in "Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC - Statements made with regard to decommissioning and waste management activities", http://eur-lex.europa.eu/LexUriServ/site/en/oj/2003/l_176/l_17620030715en00370055.pdf.

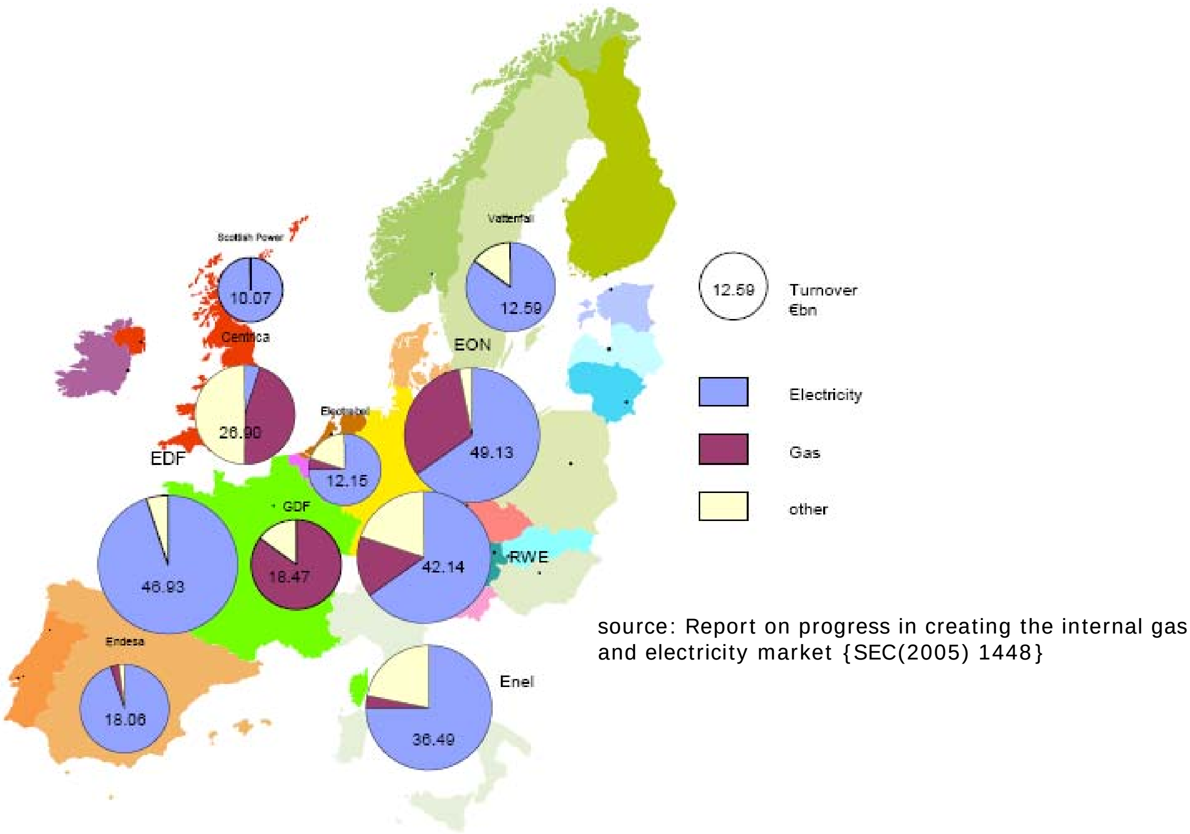

Figure 1: European main operators

After the successful merger of the German firms E.ON and Rhurgas in 2003, two new attempts of "lateral" integration between a natural gas importer/seller and a power producer are troubling the energy landscape in Western Europe: the tentative of takeover of Endesa by Gas Natural (now challenged by E.ON) in Spain and the project to merge GDF and Suez in France and Belgium. Politically, these moves towards building big national champions are clear attacks against the European Community objective to promote competition in the "European single market". The economic question is to figure out whether these inter-industry mergers are aimed at simply taking advantage of technical and contractual synergies between a provider of primary fuel and one of its main clients or at alleviating downstream competition between firms that provide imperfect substitutes to final clients as well as upstream competition on the market of natural gas for gas-fired turbines.

We address the question by means of an IO model made of four industrial entities that can be merged vertically, horizontally and laterally: *i*) an importer of natural gas selling to final consumers, *ii*) an importer of natural gas selling to power turbines, *iii*) a gas-fired turbine selling power to final consumers and *iv*) a power producer using a different primary fuel.

Final consumers have some imperfect possibility to substitute natural gas for electricity.[4] Therefore, there is a rich family of competition possibilities upstream and downstream in quantities and in linear or non linear prices. The model allows to see how the merger of some segments has an impact on profits, consumers' surplus and total welfare. As a by-product, it allows to derive policy lessons for antitrust authorities.

The paper is organised as follows. The first section presents the first best allocation, the competitive market allocation and the private monopoly's allocation in an industry where electricity can be produced from gas and non gas resources and also is an imperfect substitute for natural gas at the final consumer's level. Using a specified model with linear marginal utilities and constant marginal costs, we confirm that the monopoly's dispatch departs from the first best choice as regards final consumers but it remains efficient as for the technology mix.

In section 2, we consider that the aforementioned four pieces of the industry can be combined in different ways to compete à la Cournot on the final market. We first present the benchmark of the oligopoly game, which is a market equilibrium between a gas seller competing against a non-gas electricity producer and an electricity seller who buys gas on international markets to produce electricity. We then compare the benchmark with two alternative industrial configurations that could result from partial merging.

Section 3 analyzes the welfare performance of the alternative industrial configurations. Section 4 concludes.

[4] In the short run, this is obviously dependent on the equipment at the consumption location. Therefore, substitutability is limited and is mainly an option for industrial consumers. For instance, "In the dairy industry, most firms have multi-energy systems allowing them to shift from one energy source to another at almost no cost", Bousquet and Ivaldi (1998).

1. A model of the energy industry

We first detail the structural and behavioral hypotheses of the energy industry model (1.1). Then we determine the quantity of intermediary and final gas outputs and electricity output that maximize net social welfare (1.2). The next steps are to determine the market dispatch when there is perfect competition (1.3) and, on the contrary, when the whole industry is monopolized (1.4).

1.1. Model setting

We consider an industry made of four components, as illustrated in Figure 2:

G is an importer of natural gas for sale to the final consumer

IG is an importer of natural gas for sale to gas-fired electricity turbines

GT is the producer of electricity using a gas-fired turbine

N is the producer of electricity using a primary fuel different from natural gas

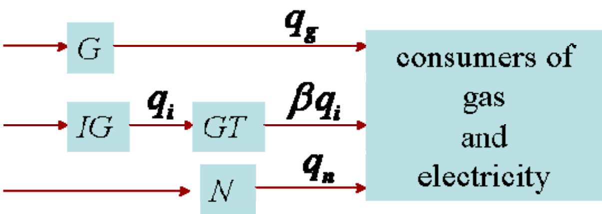

Figure 2: Components of the energy industry

Natural gas is imported at an exogenously fixed unit price equal to *c*. The non-gas technology to produce electricity is given by $C_n(q_n, K) = \begin{cases} 0 & \text{if} \quad q_n \leq K \\ \infty & \text{otherwise} \end{cases}$ whereas the production cost to produce the quantity *q* of electricity from natural gas is $C_g(q) = \frac{cq}{\beta}$ where $\beta < 1$ stands for the productivity of gas in the production of electricity. There is no marketing cost.

The consumers' surplus is represented by

$$S(q_e, q_g) = a_e q_e + a_g q_g - \frac{1}{2}(q_e^2 + q_g^2 + 2\gamma q_e q_g)$$

where $\gamma = -\frac{\partial^2 S}{\partial q_e \partial q_g} > 0$ is a substitutability index. For most installed consumers, it is nil. By contrast, it is strictly positive in some industries where heating or cooling is essential, and it is positive in the medium run, at the time to decide which energy equipment to install at the consumption spots.

1.2. First best allocation

The optimal dispatch is the solution to

$$\max_{q_e, q_g, q_i, q_n} \quad S(q_e, q_g) - c(q_i + q_g) \qquad (1)$$

subject to

$$q_n \le K \qquad (\eta)$$
$$q_i \ge 0 \qquad (\xi)$$
$$q_e = q_n + \beta q_i$$

As the marginal gross surplus functions are $\frac{\partial S}{\partial q_e} = a_e - q_e - \gamma q_g$ for electricity and $\frac{\partial S}{\partial q_g} = a_g - q_g - \gamma q_e$ for gas, the whole allocation must be solved as a set of simultaneous equations as long as $\gamma > 0$.

The first order conditions are

$$\frac{\partial S}{\partial q_e}\frac{\partial q_e}{\partial q_n} - \eta = 0, \quad \frac{\partial S}{\partial q_e}\frac{\partial q_e}{\partial q_i} - c + \xi = 0, \quad \frac{\partial S}{\partial q_g} - c = 0 .$$

One can see from Figure 3 that the solution depends on the location of the marginal surplus of electricity with respect to the merit order.

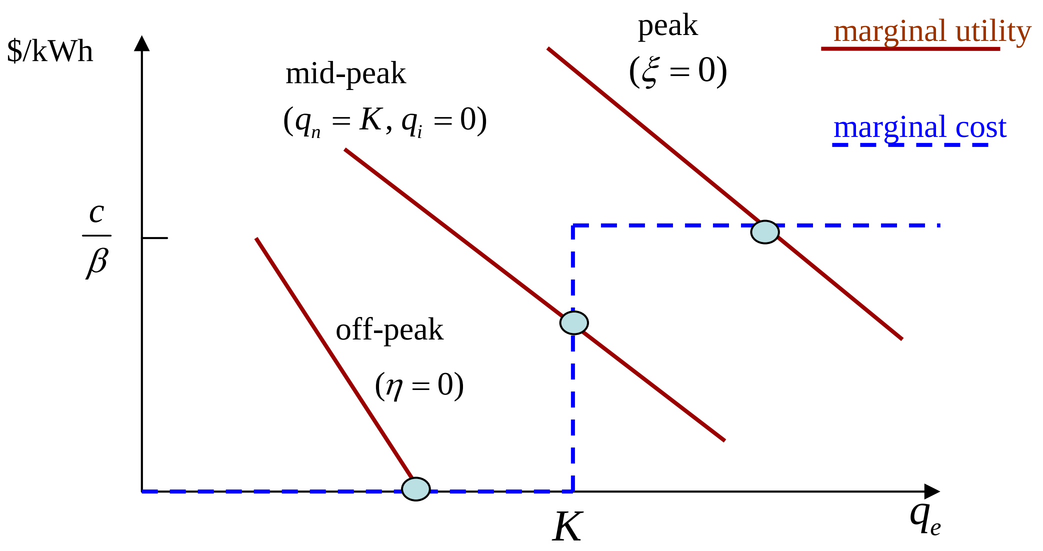

Figure 3: Optimal production of electricity

• During "off-peak periods", K is large and/or a_e is small and/or a_g is large and/or c is large. The capacity shadow price η is 0 because there is an excess of cheap electricity $q_n < K$. Consequently all the imports of natural gas are directly supplied to the final consumer. The first best allocation is

$$q_i^* = 0, \qquad q_n^* = \frac{a_e - \gamma(a_g - c)}{1-\gamma^2}, \qquad q_g^* = \frac{a_g - c - \gamma a_e}{1-\gamma^2}.$$

• In the mid-peak case, the cheap-energy constraint is binding but the marginal utility of electricity is not high enough for gas to be used in the generation of more electricity. Solving the first order conditions mainly provides the shadow value of the non-gas capacity K:

$$q_i^* = 0, \qquad q_n^* = K, \qquad q_g^* = a_g - c - \gamma K$$

$$\eta(K) = \frac{\partial S(K, q_g^*)}{\partial K} = a_e - \gamma(a_g - c) - (1-\gamma^2)K.$$

As expected, it is a decreasing function of K, but it is also a function of the parameters of the gas industry because of the substitutability of the two energy sources.

• On the contrary, at peak hours the gas turbine is dispatched because there is a lack of capacity in low-cost electricity. The first-best quantities are

$$q_e^* = q_n^* + \beta q_i^* = \frac{(a_e - \beta^{-1}c) - \gamma(a_g - c)}{(1-\gamma^2)}, \qquad q_n^* = K, \qquad q_g^* = \frac{(a_g - c) - \gamma(a_e - \beta^{-1}c)}{(1-\gamma^2)} \qquad (2)$$

The dispatch is obviously made complex by the possibility to substitute one energy for the other at the level of final consumers. In the elementary case where no consumer can choose among gas and electricity in the short run ($\gamma = 0$), the output for each energy is obviously independent from the utility parameter of the other. For example at peak periods we obtain

$$q_i^* = \frac{(a_e\beta - c) - \beta K}{\beta^2}, \qquad q_n^* = K, \qquad q_g^* = a_g - c.$$

The intermediary consumption of gas q_i^* only depends on the cost of gas and on the characteristics of the electricity sector.

When γ is positive and increases, gas and electricity become closer substitutes. The net effect on despatch of a change in γ is ambiguous.

Assume for example that $\Delta\gamma > 0$. If q_e^* increases, $\frac{\partial S}{\partial q_g}$ decreases which results in a smaller q_g^*.

But if q_g^* decreases less than γ increases, $\frac{\partial S}{\partial q_e}$ decreases so that we have a smaller q_e^*.

As long as γ is small, q_g^* and q_e^* decrease when γ is increased. This is because with this specification of the surplus function, any increase in γ *ceteris paribus* has the un desirable effect of decreasing the total consumers' surplus.

1.3. Market allocation

On the demand side, we assume that the end-users of electricity and natural gas are price-takers. Therefore, they solve

$$\max_{q_e, q_g} \quad S(q_e, q_g) - p_e q_e - p_g q_g$$

where the unit prices p_g and p_e are independent from the quantity demanded. We deduce the inverse demand functions

$$p_e = a_e - q_e - \gamma q_g \quad \text{and} \quad p_g = a_g - q_g - \gamma q_e \qquad (3)$$

or, the direct demand functions,

$$q_e = \frac{a_e - p_e - \gamma(a_g - p_g)}{1-\gamma^2} \quad \text{and} \quad q_g = \frac{a_g - p_g - \gamma(a_e - p_e)}{1-\gamma^2} \qquad (4)$$

where $q_e = q_n + \beta q_i$.

Market mechanisms will reach the first best allocation if the prices reflect the merit order as shown in the following table:

	Off-peak	Mid-peak	Peak
p_e^*	0	$\eta(K)$	$\frac{c}{\beta}$
$p_g^* = p_i^*$	c	c	c

It is easy to check that substituting these values for the prices in the demand functions (4) and controlling for $q_n \le K$ and $q_i \ge 0$, we obtain the very same allocation than at first best.

1.4 Private monopoly

The private monopoly is a totally integrated firm that controls the imports and sales of gas as well as the production and sales of electricity. Like in the first best case the same decision maker controls all the quantity variables but the objective is now the maximisation of profits

$$\max_{q_n, q_i, q_g} \quad p_e(q_n, q_i, q_g)(q_n + \beta q_i) + p_g(q_n, q_i, q_g)q_g - c(q_i + q_g)$$

$$s.t. \quad q_n \leq K \quad , \quad q_i \geq 0$$

where the inverse demand functions are given by (3).

Because the private firm uses marginal revenue functions $p_e + q_e \dfrac{dp_e}{dq_e}$ and $p_g + q_g \dfrac{dp_g}{dq_g}$ instead of marginal utility (or average revenue) p_e and p_g as benchmarks to its marginal costs of production, we obtain an undersupply of the two types of energy $q_e^M < q_e^*$ and $q_g^M < q_g^*$. Nevertheless, the private monopoly optimizes on technological choices because its interest is to minimize costs. In other words, it chooses the efficient mix of technologies for a given output.

To simplify the comparison, let us consider the case where $q_e^M > K$, that is we are in a peak period under the monopoly regime and *a fortiori* in the first best allocation.

The first order conditions are

$$q_g: \quad (p_g - c) + q_g \frac{dp_g}{dq_g} + (K + \beta q_i)\frac{dp_e}{dq_g} = 0 \tag{5}$$

$$q_i: \quad (p_e\beta - c) + \beta q_i \frac{dp_e}{dq_i} + K\frac{dp_e}{dq_i} + q_g \frac{dp_g}{dq_i} = 0 \tag{6}$$

By solving the system we obtain

$$q_e^M = q_n^M + \beta q_i^M = \frac{(a_e - \beta^{-1}c) - \gamma(a_g - c)}{2(1-\gamma^2)}, \qquad q_n^M = K, \qquad q_g^M = \frac{(a_g - c) - \gamma(a_e - \beta^{-1}c)}{2(1-\gamma^2)}. \tag{7}$$

Note that like at first best, neither the total quantity of electricity nor the quantity of gas supplied to consumers depend on *K*. But the intermediary consumption of gas q_i^M is obviously decreasing in *K*.

The distortion in the allocation of resources is also visible at the price level since prices are higher than marginal costs:

$$p_e^M = \frac{a_e + \frac{c}{\beta}}{2} > \frac{c}{\beta}, \qquad p_g^M = \frac{a_g + c}{2} > c. \tag{8}$$

It is noteworthy that these prices do not depend on the γ coefficient. This is similar to the first best case where the social planner also takes account of the global demand for energy. Finally, note that since, for a given demand, the monopoly supplies less energy than in the perfect competition framework, it is likely that it will use the gas technology less often than first best would require.

2. Mergers in an oligopolistic framework

The four pieces of the industry described in Figure 1 can be merged in a variety of ways reflecting the business plans of the assets' owners or the projects of the government to create a national champion. In subsection 2.1, we first analyze the "oligopolistic benchmark", that is market equilibrium between a gas seller *G* competing against an electricity seller *GT* who buys gas on international markets to produce electricity while the independent electricity producer from non-gas plants *N* is passive because it uses all its capacity *K*. This structure can be viewed as the (imperfect) market solution least harmful for efficiency. It could be the result of a merger like the one that would occur in Spain if the tender offer by Gas Natural for Endesa in September 2005 is cleared with remedies that oblige the new entity to sell the gas retail activity and the non-gas fired plants. In the following subsections, we consider two other industrial configurations that correspond to simplified real cases: the case where, before vertical integration, the two downstream electricity technologies are competitors like in England (2.2) and the case where the largest electricity plants, whatever the technology, remain under the control of one single decision maker, like in France (2.3).

2.1. Oligopolistic competition

We assume that we are in a regime of high demand for electricity[5] so that the non-gas plant is used at full capacity: $q_n = K$. The industry structure is like in Figure 1. The gas seller and the electricity producer who sells to the residual demand not met by *N* compete "à la Cournot". They both buy natural gas on international markets at price *c*.

[5] Consequently, we will not consider the case where, at the off-peak oligopoly equilibrium, we have $q_n^c < K$ et $q_i^c > 0$, which entails an inefficient combination of primary fuels. This case requires some additional analysis because it is typically a situation where a merger would increase efficiency. The net efficiency gain from a merger would depend on the relative duration of peak and off-peak periods.

The firm that sells natural gas to final customers solves

$$\max_{q_g} \quad [p_g(K,q_i,q_g)-c]q_g$$

and the manager of the gas turbine solves

$$\max_{q_i} \quad p_e(K,q_i,q_g)\beta q_i - cq_i$$

where $p_e = a_e - q_e - \gamma q_g$, $p_g = a_g - q_g - \gamma q_e$ and $q_e = K + \beta q_i$.

The first order condition of the gas retailer is

$$(p_g - c) + q_g \frac{dp_g}{dq_g} = 0 \tag{9}$$

As compared with the monopoly choice depicted by (5), *G* does not internalize the effect of its decision on p_e, consequently on the revenues of *GT* and *N*. Symmetrically, the first order condition of the electricity producer *GT* is

$$(\beta p_e - c) + \beta q_i \frac{dp_e}{dq_i} = 0 \tag{10}$$

Comparing with equation (6), we see that *GT* internalizes neither the effect of its decision on p_g (*G*'s revenues) nor the side effects on p_e (*N*'s revenues).

After extracting the best response functions $BR_i(q_g)$ and $BR_g(q_i)$ from the first order conditions of the gas-turbine and the gas' retailer respectively, one can determine the Cournot equilibrium q_g^c, q_i^c defined by

$$q_i^c = BR_i(q_g^c) \text{ and } q_g^c = BR_g(q_i^c)$$

Given the specifications of our model, the Cournot equilibrium outputs depicted in Figure 4, are

$$q_i^c = \frac{2(a_e - c\beta^{-1}) - \gamma(a_g - c) - (2-\gamma^2)K}{\beta(4-\gamma^2)}, \quad q_g^c = \frac{2(a_g - c) - \gamma(a_e - c\beta^{-1}) - \gamma K}{4-\gamma^2} \tag{11}$$

From the comparison with the monopoly outputs (7), we see that Cournot competition has the obvious consequence to increase all the outputs:

$$q_e^c > q_e^M, \quad q_i^c > q_i^M, \quad q_g^c > q_g^M .$$

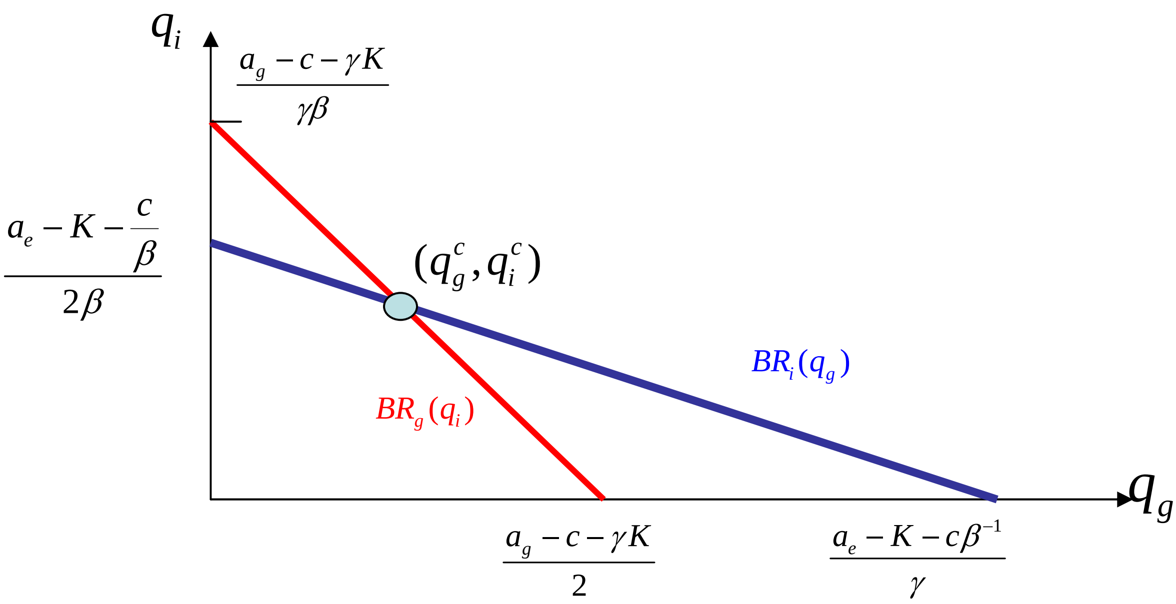

Figure 4: Cournot equilibrium in the duopoly game

Like in the monopoly case, q_i^c is decreasing with *K*. But it is interesting to note that q_g^c is decreasing with *K*. This is because the non-gas producer *N* is both a technological competitor of the gas-fired plant (then $\partial q_i^c / \partial K < 0$) and a commercial competitor of the gas retailer (then $\partial q_g^c / \partial K < 0$). Nevertheless q_e^c is increasing with *K* whereas we have seen that neither q_e^* nor q_e^M depend on *K* in the high-demand regime. This means that any increase in *K* is not totally matched by an equal decrease in the production by the gas-fired turbine, which shows that competition has an intrinsic default of efficiency at the input level.

Equilibrium prices are

$$p_e^c = \frac{2a_e + \left(2-\gamma^2\right)c\beta^{-1} - \gamma(a_g - c) - \left(2-\gamma^2\right)K}{(4-\gamma^2)}, p_g^c = \frac{2a_g + \left(2-\gamma^2\right)c - \gamma\left(a_e - c\beta^{-1}\right) - \gamma K}{(4-\gamma^2)} \quad (12)$$

Contrary to what we had in the monopoly case (see equations (8)), the equilibrium prices billed to the final consumers depend both on the substitutability coefficient and on the capacity to produce low cost energy. When γ is zero, the gas market and the electricity market are independent so that the gas price is the same as in (8) since the gas seller is a monopolist. It is not true for the electricity producer who uses gas turbines since it is facing competition by *N* and only serves residual demand.

2.2. Competition in the electricity market

Assume now that the industry structure is as in figure 5.

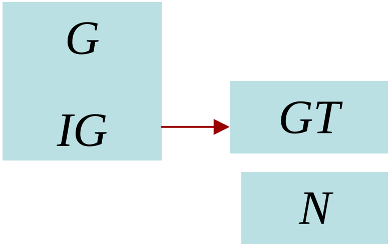

Figure 5: Upstream monopoly, downstream competition

The difference with section 2.1 is that the gas segment is monopolized, so that *GT* cannot produce electricity from natural gas at cost *c*/m^3. It has to buy it at unit price $p_i > c$. At a given price for the delivery of intermediary gas, the manager of the gas-fired turbine solves

$$\max_{q_i} \quad p_e(K, q_i, q_g)\beta q_i - p_i q_i$$

We can consider two scenarios as regards the way p_i is fixed:

i) either the group *G*+*IG* first chooses p_i, and then plays à la Cournot against *GT* to reach an equilibrium where q_g and q_i are simultaneously determined;

ii) or *G*+*IG* takes advantage from its monopoly position to be the leader both on p_i and q_g.

The most likely framework is case *i*) where p_i is fixed in a long run contract whereas q_g can be adjusted in the short run. To simplify the analysis, we therefore assume that the game is played in two stages: first, the gas monopoly fixes the price for intermediary gas, and after that the gas and electricity producers compete in quantity (knowing that *N* keeps on producing at full capacity). Solving backwards, downstream competition opposes *G* that pays *c* for each imported m^3 and *GT* that pays the gas monopoly p_i per m^3. Substituting p_i for *c* in the first order condition (10) and combining it with (9), we obtain the Cournot equilibrium outputs:

$$q_i^1(p_i) = \frac{2\left(a_e - p_i\beta^{-1}\right) - \gamma\left(a_g - c\right) - (2-\gamma^2)K}{\beta(4-\gamma^2)}, \quad q_g^1(p_i) = \frac{2\left(a_g - c\right) - \gamma\left(a_e - p_i\beta^{-1}\right) - \gamma K}{(4-\gamma^2)} \quad (13)$$

These explicit forms clearly show that the gas retailer can sell a quantity that increases with the price he charges for intermediary gas, and this obviously occurs at the expense of the quantity of gas bought by *GT*, which reduces its production of electricity.[6] Controlling p_i gives an additional advantage: the final price of gas itself is increasing with p_i as we can check by substituting (13) into (3)

$$p_g^1(p_i) = \frac{2a_g + (2-\gamma^2)c - \gamma\left(a_e - p_i\beta^{-1}\right) - \gamma K}{4-\gamma^2} \tag{14}$$

The reason is that the price of electricity is very sensible to changes in p_i. From the equilibrium price

$$p_e^1(p_i) = \frac{2a_e + \left(2-\gamma^2\right)p_i\beta^{-1} - \gamma(a_g - c) - \left(2-\gamma^2\right)K}{(4-\gamma^2)} \tag{15}$$

we can compute $\frac{\partial p_e^1}{\partial p_i} = \frac{\left(2-\gamma^2\right)\beta^{-1}}{(4-\gamma^2)}$ which is not very different from $\frac{1}{2\beta}$ as γ is small. Even with a perfectly efficient gas turbine ($\beta = 1$), the electricity producer would be obliged to pass half of the increase in gas price on the final electricity price. This decreases the quantity of electricity bought by final users which makes them ready to pay more for gas. Obviously, $\frac{\partial p_g^1}{\partial p_i} = \frac{\gamma\beta^{-1}}{4-\gamma^2}$, shows that this price effect only plays a role when there is some substitution between the two types of energy at the level of the final consumer.

We now go back to the first stage of the game. The gas monopoly *G*/*IG* solves

$$\max_{p_i} \quad (p_i - c)q_i^1(p_i) + \left(p_g^1(p_i) - c\right)q_g^1(p_i)$$

where $q_g^1(p_i)$ is given by (13) and $p_g^1(p_i)$ is given by (14). The solution of the above problem entails all the parameters of the problem in a complex formula:

$$p_i^1 = \frac{\beta}{16-6\gamma^2}\left(4\left(2-\gamma^2\right)a_e + 2\left(4-\gamma^2\right)\beta^{-1}c + \gamma^3\left(a_g - c\right) - \left(8+\gamma^4-4\gamma^2\right)K\right) \tag{16}$$

To get a taste of the bias due to gas monopolization, it is sufficient to take a look at the first order condition of *G*/*IG*. It is made of four terms:

$$q_i^1 + (p_i - c)\frac{\partial q_i^1}{\partial p_i} + q_g^1\frac{\partial p_g^1}{\partial p_i} + \left(p_g^1 - c\right)\frac{\partial q_g^1}{\partial p_i} = 0$$

$$\qquad(-) \qquad\qquad (+) \qquad\qquad\qquad (+)$$

[6] This result can be also directly derived from the fact that the best response functions $BR_i(c;q_g) > BR_i(p_i;q_g)$ and $BR_g(c;q_i)$ are decreasing in the competitor's output. In Figure 4, since the best response function of the gas firm is unchanged and the electricity firm's function moves downward, it is clear that the equilibrium supply of retailed gas increases and the equilibrium supply of intermediary gas decreases.

When $\gamma = 0$, the third and fourth terms are nil and we have the standard result of a monopolist who takes into account the depletion effect of an increase in price on the whole residual demand it serves:

$$p_i^1 = \frac{\beta\left(a_e - K\right) + c}{2}$$

When $\gamma > 0$, the gas firm takes account of the two additional effects of its price choice that we have mentioned above: the effect on the price and the effect on the output in the gas market for final customers. Given the signs of these effects, it is easy to check that the Lerner index of profitability is $\frac{(p_i^1 - c)}{p_i^1} > -\frac{\frac{q_i^1(p_i^1)}{p_i^1}}{\frac{\partial q_i^1(p_i^1)}{\partial p_i^1}}$, which is above the 'normal' monopoly's margin.

This market power is obviously alleviated by any increase in the capacity of production of cheap energy *K*.

This result has a very important policy implication: if gas and electricity become more and more substitutable at the final consumers' level, and if electricity can be produced by gas turbines, the antitrust authority should not accept that the same firm supply intermediate gas to electricity producers and compete with the very same producers on the final market.

A take over of *G+IG* on *GT* would have the positive effect to suppress the margin $(p_i^m - c)$ but the negative effect to remove a competitor from the final market. The final structure would be like in Figure 6.

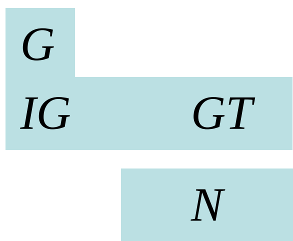

Figure 6: Downstream integration of the gas monopoly

The net effect on welfare depends on technology and preferences. It is analyzed in section 3.

An obligation to divest the gas retail activities like in the ongoing merger of GDF and Suez[7] would allow to shift from the structure of Figure 5 towards the oligopolistic case of Figure 1 - which is welfare improving- rather than towards the Figure 6 configuration.

2.3. Gas incumbent *vs.* electricity incumbent

Assume now that the initial industry is like in Figure 7. This could illustrate the current situation in France where GDF is the incumbent for gas and EDF is the incumbent for electricity.

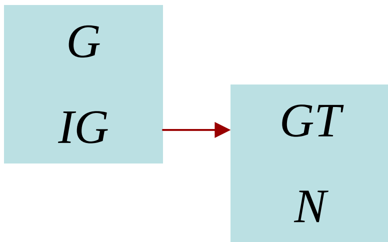

Figure 7: Gas firm *vs.* electricityfirm

In order to keep things comparable, we assume that p_i is fixed by the gas firm before quantity competition occurs on the final market.[8] From the electricity firm problem

$$\max_{q_i} \quad p_e(K, q_i, q_g)(\beta q_i + K) - p_i q_i \,,$$

we can write the best response function

$$BR_i(q_g) = \frac{a_e - 2K - \gamma q_g - p_i/\beta}{2\beta}$$

We see that two cumulative lessening effects are at work as compared with the oligopolistic case of section 2.1. First the input price effect like in the former case. But now, the electricity firm also internalize the consequences of an increase in q_i on its revenue $p_e K$ from the

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[7] Gaz de France is active in the gas sector at all levels, in electricity generation, electricity retail, and in energy services. It operates throughout Europe, but mainly in France and Belgium. In Belgium, Gaz de France, along with Centrica, has joint control over SPE, the second biggest player in the Belgian electricity and gas markets. The Suez group is active in the gas and electricity sectors, in energy services and in water and environmental services, and operates mainly in Belgium and France. Suez's main energy subsidiaries are Electrabel (electricity and gas), Distrigaz (gas) Fluxys (gas infrastructures). To address competition concerns, the group will most notably divest Distrigaz and relinquish control over Fluxys. See details at http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1558&format=HTML&aged=0&language=EN&guiLanguage=fr

[8] Here again, this is obviously exaggerated since the intermediary gas market is a bilateral monopoly. A negotiation à la Nash would be more appropriate.

cheap- electricity plant $p_e K$. Matching this function with the unchanged best response function of the group *G*+*IG*, we obtain the Cournot equilibrium

$$q_i^2(p_i) = \frac{2\left(a_e - p_i\beta^{-1}\right) - \gamma\left(a_g - c\right) - (4-\gamma^2)K}{\beta(4-\gamma^2)}, \quad q_g^2(p_i) = \frac{2\left(a_g - c\right) - \gamma\left(a_e - p_i\beta^{-1}\right)}{4-\gamma^2} \qquad (17)$$

Comparing with (13), we see that $q_i^2(p_i) < q_i^1(p_i)$ and $q_g^2(p_i) > q_g^1(p_i)$ which is the consequence of the additional lessening effect due to the internalization of $p_e K$ by the electricity group.

and the retail price of gas is $p_g^2(p_i) = \dfrac{2a_g + (2-\gamma^2)c - \gamma\left(a_e - \beta^{-1}p_i\right)}{4-\gamma^2}$ which is obviously larger than the corresponding price $p_g^1(p_i)$ given by (14) for the case where the electricity industry is not monopolized.

To finish the computation of equilibrium values, we now have to go backward and solve

$$\max_{p_i} \quad (p_i - c)q_i^2(p_i) + \left(p_g^2(p_i) - c\right)q_g^2(p_i).$$

Once more, the first order condition is made of four terms, of which two show the capacity of the gas firm to manipulate the electricity retail market. The solution to the first order condition gives

$$p_i^2 = \frac{\beta}{16-6\gamma^2}\left(4\left(2-\gamma^2\right)a_e + 2\left(4-\gamma^2\right)\beta^{-1}c + \gamma^3\left(a_g - c\right) - \left(\gamma^4 + 16 - 8\gamma^2\right)K\right) \qquad (18)$$

One can easily check that $p_i^2 < p_i^1$

3. Welfare performance of the alternative configurations

TBC

4. Conclusions

Lateral mergers between natural gas firms and electricity firms are not as simple as purely horizontal and purely vertical mergers. This is because they combine the characteristics of the pure types of integration: the merging entities are simultaneously in a client/supplier relationship like in the vertical case and in a competition relationship like the horizontal case. It is true that integration has a positive effect in terms of efficiency since the production of electricity from gas in the group can now be made at the cost of gas imports, without the distortion of the intermefdiary margin. Nevertheless, the merger also means less competition on the final market, even though there is overall little substitutability between natural gas and electrcity in the short run. Large industrial customers are able to switch from one source to the other and the merger deprives them from the possibility to benefit from some competition between the gas supplier and an independant electricity supplier.

Because of the complexity of the direct and side effects, competition authority must be more careful than in standard vertical and horizontal mergers (see Barquin et al. 2005 and 2006, Padilla *et al.*, 2005).

Many extensions of the model are feasible, among which:

- non-binding capacity for the *N*-technology
- off-peak/peak cycles
- upstream substitutability between energy sources
- more firms, some not concerned by the merger
- calibration

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