Liberalization and Market Segmentation in the Natural Gas Industry*

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Abstract

This paper examines competition in the natural gas industry, with a reference to the recent European liberalization plans. Each firm buys gas under long term contracts with take-or-pay obligations, that imply huge fixed costs and negligible marginal costs; the firms (re)sells the gas in a decentralized market, deciding which customers to approach. We show that under both sequential and simultaneous entry, there is a strong incentive to segment the market: when take-or-pay obligations are still to be covered, competing for the same customer implies losses. If instead a firm is left monopolist on a fraction of the market, exhausting its obligation, it has no further incentive to enter a second market, where the rival will be monopolist as well. Hence, in equilibrium entry is paired with monopoly pricing rather than competition. Antitrust ceilings do not prevent such an outcome while a centralized market organization, where selective entry is impossible, may induce lower equilibrium prices.

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1 Introduction

In the second part of the Nineties the European Commission has promoted through several Directives the liberalization of the main public utility markets, namely the telecommunications, the electricity and the natural gas industries. This policy, that can be traced back to the pioneering experience of the early Nineties in the UK, was rooted in the goals of enhancing competition and efficiency and completing the unification of European markets.

Some common principles can be found in the liberalization frameworks designed in the Directives: entry and competition can be obtained in those segments of the industry where the technology allows to implement a more fragmented structure; in order to overcome the bottlenecks of the natural monopoly segments (networks) owned by the incumbent, third party access (TPA) and access regulation are prescribed; finally, a more active role of the demand side is pursued by recognizing to an increasing portion of the customers the right to look for the most convenient supplier. These general principles are consistent with the idea of removing the foreclosure opportunities of the incumbent, creating a level playing field where the new comers can develop their business.

The natural gas Directive 98/30 have specified the lines of reform that the Member Countries then followed in the national liberalization plans. Today, we can evaluate the first steps of the liberalization process in the member Countries as designed in the national liberalization plans and implemented in the current policies[1]. The general principle of TPA has been confirmed, although some exceptions are admitted, namely when giving access to the transmission or distribution infrastructures would create technical or financial problems to the incumbent due to capacity constraints of take-or-pay obligations. Customers' eligibility has been promoted at different speed in the member Countries, with France at the lowest extreme (28% in 2003) and UK on the other (100% in 1998); the year when full eligibility will be realized varies across countries, with Germany reaching 100% of demand in 2000, Italy, Finland and Spain in 2003, Netherlands in 2004, Belgium and Ireland in 2005, Sweden in 2006; France has not yet set a final date for the opening of the demand side.

[1]See Euopean Commission (2002).

The principle of unbundling of the network assets and activities has been realized under different terms. The proprietary separation of the pipelines from the other activities have been chosen only in the UK and in Finland, while the milder solution of legal separation has been adopted in Belgium, Denmark, Italy and Spain; the simple accounting separation has found widespread acceptance as well (Sweden, Netherlands, Germany and France). The low profile solution to the unbundling principle, toghether with the exceptions admitted to the TPA principle and the insufficient information on available capacity of the pipelines suggest that foreclosure of the essential infrastructures will be a relevant problem in the industry, that calls for an active role of the regulators.

We argue that the main focus of the European Directive and of the national liberalization plans has been on creating an entry opportunity of new comers by guaranteeing a level playing field. Although this is undoubtly the first step, avoiding foreclosure is only a necessary condition for a competitive environment to emerge. Less attention, so far, has been devoted to the design of public policies that can promote competition in the market. In very few cases the liberalization plans have tried to limit the incumbent market power, by completely reorganizing the proprietary structure (UK), by forcing divestiture of import contracts (UK and Spain) or by setting market share ceilings (Italy and Spain). No deeper discussion took place on the features of market organization (centralized pool market vs. decentralized trades, balancing issues) that would help promoting a competitive market. And no analysis have been tempted, to the best of our knowledge, to evaluate if, once solved the foreclosure issues, the structural features of the natural gas industry would allow to obtain the expected benefits from entry.

This paper wants to explore these issues, and analyze how competition in the natural gas industry might evolve once entry barriers are removed. We build our model around three key features of the industry. First, long term import contracts, the bulk of gas supply in most European countries, impose take-or-pay (TOP) obligations to the buyer, that pays a high portion of the contracted gas no matter if it is sold or not. Consequently, the sellers have huge fixed costs and negligible marginal costs on most of the available capacity. Secondly, in a decentralized market setting each firm decides which customers to approach. Thirdly, since the product is homogeneous, if two firms compete for the same customer they face a very intense (Bertrand type) price competition.

In this setting we study the market equilibria in the sequential and in the simultaneous entry cases: the former wants to capture the initial phase after the liberalization, when the incumbent has a first mover advantage in selecting and contracting with the customers; the latter instead might be more appropriate to represent a more symmetric environment, as in a more mature phase of the market.

In both situations we find a strong and mutual incentive of the firms to segment the market and maintain high prices. In a decentralized market each firm decides which customers to serve. When two firms with TOP obligations compete for the same customer, the equilibrium prices are too low to cover the (fixed) costs of the gas, since the marginal cost is zero in this case. Consequently, competing for the same customer implies losses. When instead only one firm has TOP obligations, the (high marginal cost) rival has no gain by competing for the same customer. This feature of price competition with TOP obligations drives the commercial strategies of the firms: leaving a fraction of the customers to the rival allows it to exhaust its TOP obligations and makes it a high cost potential rival with no incentive to compete on the residual customers. In a word, leaving the rival to act as a monopolist on a fraction of the market ensures to be a monopolist on the residual demand.

Our benchmark model puts some doubts on the fact that, once successfully solved the entry barriers issues through TPA, entry will bring in competition. We consider therefore if antitrust ceilings or forced divestitures of gas contracts, by limiting the incumbent market share, can help promoting competition. We find that the segmentation outcome is not prevented under this regime, and a redistribution of market shares and profits is the only relevant effect. A more competitive outcome is instead obtained if the market is centralized, preventing selective entry in particular submarkets. Although competition in pool markets can be much more sophisticated (and inefficient) than the one we consider, our result suggest that a possible way to explore relates to the design of market organization.

The paper is organized as follows. In section 2 we decrive the main assumptions of the model; section 3 analyzes the sequential entry case; antitrust ceilings and centralized vs. decentralized markets are discussed in section 4 and 5, while the simultaneous entry case is considered in section 6. Concluding remarks follow.

2 The market

Let us first define the basic market game, with a reference to the main features of the natural gas industry. Three main assumptions are set: the product is homogeneous, the market is organized according to decentralized bilateral contracting and the supply contracts are characterized by take-or-pay commitments..

We consider a market for a homogeneous good whose quantity is denoted by q. Individual consumers $m = 1, .., M$ have completely inelastic demand d_m, with reservation price $\overline{p}$; total demand is $D = \sum_{m=1}^{M} d_m$.

Two firms, labelled for convenience as the incumbent (I) and the entrant (E), are active in this market. Each firm purchases the natural gas from the extractors and resells it to the final consumers, once delivered it through the pipeline network. In this paper we want to study the effects on entry and segmentation arising from the nature of downstream competition and of final market organization, in the absence of any barriers to entry related to the access to the transport infrastructures. Consequently, we assume that no bottleneck or abusive conduct prevents the access of the entrant to the transportation network at non discriminatory terms. Hence, the network access costs are assumed to be the same for E and I and, w.l.o.g., equal to zero.

Each firm $i = I, E$ has a portfolio of long term contracts with the extractors corresponding to an overall annual capacity k^i and a unit price w^i; moreover, take-or-pay clauses (TOP) are set on a fraction $\overline{q}^i < k^i$ of the capacity, such that an amount $w^i\ \overline{q}^i$ must be payed each year no matter if the gas is taken or not. Finally, each firm can purchase additional provisions of gas on the spot market at a unit price $w' > w^i$. For simplicity, we assume $w^E = w^I = w$.

The cost function of firm i is therefore:

$$C^i(q^i, \overline{q}^i, k^i) = \begin{cases} w\overline{q}^i & \text{for } 0 \leq q^i \leq \overline{q}^i \\ w\overline{q}^i + w(q^i - \overline{q}^i) & \text{for } \overline{q}^i \leq q^i \leq k^i \\ wk^i + w'(q^i - k^i) & \text{for } q^i > k^i \end{cases}$$

Notice that TOP clauses modify the cost structure, introducing a decreasing returns flavour: the marginal cost is zero up to the TOP obligation

$\overline{q}^i$, then jumping to w up to the overall capacity k^i; purchasing additional gas at a marginal cost $w' > w$ on the spot market reinforces even more this feature.

We assume that the incumbent has enough capacity to supply the whole market, as it did before the liberalization took place, but that its TOP obligations cover only a fraction of total demand, that is $\overline{q}^I < D \leq k^I$; moreover, the TOP obligations of the incumbent and the capacity of the entrant are sufficient to supply the market, i.e. $\overline{q}^I + k^E > D$, that is, E has enough capacity to cover the residual demand once the incumbent has satisfied its obligations. This is consistent with $\overline{q}^I + \overline{q}^E \gtreqless D$: we shall see in the equilibrium analysis that whether total obligation are larger, equal or smaller than total demand influences the nature of the price games. Finally, we assume that the incumbent is endowed with a larger amount of obligations than the entrant, i.e. $\overline{q}^I > \overline{q}^E$.

In a decentralized trade market, the firms have to decide which clients to deal with, and propose a price to each of their potential customers. We assume that the incumbent is able to move first in approaching the customers, due to his existing relationships with the clients, followed by the entrant. If no firm decides to contract with a client, no trade takes place; if only one firm applies for a customer, we assume w.l.o.g. that all the bargining power is on the firm side, while if both firms approach the same client, price competition follows. The terms of the deal, therefore, depend on the number of contracting firms and, if both apply, on the marginal cost (residual TOP obligations and capacity available) they have.

Notice that, in this setting, all the contracting episodes that occur with the incumbent still endowed with residual TOP obligations are identical, and can be grouped together. That, is, the equilibrium analysis can be developed assuming that total demand D comes from two (groups of) customers $m_1$and m_2 such that $\sum_{m \in m_1} d_m = D_1 = \overline{q}_I$ and $\sum_{m \in m_2} d_m = D_2$.

From our discussion, the timing is as follows:

- at $t = 1$ the incumbent decides whether to participate or not in D_1; then, having observed whether or not I participates, the entrant chooses to apply or not for market D_1. Then the participating firm(s) (if any) set a price simultaneously.

- at $t = 2$ the incumbent decides whether to participate or not in D_2; then, having observed whether or not I participates, the entrant chooses to apply or not for market D_2. Then the participating firm(s) (if any) set a price simultaneously.

3 The sequential entry game

We now proceed to analyze the subgame perfect equilibrium in the sequential entry game. Although the two markets are separate, a strategic link between them remains, because the residual TOP obligations in the second market depend on the outcome of the game in the first one. Hence, in terms of notation we shall define $\overline{q}_t^i$ the TOP obligations of firm i still remaining in stage (market) t. We first consider the entry decisions and price equilibria in the second market as a function of the number of firms applying for the second group of customers and their residual t.o.p. obligations, that depend on their entry and pricing strategies in the first market.

3.1 The second market subgame

We start our analysis from the the second market subgame, where the incumbent and then the entrant decide whether to apply or not for the customer, and then, if entered, simultaneously set a price. Given the time structure of the subgame, we first focus on the price games.

In terms of notation, we identify a price game at stage 2 from the number of participants and their residual TOP obligations: hence, for instance, we label a price game where only firm i enters with a positive capacity as $\left\{\overline{q}_2^i > 0\right\}$ while a price subgame where the two firms enter and only firm j has low cost capacity is labelled as $\left\{\overline{q}_2^i = 0, \overline{q}_2^j > 0\right\}$, etc. Notice that, depending on the outcome of the first entry-price subgame, the possible cases that must be considered are the following: if only firm i entered in the first market, since $D_1 = \overline{q}^I > \overline{q}^E$ and $\overline{q}^I + \overline{q}^E \gtreqless D$, firm i has exhausted its TOP obligations, while the other has still some obligations, i.e. $\overline{q}_2^i = 0$ and $\overline{q}_2^j \gtreqless D_2$. If no firm entered the first market, the residual TOP obligations exceed market demand: $\overline{q}_2^i > 0, \overline{q}_2^j > 0, \overline{q}_2^i + \overline{q}_2^j > D_2$. Finally, if both firms entered the first market, no matter how they splitted D_1, we have two cases: if $\overline{q}^I + \overline{q}^E > D$ the residual overall obligations exceed D_2, that is $\overline{q}_2^I \geq 0, \overline{q}_2^E \geq 0, \overline{q}_2^I + \overline{q}_2^E > D_2$; conversely, if $\overline{q}^I + \overline{q}^E \leq D$, the residual overall obligations are not larger than D_2, i.e. $\overline{q}_2^I \geq 0, \overline{q}_2^E \geq 0, \overline{q}_2^I + \overline{q}_2^E \leq D_2$. In both cases, the individual obligations that must still be covered in market 2 depend on how the output in the first market was allocated between the two firms.

The following proposition describes the different price equilibria and the associated equilibrium profits.

Proposition 1 *In stage (market) 2 the following price Nash equilibria exist for $i, j = I, E, i \neq j$:*

- *a): $\left\{\overline{q}_2^i \geq 0\right\}$: $p_2^i = \overline{p}$;*
- *b): $\left\{\overline{q}_2^i \gtreqless D_2, \overline{q}_2^j = 0\right\}$: $p_2^i = p_2^j = w$;*
- *c): $\left\{\overline{q}_2^i > 0, \overline{q}_2^j > 0, \overline{q}_2^i + \overline{q}_2^j > D_2\right\}$: $p_2^i = p_2^j = 0$;*
- *d): $\left\{\overline{q}_2^i > 0, \overline{q}_2^j > 0, \overline{q}_2^i + \overline{q}_2^j \leq D_2\right\}$, $p_2^i = p_2^j = w$.*

Proof. Case a) is self explanatory, and corresponds to the price equilibrium when only one firm enters the second market. In the other cases, both firms enter the second market with different amounts of residual t.o.p. obligations. Case b) corresponds to the price game when two firms enter the second market and firm i already exhausted its t.o.p obligations in the first market: the prices correspond to the standard asymmetric costs Bertrand equilibrium. In cases c) and d) both firms enter and have some residual t.o.p.: in case c) undercutting ends up at 0 since overall obligations exceed market demand, while in case d) the prices are set at w, which is the marginal cost for further price discounts. In this latter case, if total residual obligations are lower than market demand, the allocation of output and firms revenues are indeterminate (but not their profits). ■

We move now to the analysis of the entry decisions in the second market, which depend on the entry and price choices in the first market. In all the cases where a firm is indifferent between approaching or not approaching the customers, we assume that the firm does not enter: although we do not consider explicitly entry costs for approaching the customers, even a negligible entry fee would break the tie and justify our assumption. As already outlined, the entry and price decisions in the first market determine the amount of residual TOP obligations of the two firms in the second market, $\overline{q}_2^I$ and $\overline{q}_2^E$. Let us consider the four possible cases, that are analyzed in the following lemmas.

Lemma 2 *If in the first stage I entered while E did not, in the second stage subgame I does not enter while E enters. The stage equilibrium profits are $\Pi_2^I = 0$ and $\Pi_2^E = \overline{p}D_2 - w\overline{q}_2^E$.*

Proof. If in the first stage I entered and E did not, the residual TOP obligations in the second stage are $\overline{q}_2^I = 0$ for the incumbent and $\overline{q}_2^E \lesseqqgtr D_2 \leq k^E$ for the entrant. Let us consider the decisions in the second market. 1) If I enters in the second market and E enters as well, the price equilibrium is $p_2^I = p_2^E = w$ (case b) in Proposition 1) and the profits are $\Pi_2^E = -w \max \left\{ \overline{q}_2^E - D_2, 0 \right\}$, $\Pi_2^I = 0$, where we assume that I sells any output only once E has used all its TOP obligations: this is equivalent to the equilibrium outcome when the prices can be set on a finite grid with a minimum variation equal to ε, once $\varepsilon \to 0$. If E does not enter its profits are $\Pi_2^E = -w\overline{q}_2^E$. Hence, E will enter since it covers with market revenues at least part of its obligations.. 2) If I does not enter in the second market, E prefers to enter. We conclude that E will enter in any case when only I entered the first market. Since by entering I gets $\Pi_2^I = 0$, as it does by not entering, the incumbent will not enter in the second market. ■

When in the first market only the entrant participated, the entry equilibrium in the second stage is symmetric to the case above.

Lemma 3 *If in the first stage E entered while I did not, in the second stage subgame I enters while E does not. The stage equilibrium revenues are $\Pi_2^I = \overline{p}D_2 - wD_1$ and $\Pi_2^E = 0$.*

Proof. The residual low cost capacities in the second stage are $\overline{q}_2^I = D_1 > D_2$ and $\overline{q}_2^E = 0$. If I enters in the second market, E will prefer to stay out, for the same argument of the previous case, and $\Pi_2^I = \overline{p}D_2 - wD_1$. If the incumbent does not participate in the second market it gets $\Pi_2^I = -wD_1$. Hence, in this subgame I enters and E does not. ■

If no firm entered the first market, the residual low cost capacity of the two firms exceeds D_2. Given the incumbent first mover advantage, only I will enter.

Lemma 4 *If in the first stage no firm entered, in the second stage subgame I enters while E does not. The stage equilibrium profits are $\Pi_2^I = \overline{p}D_2 - wD_1$ and $\Pi_2^E = -w\overline{q}^E$.*

The more complex case is when both firms entered in the first market, splitting in some way the demand D_1. Although the allocation of D_1 between the two producers is irrelevant for the stage profits, it is crucial when the TOP residual obligations in stage two are considered. First notice that if the overall TOP obligations exceed total demand ($\overline{q}^I + \overline{q}^E > D$), the residual TOP obligations in market 2 will exceed the second market demand as well ($\overline{q}_2^I + \overline{q}_2^E > D_2$), while if $\overline{q}^I + \overline{q}^E \leq D$ and both firms entered the first market, $\overline{q}_2^I + \overline{q}_2^E \leq D_2$. Secondly, the residual TOP obligations in the second market depend on the output sold in the first market, q_1^I and q_1^E. More precisely, $\overline{q}_2^I = \overline{q}^I - q_1^I = D_1 - q_1^I = q_1^E$ and $\overline{q}_2^E = \overline{q}^E - q_1^E$. Hence, we can link the second market TOP residual obligations to the output q_1^E sold by the entrant in the first market. We have no good reason to prefer an allocation rule over the others. Instead of imposing an arbitrary allocation rule, we shall characterize the subgame perfect equilibrium in the entry and price game in the second market *for each possible allocation* of the demand between the two firms in the first market , and for the two cases of overall obligations equal or exceeding market demand.

Lemma 5 *Consider the second stage subgame when both firms entered in the first market.*

- *If $\overline{q}^I + \overline{q}^E > D$ and $q_1^E \in (0, \overline{q}^E]$, i.e. overall obligations exceed market demand and E entered producing any output up to its obligation in the first market, in the second market I enters and E does not, with stage profits $\Pi_2^I = \overline{p}D_2 - w\ q_1^E$ and $\Pi_2^E = -w(\overline{q}^E - q_1^E)$.*
- *If $\overline{q}^I + \overline{q}^E \leq D$ and $q_1^E \in (0, \overline{q}^E)$, i.e. overall obligations exceed market demand and E entered producing any output lower than its obligation in the first market, in the second market both firms enter, with stage profits $\Pi_2^I = \Pi_2^E = 0$..*

- *If* $\overline{q}^I + \overline{q}^E \leq D$ *and* $q_1^E = \overline{q}^E$, *i.e. overall obligations exceed market demand and E entered using all its obligation in the first market, in the second market I enters and E does not, with stage profits* $\Pi_2^I = \overline{p}D_2 - w\, q_1^E$ *and* $\Pi_2^E = 0$.

Proof. Consider the following cases, identified by the overall TOP obligations $\overline{q}^I + \overline{q}^E$ and by the entrant output in the first market $q_1^E \in (0, \overline{q}^E]$.

1. If overall obligations exceed market demand, $\overline{q}^I + \overline{q}^E > D$ and if $q_1^E \in (0, \overline{q}^E)$ both firms have positive obligations and overall obligations exceed D_2. Then, if both enter each obtains zero revenues (Proposition 1, case c). Hence, if I enters E does not.

2. If, instead, overall obligations exceed market demand, $\overline{q}^I + \overline{q}^E > D$ and if $q_1^E = \overline{q}^E$ the entrant has no residual obligation in the second market and, if both enter, only I serves the market (Proposition 1, case b). Consequently, if I enters E does not.

3. If overall obligations are not larger than market demand, $\overline{q}^I + \overline{q}^E \leq D$ and if $q_1^E \in (0, \overline{q}^E)$, both firms have positive obligations. Then, if both enter $p_2^I = p_2^E = w$ and they obtain positive revenues (Proposition 1, case d) while staying out a firm gets nothing. Consequently, both firms enter.

4. If overall obligations are not larger than market demand, $\overline{q}^I + \overline{q}^E \leq D$ and if $q_1^E = \overline{q}^E$, the case is equivalent to point 2. above.

■

We have characterized the entry decisions in the second market and the associated equilibrium profits as a function of the initial choice. We can therefore proceed to consider the first market decisions and the equilibrium in the entire game.

3.2 The full game

We have identified for each entry decision in the first market the corresponding equilibrium entry and price decision in the second market. The analysis of price equilibria in the first market is simpler. In fact, only cases a) and c) in Proposition 1 apply also to the initial pricing games, since if both firms enter the overall obligations exceed D_1. The overall profits will depend on the revenues in the two submarkets and on the costs, that depend on the overall production, i.e. $\Pi^i = p_1^i q_1^i + p_2^i q_2^i - C^i(q_1^i + q_2^i, \overline{q}^i, k^i)$. The following Proposition states our main result.

Proposition 6 *In the subgame perfect equilibrium of the game, the incumbent enters in the first market while the entrant enters in the second market. Both firms charge to their customer(s) the reservation price $\overline{p}$.*

Proof. If I enters in the first market, the entrant can decide to enter or not. If E does not enter, then in the second market I will stay out, and the entrant will get $\Pi^E = \overline{p}D_2 - w\overline{q}^E$. If, instead, E enters in the first market, the equilibrium prices and revenus are zero, while the second market equilibrium profits are at most zero. Hence, when the incumbent has entered in the first market, E does not enter. Hence, the profits of the incumbent if it enters (and E does not), staying out of the second market, are $\Pi^I = (\overline{p} - w)D_1$.

Alternatively, the incumbent might choose not to enter the first market, inducing E to enter D_1: we have already seen that in the corresponding subgame I will enter the second market while E will stay out. The profits in this case are $\Pi^I = \overline{p}D_2 - wD_1$ and $\Pi^E = \overline{p}D_1 - w\min\left\{D_1, k^E\right\} - w'\max\left\{D_1 - k^E, 0\right\}$. Since $D_1 > D_2$ by assumption, the incumbent will choose to enter the first market. ■

The result obtained shows that when entry is allowed, the incumbent serves a fraction of the market equal to its TOP obligations and leaves the rest to the entrant. Liberalization, in this setting, allows the entry of new firms but induces segmentation and monopoly pricing rather than competition. When a firm has TOP obligations, in fact, its cost structure is characterized by zero marginal costs and high fixed costs, a combination that makes competing for the same customer a very unappealing situation. On the other hand, leaving a fraction of the market to the rival comes out to be a mutually convenient strategy: the other firm, once exhausted its TOP obligations serving its customers in a monopoly position, becomes a high (marginal) cost competitior with no incentives to enter the residual fraction of the market. Leaving the rival in a monopoly position on a part of the market guarantees to be monopolist on the residual customers.

The key ingredients of this result are decentralized trades and TOP obligations, two central features of the natural gas industry. The segmentation result neatly emerges when firms compete a la Bertrand, as in our homogeneous product setting; but we argue that the same claim would apply to less extreme environments in which price competition is slightly relaxed through product differentiation, switching costs or other frictions to customers' mobility. In these cases, two firms endowed with large TOP obligations and competing for the same customer would be able to set equilibrium prices $p > 0$ above the (zero) marginal costs. But even these positive mark-ups might be insufficient to cover the fixed costs of the TOP obligations, i.e. $0 < p < w$.

In our analysis we assumed that $k^I > D > \overline{q}^I$, i.e. the incumbent, before the liberalization, was able to supply the market as a monopolist and that $k^E \geq D_2 \gtreqless \overline{q}^E$, that is, the entrant has enough capacity to cover the residual demand once the incumbent has satisfied its TOP obligations. In all the results, the exact amount of TOP obligations of the entrant, $\overline{q}^E$, played no role, provided that $k^E \geq D_2$. On the other hand, installing insufficient capacity would not be convenient, since E would be less efficient than the incumbent on some marginal customers. Hence, any obligation not larger than the residual demand D_2 would be equally convenient for the entrant, while larger obligations would clearly sacrifice profits.

The allocation of demand between the incumbent and the entrant in our model depends on the amount of TOP obligations held by I when liberalization starts. The market share of the incumbent after entry can be therefore very large, if $\overline{q}^I \cong D$, with a very limited scope for new comers. To avoid such an outcome, the liberalization plans in some European countries have introduced antitrust ceilings to the incumbent market share. In the following section we consider whether this instrument can help to promote competition in the market.

4 Antitrust ceilings and the persistence of segmentation

We analyze the sequential entry game of our benchmark model introducing a further restriction: the incumbent cannot supply more than a certain amount of gas, $\widehat{q}^I < \overline{q}^I$. On the other hand, I can sell (or it is forced to sell, in some cases) its TOP obligations exceeding $\widehat{q}^I$ to other operators at the unit cost w, i.e. it can resell its long run contracts exceeding the ceiling. Consequently, defining as $\overline{q}_0^E$ the TOP obligations of the entrant in the benchmark model, its overall obligations when antitrust ceilings are introduced become $\overline{q}^E = \overline{q}_0^E + (\overline{q}^I - \widehat{q}^I)$.

We can analyze the sequential entry game assuming that the two markets are $D_1' = \widehat{q}^I$ and $D_2' = D - D_1'$. As in the previous case, I decides first whether to enter the first (and then, the second) market, followed by E. Once in each market the customers have been approached, simultaneous pricing strategies are set. The price equilibria in the second stage, as described in Proposition 1, continue to hold, with the obvious qualification that $\widehat{q}_2^I$, the residual antitrust ceilings in stage two, replaces $\overline{q}_2^I$, the incumbent residual TOP obligations. Notice that, with antitrust ceilings, the incumbent cannot produce more than $\widehat{q}_2^I$, i.e. it has an infinitely inelastic supply above a given threshold, and no incentive to undercut. However, this is not enough to sustain prices higher than the marginal cost when the two firms compete for the same costumer, because the entrant, which is not capacity constrained, is always willing to undercut for any price of the incumbent higher than its marginal cost.

The entry decisions in the second market largely correspond to those of the benchmark model: if I entered in the first market while E did not, $\widehat{q}_2^I = 0$ and the incumbent cannot enter the second market, which is therefore supplied by the entrant at the monopoly price. Conversely, if the entrant alone approached the first D_1', the second customer is served by the incumbent at $\overline{p}$. The same outcome arises, due to the incumbent first mover advantage, if no firm approaches the first customer. Finally, if both firms entered in the first market, the entry and pricing decisions in the second market depend on the overall t.o.p. obligations $\widehat{q}^I + \overline{q}_2^E$ being lower, equal or exceeding market demand D, and on the allocation of output in the first market. The same price equilibria and entry decision already analyzed in the benchmark model still apply. Consequently, when moving to the first market entry decisions we find the same result as before. The following proposition summarizes the results.

Proposition 7 *In the subgame perfect equilibrium of the game with antitrust ceilings, the incumbent enters in the first market D_1' while the entrant enters in the second market D_2'. Both firms charge to their customer(s) the reservation price $\overline{p}$. The only effect of antitrust ceilings is to shift market shares from the incumbent to the entrant.*

So far we have assumed that the incumbent resells its long term contracts to the entrant under the original terms w. The effect of antitrust ceilings, in this case, is also to shift profits from the incumbent to the entrant for an amount $(\overline{p} - w)(\overline{q}^I - \widehat{q}^I)$. If the incumbent can set a unit price greater than w for the TOP obligations exceeding the antitrust ceiling, the profit shifting effect is reduced, although the outcome of the game remains as in the proposition above. Since the entrant has always the opportunity to buy on the spot market at $w' > w$, this is also the maximum price the incumbent can obtain for its TOP obligations. Hence, overall, antitrust ceilings produce market share shifting effects for an amount $(\overline{q}^I - \widehat{q}^I)$ and profit shifting effects in the range $[(w' - w)(\overline{q}^I - \widehat{q}^I), (\overline{p} - w)(\overline{q}^I - \widehat{q}^I)]$ from the incumbent to the entrant, while no effect on consumers is obtained.

5 Decentralized vs. centralized market

We have considered so far a decentralized market in which the firms have to approach the individual customers to conclude a deal. We have seen that there is a mutual incentive to segment the market, approaching different customers and avoiding competition on the same market. Antitrust ceilings, in this framework, do not help creating competition, but simply shift market shares and profits from the incumbent to the entrant. We consider now a different market organization, in which the demand is pooled toghether and the firms simply decide whether they want to participate or not in the market and, if active, propose a price. The firms now face a market demand D for prices not larger than $\overline{p}$.

It is obviously true that in this setting the two firms can choose more complex strategies, as for instance the design of supply functions, as the literature inspired by the electricity market liberalization has studied[2]. Consequently, we are not claiming to perform a complete comparison of the two forms of market organization. Trying to maintain unchanged most of the elements, we want only to analyze the effects on market equilibria of dealing separately with the customers or competing for the aggregate demand, a key difference of decentralized vs. pooled markets. In the following, we assume that total obligations do not exceed market demand, although total capacity is larger, i.e. $\overline{q}^I + \overline{q}^E \leq D < k_I + k_E$.

In this latter case the market game can be described as follows:

- At time $t = 1$ both firms decide simultaneously whether to enter the market or not;
- At time $t = 2$, having observed the entry decisions of the two firms, each firm sets its price simultaneously.

The market equilibrium in this case is presented in the following proposition

Proposition 8 *In the centralized market game both firms enter and set a price w.*

Proof. Consider the Bertrand price game when each firm has TOP obligations and capacities such that $\overline{q}^I + \overline{q}^E \leq D < k_I + k_E$. For any price above w any firm can profitably undercut the rival, while any price below is not convenient. Since the fixed costs due to the TOP obligations are covered, entry is (weakly) convenient. ■

This result suggest that once the market organization does not allow selective entry, generalized entry leads to competition and lower prices. Interestingly, the two firms are able to cover their huge fixed costs due to TOP obligations when competing in the entire market. Taken literally, the result is fragile, since even negligible entry fixed costs would prevent the second firm from entering. However, as in our comments on the segmentation case,

[2]See Klempere P., Meyer M. (1989) and, on the electricity market, Green and Newbery (1992).

we argue that the result should be imagined in slightly less extreme competitive environments in which a positive mark-up on marginal costs occurs in equilibrium: in this case, small entry costs could be covered by these mark-ups, sustaining generalized entry and competition. The key difference with the decentralized market case is that in this latter total demand can be segmented, so that the huge fixed costs due to TOP obligations cannot be covered if contemporaneous entry occurs in the submarkets. The possibility of selective entry and the losses from contemporaneous entry make it credible the segmentation result.

6 Simultaneous entry and market segmentation

So far we have focussed on a sequential entry game in which the incumbent decides first whether to contract or not with a sequence of customers. This setting seems appropriate to model the initial phase after the liberalization, when I can exploit its long lasting relations with the customers acting as a leader. We move now to a simultanous entry game where both firms decide the customers to contract with, and then compete in prices. In a sense, this second case might represent a more mature phase of the market, in which the initial asymmetries have disappeared.

We adapt the framework of the sequential entry model of the previous section to a more symmetric environment, in which $D_1 = D_2 = D/2$, both firms $i = I, E$ have the same t.o.p. obligations $\overline{q}^i = D/2$ and neither of them has an advantage in approaching the customers. The timing of the game is modified as follows:

- At time $t = 1$ both firms decide simultaneously which market(s) (if any) to enter;
- At time $t = 2$, having observed the entry decisions of the two firms, each firm sets its price simultaneously in each market where it entered.

Hence, each firm will choose whether to stay out, enter the first, the second or both markets, while the market configurations (which markets are served and by which operator) will derive from the combination of the entry choices of the two firms. In terms of notation, we define as $\{\emptyset; 2\}$ the case in which the incumbent stays out while the entrant serves only the second market, $\{1, 2; 2\}$ the situation when I enters both market and E only the second, etc. For each market configuration we consider now the corresponding price equilibria.

Some cases are rather trivial: when a firm stays out of a market while the other is active, the equilibrium profits are $(\overline{p} - w)D/2$, while when two firms with TOP obligations participate in the same market and the obligations exceed market demand the equilibrium profits are 0. A more interesting case is when a firm participates in both markets while the other enters only one of them. In this case, the price strategy for the multimarket firm will implicitly determine whether it will be active in one or two markets.

The following Lemma analyzes the equilibrium price and profits in this case.

Lemma 9 *Consider the situation in which, given the entry choices, one market (d) is a duopoly and the other (m) is monopolized. Define firm i as the firm entering two markets and firm j as the single market entrant. In equilibrium firm i sets* $p^i_m = \overline{p}$ *in the monopolized market and* $p^i_d = w$ *in the duopoly, while firm j sets* $p^j_d = w$ *in the duopoly market serving all the duopoly demand. The profits obtained are* $\Pi^i = (\overline{p} - w)D/2$ *and* $\Pi^j = 0$.

Proof. We consider the price equilibrium once firm i has entered both markets and firm j only one. Since i is monopolist in market m, $p^i_m = \overline{p}$ is the optimal price and the first market demand allows i to exhaust its TOP obligations. On any additional unit of output up to capacity firm i's marginal cost is w that becomes firm i's bottom price in undercutting. Hence, the price game in the duopoly market gives $p^i_d = p^j_d = w$ and firm j, whose marginal cost is 0, serves the second market demand. ■

The second case that deserves attention is when both firms enter the two markets.The equilibrium price and low cost capacity allocation are considered in the following Lemma.

Lemma 10 *Consider the subgame* $\{1, 2; 1, 2\}$*. The equilibrium prices are* $p^i_1 = p^j_2 = w$ *and* $p^i_2 = p^j_1 = w$*, with each firm serving one of the two submarkets.*

Proof. Consider the price pairs $p_1^i = w = p_2^i$ for firm i and $p_1^j = w = p_2^j$ for firm j, with i serving the first market and j the second. Again, we can consider it as the limiting outcome of a game where the firms set prices on a finite grid with minimum variation ε when $\varepsilon \longrightarrow 0$, when $p_1^i = p_2^j = w$ and $p_2^i = p_1^j = w + \varepsilon$. Since both firms are exhausting their obligations serving one market, their marginal cost on additional units is w and they have no gain from reducing their price from $w + \varepsilon$ to w in the market they are not currently serving. ■

The two Lemmas above share the same qualitative feature: the firms, in the price games considered, have already entered, with TOP obligations equal to a submarket. Once the pricing strategies allow to serve a single market, there is no further profit to gain. Potential competition, in the situations considered, constraints the pricing strategies, forcing the active firm to limit price at the marginal cost w in order to maintain the (high cost) rival a passive competitor. This is the case when one firm is monopolist in one market while competes in the other. But the same principle applies also when the two firms enter in both markets[3].

Once considered the price equilibria that follow from the decision to enter the markets, we can move back to this initial decision.

The table below summarized the equilibrium profits in the price games following the entry decisions of the two firms.

i \ j	1	2	1, 2
1	0 0	$(\overline{p} - w)D/2$ $(\overline{p} - w)D/2$	0 $(\overline{p} - w)D/2$
2	$(\overline{p} - w)D/2$ $(\overline{p} - w)D/2$	0 0	0 $(\overline{p} - w)D/2$
1, 2	$(\overline{p} - w)D/2$ 0	$(\overline{p} - w)D/2$ 0	0 0

Analyzing the entry decisions, we adopt the same criterion as in the sequential entry case: when entering does not improve profits, the firm stays out (saving any even negligible entry cost). When one firm enters only in one

[3]Notice that a coordination problem arises in the case of double duopolies since there exists an equilibrium in which I uses its low cost capacity in market 1 and E in market 2 or vice versa.

market, the optimal choice for the competitor is to select the other market. Entering both markets, in fact, does not improve the firm's profits since it obtains the monopoly profits in one market, where it is a monopolist, but simply reduces the rival's profits in the duopoly market, being a high cost competitor. Hence, we find here the same principle we commented upon: it is mutually convenient to be active in different markets. Once exhausted the obligations, the firm becomes a high cost competitor with no incentives to entering a second market where it would face an aggressive rival. In the analysis of the price games, where entry decisions were already taken, being passive took the form of pricing at the high unit costs w and producing nothing. Once the entry decision is considered, the same incentives suggest to stay out of the market (saving the entry costs, if any).

When instead one firm enters in both markets, the rival prefers to enter only one market. Hence, we got the following best replies in the entry game:

If firm j chooses one market, firm i select the other one. If firm j enters in both markets, firm i still prefers to choose only one market. We conclude that, while entering is convenient in general, selecting both markets is never a best reply for any conjecture on the rival's strategy.Given the symmetry of the game, the following conclusion follows.

Proposition 11 *In the simultaneous entry game there are two subgame perfect equilibria: either firm I enters the first market and firm E the second, or firm I enters the second market and firm E the first. In both case, each firm charges the monopoly price* $\overline{p}$.

Even when entry is simultaneous and the market is perfectly simmetric, we are able to replicate the segmentation result previously obtained in an asymmetric setting, where entry was sequential and the incumbent had a first mover advantage in approaching the customers and a larger low cost capacity. The only difference between the results obtained in these two settings relies on the multiplicity of equilibria in the simultaneous entry symmetric game analyzed in this section, which suggests an underlying coordination problem that was naturally solved in the sequential entry asymmetric game.

Hence, we find that with TOP obligations, the possibility of (costly) contracting with the individual customers gives a powerful incentive to firms to segment the market. Each firm, by selecting a particular subset of customers, eliminates its incentives to enter the residual markets, and implicitly suggest a mirror image entry pattern to the rival.

7 Conclusions

We have considered in this paper entry and competition in the liberalized natural gas market. The model rests on three key assumptions, that correspond to essential features of the industry: the long term contracts for the provision of gas have take or pay obligations that determine a huge fixed costs-negligible marginal cost structure; the market is decentralized and each firm decides which customer to approach and contract with; the product is homogeneous.

Our main finding is that entry can lead to segmentation and monopoly pricing rather than competition. The key mechanism, that holds under sequential as well as simultaneous entry (contracting) works as follows: in a decentralized market each firm has to choose which customers to approach; since both firms have TOP obligations, if both compete for the same customer(s) the equilibrium price does not allow to cover the huge fixed costs ($p < w$). However, if a firm exhausts its obligations acting as a monopolist in a segment of the market, it looses any incentive to further enter in the residual part of the market, where the rival will act as a monopolist as well, covering its TOP obligations. Entry therefore is paired with monopoly rather than competitive pricing.

This result persists even when antitrust ceilings of forced divestiture of import contracts are imposed, with the only effect of shifting market shares and profits. A centralized market organization, instead, preventive the selective entry strategy, may induce, at least with simple pricing strategies, lower equilibrium prices.

These results suggest that the liberalization plans, focussed so far on the task of creating opportunities of entry and a level playing field for new comers, should not take as granted that entry will bring in competition in the market. The issue of promoting competition seems the next step that the liberalization policies need to address.

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