Full cost pricing and market structure

Jean-Luc Netzer & Jacques Thépot
LARGE
Université Louis Pasteur
61, avenue de la Forêt Noire
67085 Strasbourg cedex
e-mail : thepot@cournot.u-strasbg.fr

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Abstract

Most companies prefer to use full cost pricing rather than marginal cost pricing. This article is aimed at providing economic and managerial justifications to this preference. Two organizational levels of decision in the firm are considered: (i) at the top, the business unit fixes the production capacity and uses it as a cost driver to compute the full cost (ii) at the bottom, a profit center operates on the market and chooses the output level. Full cost pricing is thus considered as the specific feature of a leader-follower game between these two entities. Two policies will be used according to whether there is an excess capacity or not. In the excess capacity case, the model reduces to the double marginalization problem. Various market structures are studied: in a monopoly, full cost pricing, though suboptimal, leads to a better fixed cost cutting incentive than the marginal cost pricing, when the fixed cost is low. In an oligopoly, it yields better profits to all the competitors. In a distribution channel, full cost pricing used by the retailer is equivalent to the marginal cost pricing, for the supplier as well as for the retailer.

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1 Introduction

Economic theory argues that the firm must use a pricing on the basis of marginal (or variable) cost, so that the fixed costs are not taken into account. In words, the consumer has not to bear the fixed cost which has to be deduced a posteriori from the overall profit.

It is known that the firms are reluctant to accept this type of reasoning; Usually they prefer to fix the prices on a full cost basis. The surveys by Govindarajan & Anthony (1983) and Shim & Sudit (1995) on American manufacturing companies indicate that more than 60% of them use full cost pricing (FCP hereafter). Such a divergence between the business practices and the theoretical recommendations is well known since the seminal article by Hall and Hitch (1939) (for a survey of the main contributions to this debate, see Lukas, 1999, cf. also Mongin, 1997). The preference of the firms to the full-cost pricing is justified by two main arguments (i) the managers are boundedly rational and they use a partial information on the costs and the demand (ii) the average cost is considered as an estimation of the long run marginal cost.

Kaplan and Atkinson (1998) suggest another type of justification

Some corporations deliberately allocate all corporate overhead expenses to operating departments with allocation bases that have little to do with the consumption of causes of the overhead costs. Perhaps the fully allocated costs are meant to encourage more aggressive pricing decisions by the decentralized managers

And Shim & Sudit (1995) indicate that:

Full-cost pricing provides a motivation to control fixed costs. For example, allocation of fixed costs to profit centers affects the performance of those centers. Accordingly, the profit center managers, whose performance varies with the amount of allocated fixed costs, can raise questions about the amount of corporate overhead and, as a result, may reduce the "empire building" phenomenon

Since the full-cost pricing amounts to pass a part of the fixed cost to the profit centers of the firm, it plays de facto the role of a cost cutting incentive for the profit centers, either to reduce the costs under their own responsibility or to push the business unit to master the corporate overhead.

Besides these internal considerations in terms of incentives, the recent literature has also advocated the role of the competitive environment of the firm: What actually matters is the type of pricing rule used within an

\footnote{quoted by Alles and Datar (1998)}
industry and its impact on the performance of the firms. Alles & Datar (1998) for instance, develop a model where two oligopolistic decentralized firms strategically select their cost-based transfer prices between production and marketing departments. They show how a cost-based transfer price can be used as a competitive weapon through a cross subsidization of some products.

This article is aimed at building a game model of the firm so as to analyze jointly the incentive and competitive aspects of the full-cost pricing. The basic ingredient is to consider a two level organization of the firm.

1.1 A two level organization

Let us consider a monoproduct firm. The technology associated with a production capacity \( y \) is characterized by a fixed cost \( F \) and an unit cost \( g \). The fixed cost may also include some overhead elements due to the organization structure. Let \( q \leq y \) the quantity produced at the operating unit cost \( c \) and sold at price \( p \) on the market. The profit of the firm is

\[
P = (p - c)q - g(y) - F.
\]

At the top level, the *business unit* fixes the production capacity and allocates the costs, using the capacity as a cost driver; at the bottom level, the *profit center* is in charge of producing and selling the good on the market. More precisely:

1. **The business unit** fixes the production capacity \( y \geq q \) and passes a part of the capacity cost on the profit center by charging it with a cost per unit of output \( \omega = g + F/y \).

   The business unit bears the residual cost \( g(y) + F(1 - q/y) \) and seeks to minimize it.

2. **The profit center** is in charge of producing and selling the good, on the basis of the capacity cost computed by the business unit. The profit center seeks to maximize the operational profit \( P^0 = (p - c - g - F/y)q \) under the market structure conditions prevailing on the product market. Without loss of generality we will assume here that the profit center is a quantity setting firm.

Hence the organizational structure of the firm is represented by a leader-follower game; the business unit program can be written in the general form:

\[
\begin{align*}
\min_{q,y} & \quad g(y - q) + F(1 - q/y) \\
q & = \arg \max_{P^0} P^0, \\
& \text{under market structure conditions;} \\
y - q & \geq 0.
\end{align*}
\]
The case where \( g = 0 \) deserves a particular consideration: For \( g = 0 \), using the change of variable \( \omega = F/y \) program (1) can be rewritten as follows:

\[
\begin{align*}
\max_{q, \omega} (\omega q - F) \\
q &= \arg \max (p - c - \omega)q, \\
\omega q &\leq F.
\end{align*}
\]

Then when the variable cost of the technology is negligible, the full cost pricing game is equivalent to a leader follower game between an upstream firm fixing the wholesale price \( \omega \) used by a downstream firm operating on the final market and incurring a distribution cost \( c \). The specific feature of the FCP game lies in the capacity constraint which is transformed in a "ceiling profit" constraint for the upstream firm expressing that it cannot recover more than the fixed cost. In this paper, we will therefore restrict our analysis to the case where \( g = 0 \), so that the production capacity essentially plays the role of a cost driver. This restriction leads to more tractable results.

1.2 Preview of the results

In this paper, we analyze the decisions and the performance of the firm determined by the Nash equilibrium conditions of the FCP game between the business unit and the profit center. The standard marginal cost pricing (MCP) will be used as a benchmark. Two different policies are likely to be alternatively used by the firm: (i) The full capacity policy, where the production capacity is equal to the output. (ii) The excess capacity policy where these values differ.

Four market structures will be successively considered with a special emphasis on the linear demand case: the monopoly, the perfect competitive case, the oligopoly and the supplier-retailer relationship. Section 2 is devoted to the monopoly case. We prove that the FCP, which is clearly sub-optimal in terms of overall profit, has stronger incentive properties for reducing the overhead cost of the organization, when the fixed cost is low. The competitive case is considered in section 3. The Cournot oligopoly case with \( n \) identical firms is studied in section 4. Three main results are obtained: (i) contrary to the monopoly case, FCP yields better profits than the MCP does (ii) there is an interval of \( n \) values in which full capacity and excess capacity policy equilibrium may coexist (ii) the Cournot oligopoly market price is a non monotonic function of \( n \). Section 5 deals with the channel distribution structure. We show that the FCP use by the retailer is equivalent to the use of MCP both by the retailer and the supplier, the latter being charged with the whole fixed cost value.
2 Full cost pricing in a monopoly

Let us assume that the firm is a monopoly on the final market with a demand $D(p)$ and an inverse demand function $p(q)$ such that $p' < 0$ and $2p' + p''q < 0$. First-order condition of $q = \arg \max F^Q$ is:

$$ (p(q) - c - \frac{F}{y}) + p'(q)q = 0. \quad (3) $$

We assume that the second-order condition $qp'' + 2p' \leq 0$, is satisfied. Then program (1) becomes

$$ \begin{cases} 
  \min_{q,y} F(1 - q/y) \\
  y - q \geq 0, \\
  (p(q) - c - \frac{F}{y}) + p'(q)q = 0.
\end{cases} \quad (4) $$

The necessary conditions are the following:

$$ \begin{cases} 
  (F/y) - \alpha + \lambda(2p' + p^2q) = 0, \\
  -F \frac{\alpha}{y^2} + \alpha + \lambda F/y^2 = 0, \\
  \alpha \geq 0, \alpha(y - q) = 0.
\end{cases} \quad (5) $$

Let us denote $\{q^*(F), y^*(F)\}$ the equilibrium output and capacity levels for a given value of the fixed cost $F$. They are determined by the following proposition:

**Proposition 2** In the monopoly case, there exists a fixed cost value, $\hat{F} > 0$, such that,

- **For $F \leq \hat{F}$**:
  - No excess capacity occurs i.e. $q^*(F) = y^*(F)$,
  - There exists a continuous equilibrium output function $q^*(.)$ which is differentiable and strictly decreasing, with $q'^m = q^*(0)$.

- **For $F > \hat{F}$**:
  - Excess capacity occurs i.e. $q^*(F) < y^*(F)$,
  - The equilibrium output function $q^*(.)$, is constant and equal to the double marginalization output $\hat{q} = q^*(\hat{F})$ solution of the equation
    $$ p - c + p^2q + 3p'q = 0. \quad (6) $$
    The production capacity $y^*(.)$ is a linear and increasing function.

Proof.
From relations 5, we know that no excess capacity holds when \( \alpha > 0 \), namely \( \lambda = 0, \alpha = \frac{F}{y} \) and \( q = y \) solution of the equation \( (p(q) - c - \frac{F}{q}) + p'(q)q = 0 \). Let us define the function

\[
\gamma(q, F) = (p(q) - c - \frac{F}{q}) + p'(q)q. 
\]  

(7)

We have \( \gamma(q^m, 0) = 0 \) and \( \frac{\partial \gamma}{\partial q}(q^m, 0) < 0 \). Using the implicit functions theorem, there exist two intervals \([0, \hat{F}[, \hat{q}, q^m]\) and a unique continuous function \( q^* : [0, \hat{F}] \rightarrow [\hat{q}, q^m], \) such that \( q^*(0) = q^m \) and \( \gamma(q^*(F), F) = 0, \forall F \in [0, \hat{F}]. \) The highest possible \( \hat{F} \) can be defined as the (lowest) value of \( F \) such that \( \frac{\partial \gamma}{\partial q}(q^*(F), F) = 0 \) (which exists by continuity of \( \frac{\partial \gamma}{\partial q} \)). Hence \( \hat{q} = q^*(\hat{F}) \) satisfies the relation \( 2p' + F/q^2 + p''q = 0. \) Eliminating \( F \) thanks to relation (7) makes \( \hat{q} \) solution of equation (6). Furthermore, \( \frac{dq^*}{dF} = -\frac{\partial \gamma}{\partial F}/\frac{\partial \gamma}{\partial q} \leq 0, \) for \( F \in [0, \hat{F}]. \) The function \( q^* \) is decreasing and the equilibrium output quantity \( q^*(F) \) is lower than \( q^m. \)

**Excess capacity occurs for** \( F > \hat{F} \) and \( \alpha = 0, \) namely when \( \lambda = q. \)

Relations 5 become :

\[
\begin{align*}
(p - c + p''q^2) + 3p'q &= 0 \\
(p - c - \frac{F}{q}) + p'q &= 0.
\end{align*}
\]  

(8)

The first equation indicates that the equilibrium output is equal to \( \hat{q} \) which is the double marginalization output (cf. Spengler, 1950): In the monopoly case, the program (2) is equivalent to the double marginalization standard model, when the ceiling profit constraint is not bidding. The second relation yields \( y = F/(p - c + p'q), \) computed for \( q = \hat{q}. \)

It can be checked that the first order conditions are also sufficient. In the full capacity case, the objective function of the business unit is zero, it cannot be higher in the feasible set ; in the excess capacity case, we are in the standard double marginalization problem. Hence the result. ■

### 2.1 The linear case

Let us assume that the demand function is linear, given by \( D(p) = N(s - p)/s, \) where \( N \) stands for the potential size of the market and \( s \geq c \) denotes
the highest willingness to pay, when the demand arises from a population of one-unit buyers. The inverse demand is given by:

\[ p(q) = s(1 - q/N). \]  

The MCP yields the quantity \( q_m = N(s - c)/2s \), the price \( p_m = (s + c)/2 \). These values do not depend on the fixed cost \( F \). They define the optimal profit \( P_m = N(s - c)^2/4s - F \). The consumer surplus is \( \Sigma_m = N(s - c)^2/8s \).

- When the cost is low, the full cost policy holds. The equilibrium output \( q_f \) is solution of the equation \((p(q) - c - F) + p'(q)q = 0 \). There are two solutions \( N(s - c) \pm \sqrt{(N^2(s - c)^2 - 8sNF)}/4s \). Only the solution with the sign “+” satisfies the continuity condition at point \( F = 0 \) indicated in proposition 2. In addition it leads to the higher value of the overall profit. Hence the equilibrium output and price are:

\[
q_f = \frac{1}{4s}N(s - c) + \sqrt{(N^2(s - c)^2 - 8sNF)}/4s,
\]

\[
p_f = \frac{3}{4}s + \frac{1}{4}c - \frac{1}{4N}\sqrt{(N^2(s - c)^2 - 8sNF)}.
\]

Clearly, the quantity is lower than the monopoly quantity \( q_f \leq q_m \) and the price is higher \( p_f \geq p_m \). The operational profit is equal to the overall profit:

\[
P_f^0 = P_f = \frac{(s - c)(N(s - c) + \sqrt{(N^2(s - c)^2 - 8sNF)})}{8s} - F/2.
\]

- When the cost is high, the excess capacity policy holds as the output is lower than the production capacity. These quantities and the price are respectively given by \( q_e = \frac{1}{4}N\frac{s - c}{s}, y_e = \frac{2F}{s - c}, p_e = \frac{3}{4}s + \frac{1}{4}c \). The operational capacity profit \( P_e^0 = \frac{N}{16s}(s - c)^2 \) is higher than the overall profit \( P_e = \frac{3N}{16s}(s - c)^2 - F \).

Because of the optimality of the monopoly standard case, we have the following inequalities:

\[
P_f = P_f^0 \leq P_m \quad (11)
\]

\[
P_e \leq P_e^0 \leq P_m \quad (12)
\]

2 This concept of solution is close to the long run equilibrium arising from an adjustment process analyzed by Hanson (1992) in the case where the cost-plus rate is supposed to be constant.
These inequalities illustrate the optimality of MCP. The suboptimality of FCP merely expresses here that the Nash equilibrium of the game between the business unit and the profit center is not Pareto efficient. The consumer surplus can also be computed; in both cases, it is given by:

\[
\begin{align*}
\Sigma_f &= (s-c)\left( N(s-c) + \sqrt{(N^2(s-c)^2 - 8cNF)} \right) - F/2 \leq \Sigma_m, \\
\Sigma_c &= \frac{1}{32s} N(s-c)(7s+c) \leq \Sigma_m.
\end{align*}
\]

Under FCP, the selling price contains a part of the fixed cost; it is then higher than in the marginal cost pricing; this induces evidently a loss of consumer surplus.

2.2 Full cost pricing as an incentive to cost cutting

The fixed cost under consideration in the model resorts, at least partly, to overhead costs which are generated throughout the whole organization. Cost saving in the organization is a matter of incentives for the members to engage in cost cutting. In this perspective, let us examine the robustness of the operational capacity and the overall profit with respect to the fixed cost.

Figure 1 depicts the curve of the profits when the fixed cost \( F \) varies (in the linear case).
• In the MCP, the profit decreases with $F$ along the line $Aa$ of slope $-1$.

• In the FCP, the overall and operational profits are equal when the fixed cost is low; they decrease with a slope lower than -1 (curve $AB$). When the fixed cost is high, these profits are diverging (curve $Bc$ for the operational capacity profit, curve $Bd$ for the overall profit). Analytically, we have the inequalities:

\[
\begin{align*}
\frac{\partial P_m}{\partial F} &= -1 \\
\frac{\partial P_f}{\partial F} &= \frac{\partial P^0_f}{\partial F} \leq -1, \\
\frac{\partial P_e}{\partial F} &= -1, \quad \frac{\partial P^0_e}{\partial F} = 0.
\end{align*}
\]

In other words, when the fixed cost is low, all the fixed cost is passed on the profit center: switching from MCP to FCP leads to a lower fixed cost sensitivity to the fixed cost: the fixed cost is included in the price and is passed on the consumer and this influences the demand; any fixed cost variation changes the selling quantity. The suboptimality of FCP is compensated by a higher fixed cost sensitivity of the profit center performance; this creates incentives to master the overhead costs at the profit center level. This is exactly the argument of Kaplan and Atkinson quoted in the introduction. Furthermore, the FCP may incite the profit center to urge the business unit to master the overall overhead expenses of the firm, as it is argued by Shim & Sudit (see above).

When the fixed cost is high, this kind of incentive properties do not exist since the operational profit is independent on the fixed cost $F$.

### 2.3 Multiproduct extension

Fixed cost allocation in multiproduct firm is a crucial issue in accounting literature. For instance, Pavia (1995) develops a profit maximizing cost allocation scheme among various products where the price of a product is based on a cost-plus approach; the cost allocation scheme affect the price and the demand of the product through an exogenously given mark up, as for instances in regulated industries (utilities, etc.). In a similar perspective, our approach can be extended to the multiproduct case to get a cost allocation scheme where the mark-ups are endogenously determined by the market power conditions of the various products.

Let us assume now that the firm is decentralized in $m$ monoproduction independent activities (plants, division, etc...). The business unit of the
firm wishes to allocate a global fixed cost $F$ among these activities. Activity $j = 1, \ldots m$ is made of a business unit and a profit center as above. The demand to the profit center $j$ is still assumed to be linear of the form $D_j(p_j) = N_j (s_j - p_j)/s_j$. Let $c_j$ be the unit variable cost and $F_j$ the allocated part of the fixed cost to activity $j$, with $\sum_{j=1}^{m} F_j = F$. Let us consider firstly the case where each business unit uses a full capacity policy, for a value $F_j$ of the allocated cost. The overall profit made by activity $j$ is then given by relation (10), namely as a function of $F_j$:

$$P_j(F_j) = \frac{(s_j - c_j) \left( \sqrt{(N_j^2 (s_j - c_j)^2 - 8 N_j F_j)} - 4 s_j F_j \right)}{8 s_j}.$$

Function $P_j(\cdot)$ is concave. Accordingly the cost allocation scheme is determined by the optimization program:

$$\begin{cases}
\max \sum_{j=1}^{m} P_j(F_j) \\
\sum_{j=1}^{m} F_j = F
\end{cases}$$

(15)

This is continuous non linear knapsack problem. In the linear demand case, analytical expressions of the solution are found:

$$F_j = F \frac{P_0^{mj}}{\sum_{k=1}^{m} P_0^{mk}},$$

(16)

where $P_0^{mj} = N_j (s_j - c_j)^2 / 4s_j$ stands for the standard monopoly profit without fixed cost of activity $j$. Hence, in the linear demand case, the global fixed cost is allocated in proportion to the classical monopoly profits. The more profitable is an activity, the higher is the part of the fixed cost allocated to it.\footnote{In the general case, the cost allocation scheme is determined by $F_j/F = \left[ - \left( \frac{p_j}{D_j'} \right)^3 D_j'' + 2 \frac{p_j^2}{D_j'} \right] / \left( \sum - \left( \frac{p_j}{D_j'} \right)^3 D_j'' + 2 \frac{p_j^2}{D_j'} \right)$, namely the optimal allocated cost is made in proportion to an expression which is related to demand elasticities.}

Activity $j$ uses a full capacity policy while $F_j \leq \frac{N_j (s_j - c_j)^2}{8 s_j} = P_0^{mj}/2$, namely, with relation(16), as soon as :

$$F \leq \left( \sum_{k=1}^{m} P_0^{mk} \right) / 2.$$

(17)

Consequently:
• If condition (17) is satisfied, the full capacity policy prevails on all the activities.

• If not, the excess capacity policy is used for all the activities. In this case, the total profit \( \sum_{k=1}^{m} p_{ek} \) is equal to \( \sum_{k=1}^{m} \frac{3N_k}{16nlk} (s_k - c_k)^2 - F \): it is independent on the cost allocation scheme.

3 Full cost pricing in a competitive industry

Let us examine the case where the industry is competitive. The profit center charges a price \( p \) equal to the unit cost \( c + F/y \). Hence the business unit program is:

\[
\begin{cases}
\min_{q,y} F(1 - q/y) \\
y - q \geq 0 \\
(p(q) - c - \frac{F}{y}) = 0.
\end{cases}
\]  

(18)

The equilibrium output and capacity levels \( \{q^*(F), y^*(F)\} \) in the competitive case are given by the following proposition:

**Proposition 3** When the industry is competitive, there exists a fixed cost value, \( \tilde{F} > 0 \), such that,

- For \( F \leq \tilde{F} \):
  - No excess capacity occurs i.e. \( q^*(F) = y^*(F) \),
  - There exists a continuous equilibrium output function \( q^*(.) \) which is differentiable and strictly decreasing, with \( q^c = p(c) = q^*(0) \).

- For \( F > \tilde{F} \):
  - Excess capacity occurs i.e. \( q^*(F) < y^*(F) \),
  - The equilibrium output function \( q^*(.) \), is constant and equal to monopoly output \( q_m = q^*(\tilde{F}) \) The production capacity \( y^*(.) \) is a linear and increasing function.

**Proof.** The proof is the same as proposition (2) with a function \( \gamma(q, F) = p(q) - c - F/q \) and we have \( \tilde{F} = -p'(q_m)q_m^2 \). ■

In the full capacity case, the equilibrium is equivalent to the Ramsey-Boiteux solution of the regulated monopoly. In the excess capacity, case, it coincides with the standard monopoly.
4 Full cost pricing in a Cournot oligopoly

Let us consider the Cournot oligopoly case with \( n \) identical firms, each of them facing a unit variable cost \( c \) and a fixed cost \( F \). The demand is still given by (9). Under MCP, the equilibrium price is \( p_e = \frac{s + nc}{n + 1} \) and the industry output is \( q_e = \frac{Nn(s - c)}{(n + 1)s} \). The consumer surplus is equal to \( \Sigma_c = \frac{Nn^2(s - c)^2}{2(n + 1)^2s} \) and the profit per firm is \( P_c = \frac{N(s - c)^2}{(n + 1)^2s} - F \).

Under FCP the business unit which fixes the production capacity \( y_i \) and the profit center which chooses the quantity \( q_i \). The profit center seeks to maximize the operational capacity profit and the business unit of any firm \( i \) seeks to minimize the residual profit \( F(q_i - y_i)/y_i \). As in the monopoly case, we have a two-stage game: At stage 1, the business units of the firms simultaneously fix the \( y_i \); at stage 2, the profit centers are involved in a Cournot competition on the quantities \( q_i \). Two types of games can be considered:

- The open loop FCP game, in which at the beginning of stage 2, the profit center of any firm \( i \) only observes its own production capacity \( y_i \);
- The closed loop FCP game, in which at the beginning of stage 2, the profit center of any firm \( i \) observes all the production capacities \( \{y_j\} \), \( j = 1, ..., n \).

For the sake of simplicity, the open loop FCP will be extensively studied; we will then just mention what is changed in the closed loop case. Furthermore, in the linear case, we will assume that:

\[
F \leq \frac{1}{8}N\frac{(s - c)^2}{s},
\]

(19)

so that, if it were a monopoly, any firm uses a full capacity policy \( (y_i = q_i) \). Of course, when the number of competitors increases, the burden of the fixed cost on the full cost of any firm is likely to increase since the quantity produced should decrease. One can then expect to have the firms using a excess capacity policy. Such is the crux of the matter.

In the open loop case, firm \( i \) determines \( y_i \) at stage 1 on the basis on its own reaction function of second stage, implicitly defined by the first order condition of stage 2 maximization:

\[
(p(q) - c - \frac{F}{y_i}) + p'(q)q_i = 0.
\]

(20)
Then the stage 1 optimization program of firm $i$ can be written:

$$
\begin{cases}
\min_{q_i,y_i} F_i(1 - q_i/y_i) \\
q_i \leq y_i \\
(p(q) - c - F/y_i) + p'(q)q_i = 0
\end{cases}
$$

the solution of which defines the reaction function $y_i(q_j), q_i(q_j)$ for $j \neq i$, respectively of the production capacity and output of firm $i$. In the linear case, solving equations (20) for $i = 1, \ldots, n$ results in the output levels in terms of all the production capacities, namely:

$$
q_i = \frac{N(s - c - nF/q)}{(n + 1)s}(\sum_{j=1}^{n} (c+\frac{F}{y_j}) -(n+1)(c+\frac{F}{y_i}))
$$

(22)

Since the $\approx$ms are identical in terms of cost arguments, they will adopt the same policies. As in the monopoly case, two situations may occur:

1. **All the firms use a full capacity policy.** We have $y_i = q_i = q/n$, where $q$ stands for total production of the industry. Relation (22) yields:

$$
\frac{N(s - c - nF/q)}{(n + 1)s} = \frac{q}{n}
$$

so that the open loop industry output is given by:

$$
q^O_f = \frac{n(N(s-c) + \sqrt{(N^2(s-c)^2 - 4FN(n+1)s))}}{2(n+1)}
$$

and the market price is:

$$
p^O_f = \frac{N(sn + 2s + cn) - n\sqrt{(N(N(s-c)^2 - 4FN(n+1)s))}}{2(n+1)n}
$$

This type of equilibrium exists for $n \leq u = \left[ \frac{N(s-c)^2}{4Fs} - 1 \right]$. It is worth noticing that price $p^O_f$ is decreasing for $n \in [1, w]$, with $w = (s - c)\sqrt{N/Fs} - 2$, and increasing for $n \geq w$. The (overall and operating) profit of any firm is given by:

$$
P^O_f = \frac{(s-c)(N(s-c) + \sqrt{(N(N(s-c)^2 - 4FN(n+1)s))})}{2(n+1)^2s} - \frac{F}{n+1}
$$

(24)

On can check that the profit per firm decreases when $n$ increases. Moreover, the profit under FCP is higher that the MCP i.e.:

$$
P^O_f \geq P^c_f \text{ pour } n \geq 2.
$$

(25)
2. All the firms uses a excess capacity policy, with \( y_i > q_i = q/n \). Combining the first order conditions of the \( n \) programs 21 yields the following relation, which generalizes (6) :

\[
(p - c) + \left(\frac{q}{n}\right)(3p' + p''q/n) = 0
\]  

(26)

When \( n \to \infty \), relation (26) becomes \( p(q) - c = 0 \) and the industry output tends to the monopoly outcome. In the linear case, we find

\[
q^O_e = \frac{n(s - c)N}{s(n + 3)}, \quad y^O_i = \frac{1}{2}F \frac{n + 3}{s - c}, \quad P^O_e = \frac{3s + nc}{n + 3}
\]

and the overall profit per firm is \( P^e = \frac{2s-c)^2 N}{(n+3)^2} - F \). As in the full capacity policy case, the overall profit of any firm is higher than under MCP :

\[
P^O_e \geq P_c, \text{ for } n \geq 2.
\]

(27)

The open loop equilibrium exists if \( q_i \leq y_i \) i.e. for \( n \geq d = (s - c)\sqrt{2N/Fs} - 3 \). Clearly, condition (19), implies \( d \leq u \); hence, for \( n \in [d, u] \), the full capacity and excess capacity policy equilibria coexist.

4.1 Comments and interpretations

Four significant elements can be drawn from the previous derivations which indicate how the FCP alters the firms’ decisions when the number of firms \( n \) varies.

4.1.1 Better profits for the firms

In the monopoly case, FCP yields lower overall profit. This is no longer true in the Cournot oligopoly case : For \( n \geq 2 \), the profit of each oligopolist is higher under FCP than MCP (cf. relation (25) and (27)). Consequently, any firm is better off with the full cost pricing provided that this rule is enforced by all the competitors. This result could justifies the existence of accounting rules and cost evaluation procedures explicitly or implicitly used within the whole industry. To some extent, the cost accounting principles the managers have acquired by education, training and/or membership of professional associations induce a form of intra industry coordination because their counterparts at the competitors share the same knowledge and ideas. Everyone in the industry compute the costs using the same reasoning, the same formulas. Furthermore, as in the monopoly case, the full cost pricing yields a consumer surplus loss. The profits are better off but FCP remains detrimental in terms of welfare.

4.1.2 Coexistence of two types of equilibria

When \( n \) increases, each oligopolist incorporates a growing part of the fixed cost in its average cost (since the quantity produced is lower because on
increasing competition). Hence three situations may occur, according to the value of $n$:

1. When the market is weakly competitive ($n \leq d$), at the equilibrium, all the firms operate using a full capacity policy.

2. When the market is strongly competitive ($n \geq u$), any firm uses an excess capacity policy.

3. When the market is moderately competitive ($d \leq n \leq u$), both previous situations may coincide: there are two equilibria even if the full capacity policy equilibrium yields better profits. Such a multiplicity leads to the instability of the industry, since any firm could be tempted to switch from an equilibrium to the other one.

Figure (2) depicts the various cases in the plane $\{F, n\}$, where curves $u(F)$ and $d(F)$ are drawn. The full capacity policy equilibrium prevails for low values of $n$ and $F$ while the excess capacity policy equilibrium holds for high values of these parameters. The area of coexistence lies between the curves $u$ and $d$; it vanishes at $F = \frac{1}{8} N (\frac{s-c}{s})^2$, for which the monopoly situation is found ($u = d = 1$).

![Figure 2: The various types of equilibria](image_url)

4.1.3 Destructive competition

Under the full cost pricing, the price is a non monotonic function of the number of oligopolists. When $n$ increases two effects are combined:
• A downward effect resulting from a stronger competition in the industry.

• An upward effect due to the increase of the average cost of all the firms, computed on a diminishing quantity.

The downward effect dominates for low values of \( n \) and the upward effect dominates for high values of \( n \). As depicted on figure (3), the market price is decreasing on \([1, w]\) and increasing on \([w, d] \). A bifurcation holds when the number of firms takes the value \( d \), since there are two equilibria, as discussed above. Hence, for \( n \geq d \):

• If the firms use the excess capacity policy, the market price decreases.

• If the firms keep the full capacity policy the price increases. For \( n = u \), the price suddenly falls to get the excess capacity curve.

As a result, Cournot competition under full cost pricing may lead to a consumer surplus destruction when the increase of the number of firms drives up the market price. This finding contrasts with the classical result of microeconomics which claims that the stronger is the competition the better is the consumer. More interestingly, it turns out that the consumer surplus is maxima for a number of firms equal to \( w \).

4.1.4 A long run efficiency loss

The long term market structure deserves also consideration. We are in a contestable market context in which the number of the firms likely to survive
in the industry is determined by the zero profit condition (cf. Martins, 1993, p. 175). Under marginal cost pricing, the maximal number of viable firms is equal to \( n_c = (s - c) \sqrt{N/sF} - 1 \), for a long run market price \( c + \sqrt{Fs/N} \). Under the full cost pricing, the maximal number is \( n^* = (s - c) \sqrt{3N/sF} - 3 \geq n_c \), for a long run market price \( c + \sqrt{3Fs/N} \). It may be asked whether the social efficiency loss embedded in the FCP rule could be offset by the access of a higher number of firms in the industry.

This is actually not true: under FCP, the long run market price is equal to \( c + \sqrt{3Fs/N} \geq c + \sqrt{Fs/N} \). Hence, the long run FCP price is higher than the MCP long run market price and then no long run efficiency gain can be expected under the full cost pricing rule.

4.2 The closed loop game

In the closed loop setting, the profit center of each firm observes the production capacity levels of all the firms. At stage 1 the business unit of firm \( i \) takes into account the full cost pricing rule used by its rivals so that it has to solve the following optimization program:

\[
\begin{align*}
& \min_{q_i, y_i} F_i (1 - q_i/y_i) \\
& y_i \geq q_i \\
& (p(q) - c - \frac{F}{y_j}) + p'(q)q_j = 0 \\
& j = 1, ..., n.
\end{align*}
\] (28)

Clearly, there is no difference with the open loop when the full capacity policy holds. In the excess capacity case, the first order conditions of the \( n \) programs of type (28) in the symmetric case leads to the relation:

\[ p(q) - c + (n + 2)p' + p^* q = 0 \] (29)

When \( n \to \infty \), relation (29) becomes \( p(q) - c + p'q = 0 \) and the industry output tends to the monopoly outcome. In the linear case, we find \( q^C_e = \frac{n}{2s(n + 1)} \), \( y^C_e = \frac{2n}{s-c} \), \( p^C_e = \frac{sn + 2s + nc}{2(n + 1)} \) and the overall profit per firm is \( P^C_e = \frac{n(n+2)(s-c)^2}{4s(n+1)^2} - F \). As in the open loop case, the overall profit of any firm is higher than under MCP. The closed loop equilibrium exists if \( q_i \leq y_i \), i.e. for \( n \geq u \). Hence, contrary to the open loop case, the full capacity and the excess capacity policy equilibria may not coexist in the closed loop game. But, as in the open loop game, no long run efficiency can be gained.
5 Full cost pricing in a distribution channel

Let us now consider the standard vertical relation case where a supplier $S$ sells at price $w$ the product to a retailer $R$ who sells it on the final market at price $p$, as represented on figure 4. We assume that the supplier incurs a unit production cost $c$ and that the unit distribution cost is negligible. The fixed cost $F$ covers the structure of the distribution channel; it can be paid either by the supplier or by the retailer. We are in a classical double marginalization context where each agent benefits from a monopoly power on the downstream demand. Under marginal cost pricing, the fixed cost does not play any role; it has just to be shared among supplier and retailer. When the final demand is given by (9), the wholesale price is $w^* = (s + c) / 2$, the retail price is $p^* = (3s + c) / 4$ and the quantity sold is $q^* = N(s - c) / 4s$. The profits (fixed cost excluded) of the firms are respectively $S^* = (s - c)^2 N / 8s$, and $R^* = (s - c)^2 N / 16s$. The consumer surplus is $\Sigma^* = (s - c)^2 N / 32s$.

In the FCP context now, Let us examine successively the cases where the fixed cost is paid by the supplier or the retailer. The analysis will be restricted to the full capacity policy situation, namely for low values of the fixed cost $F$.

5.1 Full cost pricing of the supplier

The analysis made in section 2 can be straightforwardly applied. Under FCP, the supplier organization is made of a business unit in charge of fixing the production capacity $y$ and a profit center fixing the wholesale price. The retailer profit is $R = (p - w)q$. It is maximum for $q = N(s - w) / 2s$. The operational profit of the supplier is $S^0 = (w - c - F / y)q$. Maximizing it with respect to $w$, yields $w = \frac{1}{2}(s + c + F / y)$. When the full capacity policy holds, $q = y$, and then we have:

$$q_p = \frac{N(s-c) + \sqrt{N^2(s-c)^2 - 16sNF}}{8s},$$

$$p_p = \frac{N(3s+c) - \sqrt{N^2(s-c)^2 - 16sNF}}{8N},$$

$$w_p = \frac{N(3s+c) - \sqrt{N^2(s-c)^2 - 16sNF}}{4N},$$

$$S_p = \frac{(s-c)(N(s-c) + \sqrt{N^2(s-c)^2 - 16sNF}) - 8sF}{16s},$$

$$R_p = \frac{(N(s-c) + \sqrt{N^2(s-c)^2 - 16sNF})^2}{64N^2s}.$$ 

It can be checked that FCP induces a profit loss for the supplier and the retailer as well, since $S_p \leq S^* - F$ and $R_p \leq R^*$ (with also a consumer surplus loss).

5.2 Full cost pricing of the retailer

The most interesting situation is the case where the fixed cost $F$ is charged to the retailer who incorporates it in his full cost evaluation. The retailer orga-
Figure 4: The distribution channel

nization is made of a business unit and a profit center. Maximizing its operational profit \( R^0 = (p-w-F/y)q \) yields a quantity \( q = \frac{s-w-F/y}{2s} N \). The full capacity policy holds for \( y = q \), namely:

\[
q = \frac{1}{4s} \left( N(s-w) + \sqrt{(N^2(s-w)^2 - 8sNF)} \right). \tag{30}
\]

Then the supplier maximizes its profit \( F = (w-c)q \) with respect to \( w \), for \( q \) given by the relation (30). This yields:

\[
w_d = \frac{1}{2} \frac{N(s^2 - c^2) - 8sF}{N(s-c)},
\]

Then substituting in (30) gives \( q_d = \frac{N(s-c)}{4s} \), namely \( q_d = q^* \). Consequently, the quantity sold under FCP is the same as under MCP. The retail prices are the same, \( p_d = (3s + c) / 4 = p^* \) and the profits are also equal:

\[
R_d = (p_d - w_d)q_d - F = (s-c)^2 N/16s = R^*.
\tag{31}
\]

\[
S_d = (w_d - c)q_d = (s-c)^2 N/8s - F = S^* - F.
\tag{32}
\]

When the retailer uses FCP, the equilibrium market price does not depend on the fixed cost \( F \). It is passed on the supplier and put in the wholesale price. This result deserves consideration: when the retailer takes into account the fixed cost, this reduces the quantity sold on the final market which
is equal to the quantity produced by the supplier. Hence the latter fixes its price in view of this phenomenon and is better off when bearing all the fixed cost.

6 Conclusion

This work is aimed at providing some microeconomic foundations to the full cost pricing rule. The key ingredient of our analysis is to have the firm split into two decision levels. Accordingly, the full cost pricing results from the equilibrium condition of a leader-follower game. Such a decomposition have some relevancy with regard to the common business practices of the firms: the business unit works as the control entity of the profit centers and the production capacity is a relevant cost driver for the accounting management. The study of various market structures provides some arguments justifying the use of full cost pricing rules: in the monopoly case, when the fixed cost is low, FCP is a better cost cutting incentive than MCP; in the Cournot oligopoly case, the FCP -when used by all the competitors- yields better profits to all of them since it works as a coordination device sustaining a higher value of the market price. In a distribution channel FCP, when used by the retailer, is equivalent to MCP.

Of course other types of oligopoly models have to be examined, particularly those which explicitly introduce the production capacities (cf. Kreps and Scheinkman, 1983, Thépot, 1995). More generally, our approach turns out to be a rather simple way of incorporating increasing returns to scale elements in IO standard models.

References


