"VALUE ADDED TAX AND COMPETITION"

by
Ingemar DIERICKX*
Carmen MATUTES*
Damien NEVEN*

N° 86 / 44

* Ingemar DIERICKX, Carmen MATUTES, Damien NEVEN,
INSEAD, Fontainebleau, France

Director of Publication :

Charles WYPLOSZ, Associate Dean
for Research and Development

Printed at INSEAD,
Fontainebleau, France

VALUE ADDED TAX AND COMPETITION

by

I. Dierickx

C. Matutes

D. Neven

Abstract

We analyze the Cournot model of oligopoly when the industry is subject to a value added tax (V.A.T) and firms operate with different costs. Those differences arise because, e.g. firms compete from different locations (say, different countries in the EEC). We show that an increase in the rate of V.A.T will always raise the market price (lower output) and decrease the net price (this is net of tax). Taxes will also lead to higher concentration, with low (high) cost firms increasing (decreasing) their market share. VAT will thus hurt allocative efficiency but will enhance productive efficiency. Finally, provided cost differences across firms are large enough, low cost firms will increase profit, at the expense of high cost competitors. To the extend that production cost do not vary significantly across firms, foreign competitors will thus loose, and local firms benefit, from an increase in VAT.

INSEAD, Fontainebleau

December 1986

I - INTRODUCTION

The achievement of a large european market by 1992 has been repeatedly advocated. The grand design of a European free market seems however threatened by the "ominous silence about tax" (The Economist, (1986)). Indeed, the rates of value added tax (V.A.T) vary widely within Europe, both across and within industries. For example, Britain raises 4% of G.N.P in V.A.T, while France raises 9%. Motor cars are taxed at 14% in Germany and 33.3% in France. Such differences seem to act as a hidden barrier to trade (see Geroski and Jacquemin (1985)) and, it is argued, "nothing would encourage success in European business more tellingly than the removal (of those differences) that hinder the flow of goods across the European Community" (The Economist, (1986)). Hence, setting uniform rates of V.A.T in the E.E.C is a political objective. However, apart from the compelling argument that such reform would lower transaction cost (think of customs posts), there is one issue, which has remained largely unnoticed ; changing rates of V.A.T will modify industrial conduct. Oligopolists will presumably adjust their strategies within the different markets in which they operate. Who will gain ? Who will loose ? Are the consumers likely to benefit ? These are the questions addressed in the present paper.

Until recently, the public finance literature has dealt with the polar cases of perfect competition and monopoly. Willig (1983) and Brandts (1986) have considered taxes with imperfect competition, but their main concern lies with optimal taxation. To the best of our knowledge, the incidence of taxes on rivalry and profitability has been analysed solely by Katz and

Rosen (1983), Seade (1984) and Gual (1986). Seade (1983) was focusing on excise taxes, quite different from V.A.T, which is the concern of the present paper. Katz and Rosen (1983) use the conjectural variation model of oligopoly to show the incidence of proportional taxes on inputs which are formally equivalent to V.A.T (see below). They conclude that profit could in some circumstances increase, as a result of higher taxes. However, these authors do not allow for cost differences across firms, which is a crucial element of the present model, with respect to the analysis of intra-EEC trade. Finally, Gual (1986) deals with V.A.T but assumes that firms compete in a Bertrand fashion. He is mainly concerned with the incidence of taxes on equilibrium prices. Nevertheless, he conjectures that profits "are not likely" to increase as a result of higher taxes. By contrast, we shall focus on a specific industry in which an homogenous commodity is sold by Cournot-type oligopolists. We shall assume that firms operate with different costs. Those differences are meant to capture an important asymetry between national and foreign producers; to the extent that production costs do not vary significantly across firms, foreign producers will incur larger total costs than local competitors because of transportation. In this context, we show that, for a large class of demand functions, an increase in V.A.T will lead to an increase in market price but a fall in the net price (i.e. net of tax). Allocative efficiency[1] will thus be penalised. More importantly, strategic interactions between firms are such that low cost (national) firms will experience an increase in market share, to the expense of high cost (foreign) producers. Hence, the intuition of Geroski and Jacquemin (1985) that V.A.T differentials reduce trade is fully supported by the model. In addition, VAT will tend to enhance productive efficieny, with low cost firms producing a larger share of total output.

Next, we examine the impact of V.A.T on profits. We show that provided cost differences across firms are wide enough, low cost producers will actually benefit from an increase in V.A.T. These firms will tend to increase output, while high cost (foreign) producers restrict their shipment. On the whole, even though the net price unambiguously falls, profit will increase. This is to say that countries that will increase (decrease) V.A.T towards a uniform target will do so, to the benefit (expense) of national producers. To illustrate, we can say that french car manufacturers have nothing to gain from common V.A.T rates, while German manufacturers do.

In section I, we set out the model and analyze how prices and market shares are affected by a change in V.A.T. In section III, we characterize the resulting profits and present in more details the case of a linear demand.

II - Taxes, market equilibrium and market shares

Assume that there are n firms (i = 1, ...n) producing an homogenous commodity. The aggregate demand for this commodity will be represented by the following (inverse) demand curve :

$$P \equiv P(Q)$$

in which P and Q will denote respectively the price and total quantity sold in the market. This demand curve is assumed to meet the following conditions :

$$P'(Q) < 0 \quad \forall\, Q \qquad (1)$$

$$P'(Q) + P''(Q)\, Q < 0 \quad \forall\, Q \qquad (2)$$

where ' (") denote first (second) order derivatives with respect to Q. These are mild restrictions that will be used later to derive existence of an equilibrium. Each firm is endowed with a quadratic cost function C_i, written :

$$C_i(q_i) = F + c_i\, q_i + \frac{b}{2}\, q_i^2 \qquad (3)$$

in which F is a fixed cost and q_i is the quantity produced (sold) by firm i (with $Q = \sum_{i=1}^{n} q_i$). We shall also assume that costs are always non decreasing, so that $-bq_i > c_i$, $\forall\, q_i$. What we have in mind is that firms operate with similar (constant) marginal cost of production[2] but incur different transportation costs. The cost function we use (see (3)) allows for increasing (b < 0) as well as decreasing returns (b > 0) to scale in transportation.

Let us assume that the government of one country imposes a tax on value added, at rate T. By definition, such tax does not have any incidence on costs (in the EEC, all taxes paid on inputs are fully rebatted to the firms). This levy is thus equivalent to a sales tax on final output. The price, net of tax, which is the average revenue[3] to the firms is then written :

$$\tilde{P} \equiv \frac{P}{(1+T)}$$

Each firm is assumed to select output (q_i) independently so as to maximise the following profit function :

$$\Pi_i = \tilde{P}(Q)\, q_i - C_i(q_i) \qquad (4)$$

We seek for a Nash equilibrium, i.e. a vector of outputs $(q_1^*, \ldots\ldots, q_n^*) \equiv \{q_i^*\}$, s.t.

$$\Pi_i(\{q_i^*\}) \geq \Pi_i(q_1^*, \ldots, q_{i-1}^*, q_i, \ldots, q_n^*) \qquad \forall\, q_i, \quad \forall\, i$$

Under the assumptions above (1)-(3), there will also be an equilibrium $\{q_i^*\}$, by theorem 3 of Novshek (1985). In order to perform meaningful comparative statics, one should also check that this equilibrium is unique. This is the object of proposition 1.

Proposition 1. Under the assumptions (1)-(3) above, the Cournot-Nash equilibrium is unique.

Proof : At any equilibrium point $\{q_i^*\}$, first and second order conditions for a maximum of (4) should be fulfilled, $\forall$ i. These conditions are written :

$$\tilde{P}(Q) + \tilde{P}'(Q)\, q_i - c_i - b\, q_i = 0 \qquad \forall i \qquad (5)$$

$$2\, \tilde{P}'(Q) - b + \tilde{P}''(Q)\, q_i < 0 \qquad \forall i \qquad (6)$$

Rewriting (5)-(6), using the change of variables

$$\tilde{c}_i \equiv c_i\ (1+T), \qquad \tilde{b}_i \equiv b_i\ (1+T),$$

one obtains :

$$P(Q) + P'(Q)\ q_i - \tilde{b}\ q_i = \tilde{c}_i \tag{5'}$$

$$2\ P'(Q) - \tilde{b} + P''(Q)\ q_i < 0 \tag{6'}$$

Summing (5′) across[4] firms yields :

$$n\ P(Q) + P'(Q)\ Q - \tilde{b}\ Q = n\bar{c}\ (1+T) \tag{7}$$

in which $\bar{c} \equiv \sum_{i=1}^{n} c_i/n$. The right hand side of (7) is a constant. Taking first order derivative of the left hand side with respect to Q, one obtains:

$$(n+1)\ P'(Q) + P''(Q)\ Q - \tilde{b} \tag{8}$$

This expression is unambiguously negative by (6). It follows that the LHS of (7) is monotonic decreasing in Q. Consequently, (the RHS of (7) being constant) there is a unique Q, and related P(Q), P′(Q), such that (7) holds. In turn, P(Q), P′(Q) are uniquely defined in (5′), which implies that $\{q_i^*\}$ is unique.

Even though equilibrium exists and is unique under the conditions stated above, one might also require the equilibrium to be stable (in the usual sense, see Dixit (1986)) in order to avoid perverse comparative statics. This might occur if there are strongly increasing returns to scale. In what follows, we shall thus exclude these perverse cases by assuming that the following conditions for stability are met :

$$\tilde{P}'(Q) - b < 0 \qquad (9)$$

and

$$\tilde{P}'(Q) + \tilde{P}''(Q) - \tilde{b} < 0 \qquad (9')$$

This last condition is slightly stronger than (3). It is however weaker than the concavity assumption on demand ($P''(Q) < 0$), which is fairly standard in the literature. Basically, we allow demand to be convex, but not 'too convex'.

Let us now investigate the incidence of an increase in the tax rate on the equilibrium total quantity and prices.

Proposition 2. Under the assumptions above, an increase in the tax rate will always lead to (i) a fall in the total quantity produced, (ii) a rise in the market price and (iii) a fall in the net price.

Proof : Totally differentiating the first order conditions (as given in (5)) and adding up (across firms) the resulting expressions, one obtains[5] :

$$(P'(Q) - \tilde{b})\, dQ + P''(Q)\, Q\, dQ + n\, P'(Q)\, dQ - [n\bar{c} + b\, Q]\, dT = 0 \qquad (10)$$

Consequently,

$$\frac{dQ}{dT} = \frac{n\bar{c} + b\, Q}{(n+1)P'(Q) - \tilde{b} + P''(Q)Q} \qquad (11)$$

The numerator of (11) is positive (by (3)). The denominator is negative (by (6)), so that (11) is negative. This completes the proof for part (i) of proposition 2. Part (ii) follows directly (with $P'(Q) < 0$).

Next, $\frac{d\tilde{P}}{dT}$ is written =

$$\frac{d\tilde{P}}{dT} = [\ P'(Q)\ \frac{dQ}{dT}\,(1+T) - P(Q)\ ]\ \ [1+T]^2$$

$$= \frac{P'(Q)\,[n\bar{c}(1+T) + \tilde{b}\,Q] - P(Q)\,[(n+1)P'(Q) + P(Q)\tilde{b} - P(Q)P''(Q)Q]}{(1+T)^2\quad [P'(Q)\,(n+1) - \tilde{b} + P''(Q)\,Q]}$$

$$= \frac{P'[-nP(Q) + n\bar{c}(1+T) + \tilde{b}Q] - P(Q)\,[P'(Q) + P''(Q)Q - \tilde{b}]}{(1+T)^2\quad [P'(Q)\,(n+1) - \tilde{b} + P''(Q)\,Q\ ]} \tag{12}$$

The denominator in (12) is negative by (6). The first and second term of the numerator are both positive by (7) and (9'), respectively. Consequently, (12) < 0, so that the net price falls as the rate of tax increases.

These results provide a first insight into the incidence of VAT, with respect to the market equilibrium ; as a result of taxation, consumers will be worse off, in the restricted sense that consumer surplus will fall (Q decreases). Total revenue in the industry will also be reduced (both Q and $\tilde{P}$ fall). The same effects would actually both obtain in monopoly and perfect competition (with $b = 0$) so that our results appear as an extension of these polar cases. The main focus of this paper is however the incidence of taxes on rivalry and profitability. We first look at the distribution of market shares, with $S_i \equiv q_i\ /\ Q$ denoting the market share of firm i.

Proposition 3. As the tax rate increases, the firms with cost below (above) average will increase (decrease) their market share. This is, $\forall$ i s.t. $c_i \gtrless \bar{c}$, $\frac{d S_i}{d T} \lessgtr 0$.

Proof : First (i) we derive explicitly the distribution of market shares in equilibrium, S_i $\forall$ i, and subsequently (ii) analyse how they change in response to a rise in tax ($\frac{dS_i}{dT}$ $\forall$ i).

(i) It is convenient to rewrite the first order conditions (5′), using $S_i \equiv q_i/Q$ and the elasticity $\eta \equiv (P'(Q)/P(Q))\, Q$. One obtains :

$$P(Q)\ [1 + \eta\ S_i] = n\bar{c}(1+T) + \tilde{b}\ q_i \qquad \forall\ i \qquad (13)$$

Summing the equations in (13) across firms, in order to derive P(Q) yields :

$$P(Q)\ [n + \eta] = n\bar{c}(1+T) + \tilde{b}\ Q$$

$$\text{or } P(Q) = \frac{n\bar{c}(1+T) + b\ \tilde{Q}}{(n + \eta)} \qquad (14)$$

Using (14) to substitute for P(Q), (13) is written :

$$\frac{[n\bar{c}(1+T) + \tilde{b}\ Q\ ]}{(n + \eta)}\ [1 + \eta\ S_i] = \tilde{c}_i + \tilde{b}\ q_i \qquad \forall\ i$$

which, after some manipulations, yields :

$$S_i = \frac{(c_i - \bar{c}) + (c_i\ \eta - b\ Q)/n}{\eta\ \bar{c} - b\ Q} \qquad \forall\ i \qquad (15)$$

From (15), it is apparent that low (high) cost firms will have relatively large (small) market shares in equilibrium.

(ii) Taking the derivative of (15) with respect to T, one obtains :

$$\frac{d\,S_i}{d\,T} = \frac{K}{[\eta\,\bar{c} - bQ]^2}$$

in which $K \equiv [(\frac{c_i}{n}\ \frac{d\eta}{dT} - \frac{b}{n}\ \frac{dQ}{dT})(\eta\bar{c} - bQ) - (c_i - \bar{c} + \frac{c_i}{n}\ \eta - \frac{bQ}{n})(\bar{c}\ \frac{d\eta}{dT} - b\frac{dQ}{dT})]$

and $\operatorname{sgn} \frac{dS_i}{dT} = \operatorname{sgn} K$.

Expanding terms, with $\frac{d\eta}{dT} = \frac{d\eta}{dQ}\ \frac{dQ}{dT}$, K is rewritten :

$$K = (c_i - \bar{c})\ \frac{(n + \eta)}{n}\ \frac{dQ}{dT}\ [b - \frac{d\eta}{dQ}\ \tilde{P}(Q)] \tag{16}$$

The second term in (16) is positive by the first order conditions (14). $\frac{dQ}{dT} <$ 0, by proposition 2. As for the last term, expanding $\frac{d\eta}{dQ}$, one obtains :

$$[b - \frac{d\eta}{dQ}\ \tilde{P}(Q)] = b - [P'(Q) + P''(Q)\ Q] + \frac{[P'(Q)]^2\ Q}{P(Q)}$$

which is unambiguously positive by the stability condition (9′). Hence, it follows that (since $\operatorname{sgn} \frac{dS_i}{dT} = \operatorname{sgn} k$), $\operatorname{sgn} \frac{dS_i}{dT} = - \operatorname{sgn} (c_i - \bar{c})$.

Consequently, $\frac{dS_i}{dT} \gtrless 0$ as $c_i \lessgtr \bar{c}$.

Hence, not only do low cost firms enjoy (relatively) large market shares, but the more so, the higher the tax rate. This is in contrast with the results put forward by Seade (1985) ; he shows that, with linear demand and costs, an excise tax might actually lead to an increase in the market share of high cost firms. This result is obtained because an excise tax will tend to reduce the relative cost differentials among firms (by adding a constant across the board). As a consequence, excise taxes can lead to a loss of productive efficiency. By contrast, a VAT, or equivalently, a proportional tax on inputs, enhances productive efficiency ; low cost firms will always increase their market share and the average production cost in the market will fall. Hence, it seems that VAT not only avoids distortions due to cascade taxation but also has the virtue of enhancing productive efficiency, as compared to excise taxes. This second property of VAT could also be exploited in differents contexts, involving competitors with different costs. This will typically occur, for example, in declining industries as argued by Ghemawat and Nalebuff (1986). These authors analyse different policy instruments that would increase productive efficiency in such industries. They show that subsidies targetted to the more efficient competitors will be effective in increasing productive efficiency. Our results suggest that VAT will have exactly the same effect.

Proposition 3 also gives support to the intuition by Geroski and Jacquemin (1985) that VAT differentials in the EEC act as a barrier to trade. Our results suggest that a country which imposes a relatively high VAT penalises foreign firms and favours local firms, with respect to sales. Ceteribus paribus, imports will be impeded in countries with high VAT. It is worth emphasising however that foreign firms are not directly discriminated against. This is the interplay between a constraint common to all firms (the tax) and the strategic interaction between firms that yields a relative disadvantage to foreign firms. As a corollary, it also follows that (relative) high rates of taxes act as an import barrier. However, it remains to see whether this policy is rational, i.e. whether high taxes effectively increase the profitability of local firms. At the outset, increasing profits should come as a surprise because it will require local firms to increase output (and not only market share) to compensate for the fall in the net price. This topic is tackled in the ensuing section.

III - Taxes and profitability

In what follows, we shall restrict the model somewhat by assuming that demand is concave ($P''(Q) < 0$, $\forall Q$) and that marginal cost is constant ($b = 0$). We obtain the following proposition.

Proposition 4. For any tax rate, number of firms and distribution of costs $(c_1,\ldots,c_n)$, s.t. $\tilde{P}(Q)\,(n+1) / 2n\bar{c} < 1$, there is a range of cost for which a firm operating with a cost in this range will increase profits following a rise in tax. This is, $\forall T$, $\forall n$, $\forall (c_1,\ldots,c_n)$, s.t. $\tilde{P}(Q)\,(n+1) / 2n\bar{c} < 1$, $\exists$ $\bar{\bar{c}}$, s.t. $\forall c_i \in [0, \bar{\bar{c}}[$, $\frac{d\Pi_i(c_i)}{dT} > 0$.

The proof of this proposition is relegated to the appendix. Let us however briefly characterise the circumstances in which profits of low cost firms will rise. As expressed in the conditions of proposition 4, the net price should be fairly close to the average cost (approximately twice as high). Profitability in the industry as a whole should thus be low and this will occur, e.g., with a high taxe rate and a large number of similar firms. Typically, a mass of firms with costs around the average will enable firms with cost significantly lower than average to increase profits. The intuition behind this result is that low cost firms will then increase output enough to compensate for the decrease in net price. In order to clarify these issues, we shall now develop the model explicitly for the case of a linear demand.

Proposition 5. Assume that demand is linear (with $P(Q) = A - B\,Q$). Any firm with cost below $\bar{\bar{c}} = (n\bar{c} - \tilde{A})/(n+1)$ will increase output and profits following a rise in tax. This is, $\forall\, T$, $\forall\, n$, $\forall\, (c_1,\dots,c_n)$, s.t. $n\bar{c} > \tilde{A}$, $\exists$

$\bar{\bar{c}} = (n\bar{c} - \tilde{A})/(n+1)$, s.t. $\forall\, c_i \in [0, \bar{\bar{c}}[$, $\dfrac{d\Pi_i(c_i)}{dT} > 0$.

Proof : Routine calculations yield individual outputs as well as the total quantity and the net price in equilibrium :

$$q_i = \frac{A + (n\bar{c} - (n+1)c_i)\,(1+T)}{B\,(n+1)}$$

$$Q = \frac{n\,(A - \bar{c}(1+T))}{B(n+1)}$$

$$\tilde{P} = \frac{\tilde{A} + n\bar{c}}{(n+1)}$$

So that equilibrium profits can be computed as :

$$\Pi_i = \frac{(1+T)}{B(n+1)^2}\,D^2 \equiv \frac{(1+T)}{B(n+1)^2}\left[\frac{A + n\bar{c}(1+T)}{(1+T)} - c_i(n+1)\right]^2$$

in which $D \geq 0$. Taking first order derivative of this expression with respect to T, one obtains ;

$$\frac{d\Pi_i}{dT} = \frac{D}{B(n+1)^2}\left[\frac{-A + n\bar{c}(1+T)}{(1+T)} - c_i(n+1)\right]$$

Developing D yields a quadratic form in c_i. Deriving the roots of this equation, we obtain that :

$$\frac{d\Pi_i}{dT} = 0 \text{ for } c_i = (n\bar{c} \pm \tilde{A}) / (n+1).$$

Next, it is easy to check that $\frac{d\Pi_i}{dT} > 0$ for $c_i < \bar{\bar{c}}$ and $c_i > (n\bar{c} + \tilde{A})/(n+1)$. However, any firm with cost in this second region will incur a loss since precisely $\tilde{P} = (n\bar{c} + \tilde{A})/(n+1)$. Hence, only the first region of cost, $c_i < \bar{\bar{c}}$ will yield positive equilibrium output and increasing profits with respect to the tax rate.

Intuition as to why profits of low cost firms might increase, can be gained by analysing the function $(d\Pi_i / dT)$ in some details (see figure 1). This function has a minimum for $c_i = n\bar{c} / (n+1)$ and crosses the horizontal axis for $c_i = (n\bar{c} \pm \tilde{A})/(n+1)$. Besides, it is easy to check that a firm will increase output iff its cost is below $(n\bar{c})/(n+1)$ and will increase market share iff its cost is below average (see proposition 3). The firms can then be sorted out into four categories. First, firms with cost below $\bar{\bar{c}}$ will increase output sufficiently to compensate for the drop in net price (see proposition 5). Their profit will increase. Second, the firms will larger cost, but such that $\bar{\bar{c}} < c_i < n\bar{c}/(n+1)$, will still increase output, not enough however to overcome the decrease in price. Their profit will fall. Third, the firms with cost such that $n\bar{c}/(n+1) < c_i < \bar{c}$ will increase market share, but not output. Of course, their profit falls. Finally, for the firms with cost above average, market share, and hence profit, will fall.

Next, it is also apparent from this analysis that the range of costs for which profit will increase, will be larger, the larger is $\bar{\bar{c}}$. In turn, $\bar{\bar{c}}$ increases with $\bar{c}$. More importantly, for a given average $\bar{c}$, the range $[0, \bar{\bar{c}}[$ will be relatively large, the closer is $n\bar{c}$ to $\tilde{A}$. This is to say that the net price should be fairly close to the average cost. As before (with general demand), low cost firms are likely to increase profits if there is a large number of firms with cost around the average.

IV - Conclusion

In this paper, we have analysed the incidence of VAT on rivalry and profits. This topic is closely related to the ongoing objective of setting uniform VAT rates across the EEC. We show that when VAT is raised, total output and the average revenue to the firms will fall. Hence, as expected, VAT will have a negative impact on allocative efficiency. However, low cost firms will also increase their market share, when VAT is raised, to the expense of high cost firms. This property is very appealing because productive efficiency will then be enhanced. Hence, VAT has a double virtue : first, as usually acknowledged, VAT avoids distortions due to cascade taxation. Second, VAT will improve productive efficiency, in contrast with excise taxation that might penalise efficieny (see Seade(1984)). This second property also suggests that VAT could be a welfare improving barrier to entry : von Weizsäcker (1980) shows that (with linear demand and quadratic cost) there will be insufficient barriers to entry because the zero profit equilibrium will involve too many Cournot players, producing each too small an output. Our results suggest that imposing a VAT will reduce the number of firms, increase production of efficient firms and drive inefficient firms out of business. Hence, at least with respect to the number of firms and productive efficiency, welfare will be improved. It remains to be seen in further research whether the subsequent welfare reducing fall in total output (which could be marginal for some distribution of costs) will compensate this positive effect.

Finally, our results also suggest an extension of the recent work by Salop and Scheffman (1983). These authors show that it will in the interest of an incumbent to raise the cost of a potential entrant. This will shift the reaction function of the potential rival in the event of entry, to the benefit of the incumbent. Our results extend this idea by showing that it might be in the incumbent's interest to impose a cost, or more generally a constraint, not merely to the entrant, but also to itself, or the industry as a whole. Provided there is a cost asymmetry to start with, or provided the constraint affects the incumbent and the entrant in different ways, imposing a common constraint will raise the profit of the incumbent and lower the profit of the potential rival in the event of entry.

FOOTNOTES

(1) - Allocation efficiency refers to the total amount of output. it usually entails pricing at marginal cost. Technical efficiency, by contrast, refers to the average production cost; it is maximized when a given output is produced at the minimum average cost.

(2) - The assumption of constant marginal cost of production enables us to focus on one country only. With non linear costs, firms strategies in the various markets (EEC countries) will be interdependent.

(3) - This formulation implies that firms quote the net price ($\tilde{P}$) and charge the tax when transaction takes place. It seems that this is the prevalent system in the EEC. Alternatively, the firms could quote the market price and pay the tax on that base (in such case $\tilde{P} = P(1-T)$). Both formulation do however yield identical results.

(4) - We assume implicitly that there is an interior solution to each firm's maximization problem. Allowing for corner solutions (at $q_i^* = 0$, for some i) would not affect the proof; in such case, (7) is obtained by summation across active firms. Permutations of active and non-active firms at different equilibrium points is then ruled out by the fact that equilibrium quantities are always strictly monotonic decreasing in c_i (see (5')).

(5) - Since we are looking at changes around the equilibrium, the values of all variable should have an a *. We shall however drop this superscript since there is no ambiguity.

Appendix

This appendix provides the proof of proposition 4 which goes along the following lines.

(i) First, we derive the equilibrium profits ∇_i. (ii) Second, we take the derivative of the profit functions with respect to the tax rate; i.e. $\frac{d\Pi_i}{dT}$, ∇i. (iii) Third, we analyse how $\frac{d\Pi_i}{dT}$ varies with c_i, holding $\bar{c}$ constant. We show that $\frac{d\Pi_i}{dT}(c_i)$ is monotonic decreasing for $c_i < \frac{\bar{c}\, n}{n+1}$ and monotonic increasing for $c_i > \bar{c}$. (iv) Finally, we show that $\frac{d\Pi_i}{dT}(c_i = 0) > 0$ provided $P(Q) \frac{n+1}{2n\bar{c}} < 1$. It follows that when this condition is met, by the continuity of $\frac{d\Pi_i}{dT}$, there is a finite range of cost below some $\bar{\bar{c}}$, s.t. $\nabla\, c_i \in [0, \bar{\bar{c}}_i[$, $\frac{d\Pi_i}{dT}(c_i) > 0$.

(i) From the first-order conditions (setting b = 0), individual market shares are written :

$$S_i = \frac{c_i - \tilde{P}(Q)}{\tilde{P}'(Q)Q}$$

Hence, any difference in market shares between say, firm i and k is expressed as :

$$S_k = S_i + \frac{c_k - c_i}{\tilde{P}'(Q)Q} \qquad \text{(A1)}$$

with $S_i(\bar{c}) = \frac{1}{n}$ (from (15)), (A1) can be transformed as

$$S_k = \frac{1}{n} + \frac{c_k - \bar{c}}{\tilde{P}'(Q)Q} .$$

The profit function (∇ i) can then be written :

$$\Pi_i = (\tilde{P}(Q) - c_i)\, S_iQ = (\tilde{P}(Q) - c_i)\, \frac{Q}{n} + \frac{P(Q)}{P'(Q)}\, (c_i - \bar{c}) - \frac{c_i(c_i-\bar{c})}{\tilde{P}'(Q)}, \quad \nabla i \qquad \text{(A2)}$$

(ii) taking the derivative of (A2), with respect to T, one obtains :

$$\frac{d\Pi_i}{dT} = \frac{dQ}{dT}\left[\frac{\tilde{P}(Q)-c_i}{n} + \tilde{P}'(Q)\,\frac{Q}{n} + c_i - \bar{c} \right]$$

$$- \frac{\tilde{P}(Q)\, Q}{(1+T)n} - \frac{(\tilde{P}(Q)-c_i)\, \tilde{P}''(Q)}{[\tilde{P}'(Q)]^2}\, (c_i-\bar{c})\, \frac{dQ}{dT} - \frac{(c_i-\bar{c})c_i}{P'(Q)} \qquad \text{(A3)}$$

(iii) We investigate the shape of (A3) with respect to c_i, holding $\bar{c}$ constant. We compute $\frac{d^2\Pi_i}{dT\, dc_i}$ from (A3):

$$\frac{d^2\Pi_i}{dT\, dc_i} = \frac{dQ}{dT}\left[\frac{n-1}{n} - \frac{(\tilde{P}(Q)-c_i)\tilde{P}''(Q)}{[\tilde{P}'(Q)]^2} + \frac{\tilde{P}''(Q)}{[P'(Q)]^2}\, (c_i-\bar{c}) \right] - \frac{2c_i-\bar{c}}{P'(Q)} \qquad \text{(A4)}$$

Replacing $\frac{dQ}{d\bar{T}}$ by its value, as given by (ii), we obtain :

$$\text{sgn } [A4] = \text{sgn } \left[\frac{[(n-1)[\tilde{P}'(Q)]^2 + \tilde{P}''(Q)\ n\ [2c_i - \bar{c} - \tilde{P}(Q)]}{[P'(Q)]^2\ [P'(Q)(n+1) + P''(Q)\ Q]} \right] - \frac{2(c_i - c)}{P'(Q)\bar{c}}]$$

which after some manipulation yields :

$$\text{sgn } \left[\frac{d^2\Pi_i}{d\bar{T}\, dc_i} \right] = \text{sgn } \{ - [\tilde{P}'(Q)]^2\ 2[n\bar{c} - c_i(n+1)]$$

$$- \tilde{P}''(Q)\ [- \tilde{P}(Q)Q(2c_i - \bar{c}) + n\bar{c}\ (2c_i - \bar{c}) - \bar{c}n\ \tilde{P}(Q)] \} \qquad \text{(A5)}$$

Adding and substracting $n\ [c_i - P'(Q)q_i]\ \bar{c}\ \tilde{P}''(Q)$ in (A5), and using (5), one obtains :

$$\text{sgn } \left[\frac{d^2\Pi_i}{d\bar{T}\, dc_i} \right] = \text{sgn } \{ - [\tilde{P}'(Q)]^2\ \ 2\ (n\bar{c} - c_i(n+1))$$

$$- \tilde{P}''(Q)\ (- \tilde{P}'(Q)\ Q\ [2c_i - \bar{c}\ (1+S_i n)] + \bar{c}n\ (c_i - \bar{c}))\} \qquad \text{(A6)}$$

Simply by inspection of (A6), it follows that :

- if $c_i > \bar{c}$, with $S_i < \frac{1}{n}$, (A6) > 0, so that $\frac{d\Pi_i}{d\bar{T}}$ is monotonic increasing in c_i, for this range.

- if $c_i < \frac{\bar{c}n}{n+1}$, with $S_i > \frac{1}{n}$, (A6) < 0 and $\frac{d\Pi_i}{d\bar{T}}$ is monotonic decreasing in c_i.

(iv) Finally, we compute $\frac{d\Pi_i}{dT}$ $(c_i = 0)$:

$$\frac{d\Pi_i}{dT}\,(c_i = 0) = \frac{dQ}{dT}\left[\frac{\tilde{P}(Q) + \tilde{P}'(Q)Q}{n} - \bar{c}\right] - \frac{\tilde{P}(Q)Q}{(1+T)n} + \tilde{P}(Q)\tilde{P}''(Q)\,\bar{c}\,\frac{dQ}{dT} \qquad [A7]$$

Developing $\frac{dQ}{dT}$, as given by (11), and rearranging terms in [A7], it follows that :

$$\operatorname{sgn}\frac{d\Pi_i}{dT}\,(c_i = 0) = -\operatorname{sgn}\left\{\frac{\bar{c}\,P(Q)P''(Q)\,(n-1)}{[P'(Q)]^2\,n} + \frac{P(Q)P(Q)P''(Q)}{n\,[P'(Q)]^2}\left[2 - \frac{\tilde{P}(Q)}{\bar{c}}\right] + \tilde{P}(Q)\left[\frac{\tilde{P}(Q)\,(n+1)}{n\,\bar{c}} - 2\right]\right\} \qquad [A8]$$

The expression within brackets in the RHS of [A8] will be unambiguously negative provided $\frac{\tilde{P}(Q)\,(n+1)}{n\,\bar{c}} < 2$. Consequently, if this condition is met, $\frac{d\Pi_i}{dT}\,(c_i = 0) > 0$ and proposition 5 follows.

References

Brandts, J., (1980), Taxation, oligopoly and inter-industry structure, mimeo

Dixit, A., (1986), Comparative statics for oligopoly, International Economic Review, 27(1), 107-122

The Economist, (1986), An uncommon market, August 16, 9-10

Geroski, P. and A. Jacquemin, (1985), Industrial change, barriers to mobility and European industrial policy, Economic Policy, 1, 170-218

Ghemawat, P. and B. Nalebuff, (1986), Excess capacity, efficieny and industrial policy, mimeo

Gual, J., (1986), A note on the impact of the value added tax on a differentiated duopoly, U.C. Berkeley, mimeo

Katz, M. and H. Rosen, (1983), Tax analysis in an oligopoly model, NBER Working Paper N° 1088

Novshek, W., (1985), On the existence of Cournot equilibrium, The Review of Economic Studies, 52, 85-98

Salop, S. and D. Scheffman, (1983), Rising rivals' costs, American Economic Review, Papers and Proceedings, 73(2), 267-271

Seade, J., (1985), Profitable cost increases and the shifting of taxation : equilibrium responses of markets in oligopoly, Warwick Economic Research paper N° 260 von Weizsäcker, C., (1980), A welfare analysis of barriers to entry, The Bell Journal of Economics, 11(2), 399-420

Willig, R., (1983), Sector differentiated capital taxation with imperfect competition and inter-industry flows, Journal of Public Economics, 21, 295-316

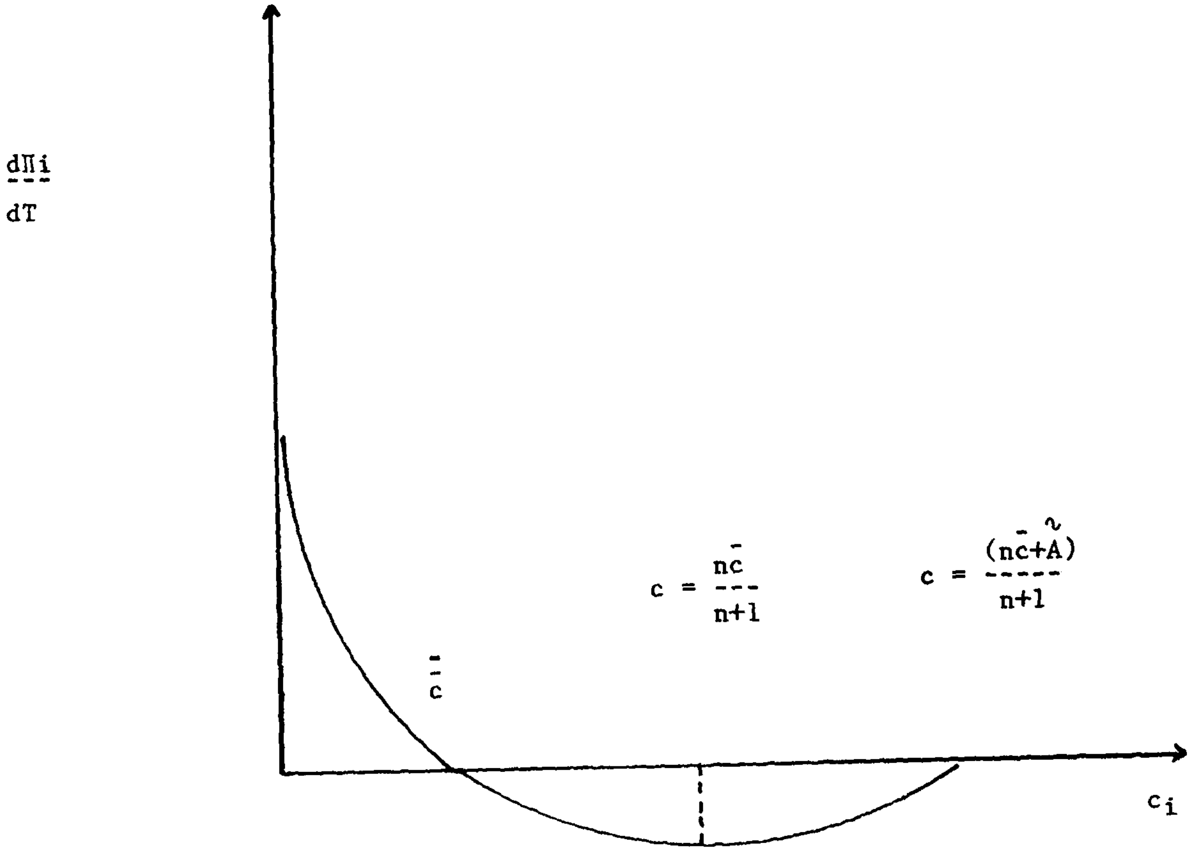

Figure 1

1984

84/01	Arnoud DE MEYER	"A technological life-cycle to the organisational factors determining gatekeeper activities" , November 1983.
84/02	Jeffrey SACHS and Charles A. WYPLOSZ	"La politique budgétaire et le taux de change réel", November 1983.
84/03	Jeffrey SACHS and Charles A. WYPLOSZ	"Real exchange rate effects of fiscal policy", December 1983.
84/04	Gabriel A. HAWAWINI	"European equity markets: a review of the evidence on price behavior and efficiency", February 1984.
84/05	Charles A. WYPLOSZ	"Capital controls and balance of payments crises", February 1984.
84/06	Gabriel A. HAWAWINI	"An uncertainty model of the professional partnership", November 1983.
84/07	Gabriel A. HAWAWINI	"The geometry of risk aversion", October 1983.
84/08	Gabriel A. HAWAWINI, Pierre MICHEL and Claude J. VIALLET	"Risk, Return and equilibrium of the NYSE: update, robustness of results and extensions" December 1983.
84/09	Gabriel A. HAWAWINI, Claude J. VIALLET and Ashok VORA	"Industry influence on firm's investment in working capital: theory and evidence", January 1984.
84/10	Gabriel A. HAWAWINI and Pierre A. MICHEL	"Impact of the Belgian Financial Reporting Act of 1976 on the systematic risk of common stocks", January 1984.
84/11	Jean DERMINE	"On the measurement of the market value of a bank", April 1984.
84/12	Antonio M. BORGES	"Tax reform in Portugal: a general equilibrium analysis of the introduction of a value added tax", December 1984.
84/13	Arnoud DE MEYER and Kasra FERDOWS	"Integration of information systems in manufacturing", December 1984.

1985

85/01	Jean DERMINE	"The measurement of interest rate risk by financial intermediaries", December 1983, Revised December 1984.
85/02	Philippe A. NAERT and Els GIJSBRECHTS	"Diffusion model for new product introduction in existing markets" .
85/03	Philippe A. NAERT and Els GIJSBRECHTS	"Towards a decision support system for hierarchically allocating marketing resources across and within product groups" .
85/04	Philippe A. NAERT and Marcel WEVERBERGH	"Market share specification, estimation and validation: towards reconciling seemingly divergent views" .
85/05	Ahmet AYKAC, Marcel CORSTJENS, David GAUTSCHI and Ira HOROWITZ	"Estimation uncertainty and optimal advertising decisions", Second draft, April 1985.
85/06	Kasra FERDOWS	"The shifting paradigms of manufacturing: inventory, quality and now versatility", March 1985.
85/07	Kasra FERDOWS, Jeffrey G. MILLER, Jinchiro NAKANE and Thomas E.VOLLMANN.	"Evolving manufacturing strategies in Europe, Japan and North-America"
85/08	Spyros MAKRIDAKIS and Robert CARBONE	"Forecasting when pattern changes occur beyond the historical data" , April 1985.
85/09	Spyros MAKRIDAKIS and Robert CARBONE	"Sampling distribution of post-sample forecasting errors" , February 1985.
85/10	Jean DERMINE	"Portfolio optimization by financial intermediaries in an asset pricing model".
85/11	Antonio M. BORGES and Alfredo M. PEREIRA	"Energy demand in Portuguese manufacturing: a two-stage model".
85/12	Arnoud DE MEYER	"Defining a manufacturing strategy - a survey of European manufacturers".
85/13	Arnoud DE MEYER	"Large European manufacturers and the management of R & D".
85/14	Ahmet AYKAC, Marcel CORSTJENS, David GAUTSCHI and Douglas L. MacLACHLAN	"The advertising-sales relationship in the U.S. cigarette industry: a comparison of correlational and causality testing approaches".
85/15	Arnoud DE MEYER and Roland VAN DIERDONCK	"Organizing a technology jump or overcoming the technological hurdle".
85/16	Herwig M. LANGOHR and Antony M. SANTOMERO	"Commercial bank refinancing and economic stability: an analysis of European features".
85/17	Manfred F.R. KETS DE VRIES and Danny MILLER	"Personality, culture and organization".
85/18	Manfred F.R. KETS DE VRIES	"The darker side of entrepreneurship".
85/19	Manfred F.R. KETS DE VRIES and Dany MILLER	"Narcissism and leadership: an object relations perspective".
85/20	Manfred F.R. KETS DE VRIES and Dany MILLER	"Interpreting organizational texts".

85/21	Herwig M. LANGOHR and Claude J. VIALLET	**"Nationalization, compensation and wealth transfers: France 1981-1982"** 1, Final version July 1985.
85/22	Herwig M. LANGOHR and B. Espen ECKBO	**"Takeover premiums, disclosure regulations, and the market for corporate control. A comparative analysis of public tender offers, controlling-block trades and minority buyout in France"**, July 1985.
85/23	Manfred F.R. KETS DE VRIES and Dany MILLER	**"Barriers to adaptation: personal, cultural and organizational perspectives"**.
85/24	Spyros MAKRIDAKIS	**"The art and science of forecasting: an assessment and future directions"**.
85/25	Gabriel HAWAWINI	**"Financial innovation and recent developments in the French capital markets"**, October 1985.
85/26	Karel O. COOL and Dan E. SCHENDEL	**"Patterns of competition, strategic group formation and the performance case of the US pharmaceutical industry, 1963-1982"**, October 1985.
85/27	Arnoud DE MEYER	**"European manufacturing: a comparative study (1985)"**.

1986

86/01	Arnoud DE MEYER	**"The R & D/Production interface"**.
86/02	Philippe A. NAERT Marcel WEVERBERGH and Guido VERSWIJVEL	**"Subjective estimation in integrating communication budget and allocation decisions: a case study"**, January 1986.
86/03	Michael BRIMM	**"Sponsorship and the diffusion of organizational innovation: a preliminary view"**.
86/04	Spyros MAKRIDAKIS and Michèle HIBON	**"Confidence intervals: an empirical investigation for the series in the M-Competition"** .
86/05	Charles A. WYPLOSZ	**"A note on the reduction of the workweek"**, July 1985.
86/06	Francesco GIAVAZZI, Jeff R. SHEEN and Charles A. WYPLOSZ	**"The real exchange rate and the fiscal aspects of a natural resource discovery"**, Revised version: February 1986.
86/07	Douglas L. MacLACHLAN and Spyros MAKRIDAKIS	**"Judgmental biases in sales forecasting"**, February 1986.
86/08	José de la TORRE and David H. NECKAR	**"Forecasting political risks for international operations"**, Second Draft: March 3, 1986.
86/09	Philippe C. HASPESLAGH	**"Conceptualizing the strategic process in diversified firms: the role and nature of the corporate influence process"**, February 1986.
86/10	R. MOENART, Arnoud DE MEYER, J. BARBE and D. DESCHOOLMEESTER.	**"Analysing the issues concerning technological de-maturity"**.
86/11	Philippe A. NAERT and Alain BULTEZ	**"From "Lydiametry" to "Pinkhamization": misspecifying advertising dynamics rarely affects profitability"**.
86/12	Roger BETANCOURT and David GAUTSCHI	**"The economics of retail firms"**, Revised April 1986.
86/13	S.P. ANDERSON and Damien J. NEVEN	**"Spatial competition à la Cournot"**.
86/14	Charles WALDMAN	**"Comparaison internationale des marges brutes du commerce"**, June 1985.
86/15	Mihkel TOMBAK and Arnoud DE MEYER	**"How the managerial attitudes of firms with FMS differ from other manufacturing firms: survey results"**, June 1986.
86/16	B. Espen ECKBO and Herwig M. LANGOHR	**"Les primes des offres publiques, la note d'information et le marché des transferts de contrôle des sociétés"**.
86/17	David B. JEMISON	**"Strategic capability transfer in acquisition integration"**, May 1986.
86/18	James TEBOUL and V. MALLERET	**"Towards an operational definition of services"**, 1986.
86/19	Rob R. WEITZ	**"Nostradamus: a knowledge-based forecasting advisor"**.
86/20	Albert CORHAY, Gabriel HAWAWINI and Pierre A. MICHEL	**"The pricing of equity on the London stock exchange: seasonality and size premium"**, June 1986.
86/21	Albert CORHAY, Gabriel A. HAWAWINI and Pierre A. MICHEL	**"Risk-premia seasonality in U.S. and European equity markets"**, February 1986.
86/22	Albert CORHAY, Gabriel A. HAWAWINI and Pierre A. MICHEL	**"Seasonality in the risk-return relationships some international evidence"**, July 1986.
86/23	Arnoud DE MEYER	**"An exploratory study on the integration of information systems in manufacturing"**, July 1986.
86/24	David GAUTSCHI and Vithala R. RAO	**"A methodology for specification and aggregation in product concept testing"**, July 1986.
86/25	H. Peter GRAY and Ingo WALTER	**"Protection"**, August 1986.
86/26	Barry EICHENGREEN and Charles WYPLOSZ	**"The economic consequences of the Franc Poincare"**, September 1986.

86/27	Karel COOL and Ingemar DIERICKX	"Negative risk-return relationships in business strategy: paradox or truism?", October 1986.
86/28	Manfred KETS DE VRIES and Danny MILLER	"Interpreting organizational texts.
86/29	Manfred KETS DE VRIES	"Why follow the leader?".
86/30	Manfred KETS DE VRIES	"The succession game: the real story.
86/31	Arnoud DE MEYER	"Flexibility: the next competitive battle".
86/32	Karel COOL and Dan SCHENDEL	Performance differences among strategic group members", October 1986.
86/33	Ernst BALTENSPERGER and Jean DERMINE	"The role of public policy in insuring financial stability: a cross-country, comparative perspective", August 1986, Revised November 1986.
86/34	Philippe HASPESLAGH and David JEMISON	"Acquisitions: myths and reality", July 1986.
86/35	Jean DERMINE	"Measuring the market value of a bank, a primer", November 1986.
86/36	Albert CORHAY and Gabriel HAWAWINI	"Seasonality in the risk-return relationship: some international evidence", Revised version: November 1986.
86/37	David GAUTSCHI and Roger BETANCOURT	"The evolution of retailing: a suggested economic interpretation".
86/38	Gabriel HAWAWINI	"Financial innovation and recent developments in the French capital markets", Revised version: November 1986.
86/39	Gabriel HAWAWINI Pierre MICHEL and Alber CORHAY	"The pricing of common stocks on the Brussels stock exchange: a re-examination of the evidence", December 1986.
86/40	Charles WYPLOSZ	"Capital flows liberalization and the EMS, a French perspective", December 1986.
86/41	Kasra FERDOWS and Wickham SKINNER	"Manufacturing in a new perspective", July 1986.
86/42	Kasra FERDOWS and Per LINDBERG	"FMS as indicator of manufacturing strategy", December 1986.
86/43	Damien NEVEN	"On the existence of equilibrium in hotelling's model", November 1986.

EURO-ASIA CENTRE

CAMPUS INSEAD

Boulevard de Constance
77309 Fontainebleau Cedex, France
Telephone (1) 60 72 40 40
Telecopy (1) 60 72 40 49
Telex 690389

EAC RESEARCH PAPERS

EAC RESEARCH PAPERS

(Academic papers based on the research of EAC Faculty and research staff)

1. LASSERRE Philippe (Research Paper n° 1)
   A contribution to the study of entrepreneurship development in Indonesia. 1980.

2. BOISOT Max and LASSERRE Philippe (Research Paper n° 2)
   The transfer of technology from European to ASEAN entreprises: strategies and practices in the chemical and pharmaceutical sectors. 1980.

3. AMAKO Tetsuo (Research Paper n° 3)
   Possibilité d'un transfert à l'étranger des techniques japonaises de gestion du personnel: le cas français. 1982.

4. SCHUTTE Hellmut (Research Paper n° 8)
   Wirtschaftliche Kooperation zwischen den ASEAN - Ländern und Nordrhein-Westfalen - Hemmungsfaktoren und Chancen für die deutsche Wirtschaft. 1983.

5. ISHIYAMA Yoshihide (Research Paper n° 14)
   The political economy of liberalisation of the financial system in Japan. 1984.

6. LASSERRE Philippe (Research Paper n° 17)
   Singapour comme centre régional. L'expérience d'entreprises françaises. 1985.

7. Von KIRCHBACH Friedrich (Research Paper n° 18)
   Patterns of export channels to developing Asia. 1984.

8. MITTER Rajan (Research Paper n° 19)
   A survey of European business in India. 1984.

9. CHAPON Marie-Claude (Research Paper n° 22)
   Stratégies des entreprises japonaises en Afrique. 1985.