ADJUSTMENT COSTS, CONCENTRATION AND PRICE BEHAVIOUR*

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The effect of concentration on price stickiness is studied, by assuming quadratic and more general forms of adjustment costs. We analyze and characterize the two contradictory conclusions which emerge from empirical studies.

THE ASSUMPTION that there exists a relation between the degree of concentration in an industry and the speed at which prices adjust to production costs has been the topic of a large number of (mainly empirical) papers. The various (contradictory) results can be summarized as follows:

(a) The more concentrated the industry, the more rapidly will cost variations be transmitted into prices. The rationale for this, as argued by Stigler [1964] is that secret cutting of prices is easier to detect by others when there are few firms, and will thus be avoided; for the same reason, in concentrated industries, firms will avoid lagging prices behind costs. Empirical evidence of this link between price sluggishness and concentration is given by Domberger [1981], [1983].

(b) The more concentrated the industry, the less rapidly will cost variations be transmitted into prices. Reasons for this behaviour have been given (i) by Sweezy [1939]—an oligopolist expects his competitors to react differently to a decrease and to an increase of his price; while a decrease will be followed, an increase will not; this leads to a discontinuity in the marginal revenue curve and variations in the cost curve will not be passed onto prices; (ii) by Eichner [1973]—concentrated industries are often associated with increasing returns to scale and hence large irreversible investments, which induce firms to peg their prices on long run objectives rather than follow short run cost fluctuations; (iii) by Philips [1980], [1983]—intertemporal price discrimination leads to markup pricing, but the markup is smaller in concentrated industries than in others; and (iv) by Ross and Wachter [1975]—in oligopolistic industries, prices do not react to costs continuously, but in discrete steps. Empirical evidence can be found e.g. in Philips [1973], Dixon [1983], Encaoua [1983], Encaoua and Geroski [1984].

In this paper, we consider an oligopolistic industry in which firms bear

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* We are largely indebted to S. Domberger who has pointed out to us the particularity of the assumption of quadratic adjustment costs. The first author acknowledges support from the Centre National de la Recherche Scientifique, Paris and Action de Recherches Concertées of the Belgian Government under contract 84-89/65.
adjustment costs on output changes.\footnote{This leads to the same conclusion as the usual assumption of adjustment costs on prices, but seems a more reasonable formulation, since it can be interpreted in terms of capacity adjustment costs.} We first study the simple case of quadratic adjustment costs which leads to conclusion (b) that concentration decreases the speed of adjustment of prices. We next consider more general forms of adjustment costs and show that, under reasonable assumptions, both empirical observations (a) and (b) can be sustained.

A simple linear quadratic model

There are \(n\) firms in the industry and, at time \(t\), each firm chooses its output \(q_i\) in order to maximize\footnote{To keep things simple, we maximize the static profit function. Intertemporal optimization of profits leads to the same conclusions. See Ginsburgh, Michel and Moes (1987).} its profit \(\pi_i\), with

\[
\pi_i = q_i p_i(q_i) - \gamma_i q_i - c_i(q_i, q_{i,t-1})
\]

In this expression, \(p_i(q_i)\) is the industry demand curve with

\[
q_i = \sum_i q_{in}
\]

\(\gamma_i\) is the marginal production cost and \(c_i(q_i, q_{i,t-1})\) is a cost which originates from changes in the output level.

Let us approximate the industry demand curve by:

\[
p_i(q_i) = \alpha - \beta q_i; \quad \beta > 0
\]

and assume that adjustment costs are quadratic and identical for all firms:

\[
c_i(q_i, q_{i,t-1}) = \frac{c}{2}(q_i - q_{i,t-1})^2
\]

In the Cournot approach, each firm \(i\) is a quantity setter; the first order condition leads to

\[
\frac{\partial \pi_i}{\partial q_i} = \alpha - \beta q_i - 2\beta q_i - \gamma_i - c(q_i - q_{i,t-1}) = 0
\]

Aggregating over firms and solving for \(q_i\) leads to

\[
q_i = \lambda q_{i-1} + \mu \left(\alpha - \frac{\sum \gamma_i}{n}\right)
\]

where \(\lambda = c/(n+2)\beta + c\) and \(\mu = n/(n+2)\beta + c\).

Alternatively, in terms of the industry price level, we have:

\[
p_i = \lambda p_{i-1} + \xi(2\alpha + \sum \gamma_i)
\]

where \(\xi = \beta/(n+2)\beta + c\).
In (1), costs are transmitted into prices ($\xi > 0$) but there is a lag as long as $\lambda > 0$. Clearly, a positive adjustment cost $c$ implies $0 < \lambda < 1$ for finite $n$. Notice also that $\delta \lambda / \delta n < 0$ which shows that adjustment of prices to costs will be faster the larger the number of firms in the industry. If the industry is competitive, even in the presence of output adjustment costs, $\lambda$ tends to 0 when $n$ becomes large and prices will instantaneously react to the average marginal cost (the limit of $\xi \sum \gamma_i$ tends to $\gamma = \sum \gamma_i / n$).

Another assumption on adjustment costs

Quadratic costs are largely responsible for the previous conclusion. To see this, we consider a cost function $c(q_i, q_{i-1})$ which is convex and homogeneous of degree $\theta$.

In order to aggregate over firms the first order conditions, we assume that firms are identical, so that $q_i = q_i / n$ and $\gamma_i = \gamma$. Then,

$$\alpha - \beta q_i - 2\beta \frac{q_i}{n} - \gamma - c_1\left(\frac{q_i}{n}, \frac{q_{i-1}}{n}\right) = 0$$

where $c_1$ is the derivative of $c(\ldots)$ with respect to the first argument. Since $c$ is homogeneous of degree $\theta$, $c_1$ is homogeneous of degree $\theta - 1$, and

$$c_1\left(\frac{q_i}{n}, \frac{q_{i-1}}{n}\right) = n^{1-\theta} c_1(q_i, q_{i-1})$$

Substituting $(\alpha - p_i) / \beta$ for $q_i$, we get

$$F(p_i, p_{i-1}) = \frac{2\alpha}{n} + \frac{n+2}{n} p_i - \gamma - c_1\left(\frac{\alpha - p_i}{\beta}, \frac{\alpha - p_{i-1}}{\beta}\right) = 0$$

Hence,

$$\lambda = \frac{dp_i}{dp_{i-1}} = -\frac{\partial F}{\partial p_{i-1}}$$

will give us an expression for inertia:

$$\lambda = \frac{-c_{12}}{\beta(n+2)n^{\theta-2} + c_{11}}$$

where $c_{11}$ and $c_{12}$ are the partial derivatives of $c_1$. Convexity of $c$ and the assumption that $c_{12} < 0$ ensure $\lambda > 0$.

The marginal effect

$$\frac{d\lambda}{dn} = \frac{-\beta c_{12}}{[\beta(n+2)n^{\theta-2} + c_{11}]^2} [(1 - \theta)n^{\theta-2} + 2(2 - \theta)n^{\theta-3}]$$

may be positive or negative. It is always positive if $\theta < 1$, i.e. if there are economies of scale in adjustment costs. It is always negative if $\theta > 2$, i.e. in the case of large diseconomies of scale. For $1 < \theta < 2$, 

\[
\frac{d\lambda}{dn} \leq 0 \iff n \leq \frac{2(2-\theta)}{\theta-1}
\]

When the number of firms goes to infinity, three cases have to be distinguished:

1. Economies of scale in adjustment costs \((\theta \leq 1)\) imply

\[
\lim_{n \to \infty} \lambda = -\frac{c_{11}}{c_{11}} > 0 \quad \text{and} \quad \frac{d\lambda}{dn} > 0
\]

so that even under perfect competition, prices do not adjust instantaneously to costs and there is a negative effect of concentration on price inertia.

2. Large diseconomies of scale in adjustment costs \((\theta \geq 2)\) imply

\[
\lim_{n \to \infty} \lambda = 0 \quad \text{and} \quad \frac{d\lambda}{dn} < 0
\]

There is no price stickiness if markets are perfect, and a positive effect of concentration on price inertia.

3. Small diseconomies of scale \((1 < \theta < 2)\) lead to

\[
\lim_{n \to \infty} \lambda = 0
\]

while the effect of concentration on inertia changes with the number of firms \(n\); the effect is negative for small \(n\) and positive for large \(n\).

Very little, if anything, is known about the costs which firms bear when they adjust their output. The assumption of quadratic costs is probably the most common. It leads, as we have seen, to rather specific results. However, for functions close to the quadratic (i.e. \(\theta\) close to 2) it is interesting to note that the conclusions are not only theoretically satisfactory (since prices will instantaneously adjust to costs in a competitive environment) but, also, that they are consistent with apparently contradictory empirical findings. They show that the effects depend on the number of firms in an industry, suggesting the possibility of a test using cross country industry data.

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REFERENCES


ENCAOUA, D. and GEROSKI, P., 1984, 'Price Dynamics and Competition in Five OECD Countries', Université de Paris I.

GINSBURGH, V., MICHEL, Ph. and MOES, Ph., 1987, 'Quantity Dynamics vs. Price Dynamics', manuscript.


