A Practical Way of Assessing Firms' X-Efficiency and Ability to Compete in Mature Good Industries:
The Case of Textiles and Apparel*

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I. Introduction

In both industrial and developing countries, the textile and apparel industries contribute significantly to both overall employment and exports earnings (some $60 billion in 1980). These closely related activities, referred to hereafter as simply "textiles," used to be perceived as a relatively stable industry because it was dominated by some three dozens multinational firms, located in five industrial countries (U.S.A., U.K., W. Germany, France and Japan), whose market shares were largely determined by historical precedents and colonial ties. Since the mid-1960s, however, technical innovations and the speed at which they are still being diffused, coupled with other rationalization efforts in the newly industrialized countries (NICs) have sent shock waves through the thus far considered quiet 'fief' of the multinationals. But more importantly, these changes have given rise to a series of misconceptions and policy measures in industrial countries (ICs) that have had and still are having dear consequences for both employment and industrial organization.

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cerned mostly with offsetting competitive advantages arising out of differences in relative prices, and in productive system's efficiency.

For the sake of operationality, however, a few simplifying assumptions should be first discussed. Since we will be dealing with multi-product firms, the concept of 'composite' output is appropriate so as to avoid the usual difficulties of establishing industry boundaries. Also, less emphasis will be put on how static equilibria are reached through maximizing 'first principles.' As a matter of fact, it will simply be assumed that output prices are determined by fixed producers' markups; such a specification fits the data well and it is easier to manipulate. In short, the simplification attempt will center around the averaging process which, as usual, involves a trade-off between microscopic information and tractability.

A. Firms' Production and Costs Problems

In order to capture intrafirm differences and restrict the analysis to price competition, let us suppose that member firms in a K-firm 'group' ($k = 1, 2, \ldots, k$) have slightly different factor productivities, stemming from possible differences in technology, managerial expertise, input quality, environmental conditions, etc. Suppose also that each firm k produces the same set of $j (= 1, 2, \ldots, j)$ mature products, each related on the input side. Then, it can be said that the k^{th} firm uses a column vector of fixed endowment $\hat{R}_k$ to produce an output vector $\hat{X}_k$ from a linear process described by the coefficient matrix $\hat{A}_k = (a_{ij}^k)$, $i = 1, 2, \ldots I$. In other words, the k^{th} firm solves the production problem:

$$(1) \quad \underset{\hat{X}_k}{\text{Max}}\ F_k(\hat{X}_k) = \left\{ \hat{\lambda}_k \hat{X}_k : \hat{A}_k \hat{X}_k \leqslant \hat{R}_k, \hat{X}_k \geqslant \hat{0} \right\},$$

where

$$\hat{X}_k = (X_{k1}, X_{k2}, \ldots, X_{kj})^T$$

$$\hat{\lambda}_k = (\lambda_{k1}, \lambda_{k2}, \ldots, \lambda_{kj})$$

where τ is a fixed markup over direct costs, $\hat{P}_k$ is a row vector of factor rewards. Therefore, at the end of the production period, firm k produces $\overline{X}_k^o$ costs C_k^o.

Similarly, firm $\nu \neq k(\nu = 1, 2, \ldots, k)$ produces a feasible output vector $\hat{X}_\nu^o$, weighted by $\hat{\lambda}_\nu$ to yield $\overline{X}_\nu^o$, at costs C_ν^o, while $\hat{V}_\nu$ is used for internal adjustments if necessary.

Differences in output brought about by overall differences in firms' *system efficiency*, and differences in *cost-effectiveness* mainly due to differences in factor rewards are captured in the ratio:

$$(4) \qquad \beta_{k\nu} = \frac{\overline{X}^o_k}{X^o_\nu} \; \frac{C^o_\nu}{C^o_k} = X \cdot \delta$$

Equation 4 stresses the intrafirm production-cost asymmetry widely observed in actual markets. In other words, it emphasizes that the k^{th} firm, say, may well have a more efficient productive system $(\overline{X}_k^o \ \overline{X}_\nu^o)$, which could nonetheless be more than neutralized by a cost disadvantage $(C_k^o > C_\nu^o)$ because, say, $\hat{P}_k \gg \hat{P}_\nu$. As an objective definition of the 'best available technology' is hard to pinpoint, (4) is a simple heuristic that allows us to say that firm k outranks firm ν on X-efficiency grounds if $\beta_{k\nu} > 1$. Hereafter $\beta_{k\nu}$ will be referred as an *intrafirm efficiency index*.

B. Industry-Wide Ranking

The index $\beta_{k\nu}$ is very helpful in assessing the combined efficiencies of two firms.[2] Though a measure on interval scale, it is nonetheless invariant over any linear transformation. Hence, it can be used in ordinary mathematical operations to gauge firms' standing industry-wide. For this purpose, form the square matrix $\hat{\beta} = [\, u_{k\nu} \,]$ after computing the relative efficiency of, say, firm k vis-à-vis every one of its competitors according to (4). Realizing that $u_{k\nu}$ is the unit cost of ν over that of k, the matrix is formed with the simple rule that each element is the ratio of the column value over the row value (u_ν / u_k).

2 For an application of this index to local industries and to trade policy formulation, see Dominique and Oral (1986), and Oral and Ozkan.

i.e. $\hat{s}_v(s_1, s_2, \ldots, s_v)^T$, $\hat{u}_{kv} = (u_{k1}, u_{k2}, \ldots, u_{kv})$, and $\bar{u}$ is the industry unit costs. E_k is, therefore, an index of the k^{th} firm's ability to compete in terms of price.[3]

Following Hicks (1946), Samuelson (1947) and in particular Kalecki (1971), it is perfectly legitimate to assume a cluster of output prices P_{xv}'s, formed by marking up unit costs by θ. Hence, there exists a $\bar{P}$ given by:

$$(8) \quad \bar{P}_x = (1+\bar{\theta})\bar{u} = (1+\bar{\theta})\; E_k u_k ; \forall k,$$

where $\bar{\theta}$ is the average industry mark-up.

Since E_k, u_k and $\Sigma\, \bar{X}_v^o$ can be directly observed, one is tempted at this point to write out the system in full as

$$(9) \quad \begin{bmatrix} u_{11} & u_{12} & u_{13} & \ldots & u_{1v} \\ u_{21} & u_{22} & u_{23} & \ldots & u_{2v} \\ \cdot & & & & \\ \cdot & & & & \\ \cdot & & & & \\ u_{k1} & u_{k2} & u_{k3} & \ldots & u_{kv} \end{bmatrix} \begin{bmatrix} S_1 \\ S_2 \\ \cdot \\ \cdot \\ \cdot \\ s_v \end{bmatrix} = \begin{bmatrix} E_1 u_1 \\ E_2 u_2 \\ \\ \\ \\ E_k u_k \end{bmatrix}$$

It so happens that (9) has many solutions due to the singularity of the $\hat{\beta}$ matrix. Hence market shares are none other than a system of weights, exogenous to the productive structure in the short-run[4].

[3] Although a relative measure, E_k is also a control parameter. It takes on the value of unity for the two extreme cases of monopoly and for perfect competition if firms' technological heterogeneity is assumed away. In all other cases, its value is inversely proportional to a firm's X-inefficiency.

[4] This result seems to have implications for the two conflicting paradigms of industrial organization, i.e. the traditional structure-conduct-performance flow of causality which is supposed to lead to collusion and monopoly rents, and the alternative efficient-structure proposition (Demsetz; Carter) which sees such rents as rewards to 'superior ability.' Casual empiricism seems to support both views (e.g., Clarke, Davies and Waterson), hence the debate lingers on. Equation (9) above is saying that a market share distribution which reflects productive superiority alone in the short run is a coincidence or is a long run outcome if large inefficient firms remain passive to the end. Or else, 'superior ability' must mean superiority in *producing* and in *marketing*, something which is not clear in the original Demsetz's paper.

$$w_{ki} = \frac{P_{ki}\, q_{ki}}{\Sigma P_{ki}\, q_{ki}} \; ; \forall i .$$

Then the rate of change in the intra-firm efficiency index ($\beta_{k\nu}$), given in (4), over a small time interval Δt is:

$$(12) \quad \dot{\beta}_k = \frac{d}{dt} \ln [X(t)\, \delta(t)] = \frac{d}{dt} \ln [u_{k\nu}(t)] ;$$

Therefore,

$$(13) \quad \dot{\beta}_{k\nu}(t) = \frac{dP_k^*}{P_k^*} - \frac{dP_\nu^*}{P_\nu^*} +$$

$$\left(\sum_i w_{\nu i} \frac{dP_{\nu i}}{P_{\nu i}} - \sum_i w_{ki} \frac{dP_{ki}}{P_{ki}} \right)$$

where P* is the total factor productivity growth. Otherwise put, the change in relative efficiency for any two firms k and ν depends on their differences in total factor productivity growth and in their shared-weighted rates of change in input prices. In the end then, this result shows that the production-cost symmetry assumption of the conventional theory of the firm can easily be relaxed for increased realism; and in the next section this scheme is utilized to grapple with the apparent turmoil in the international textiles industry.

III. The Data

The data utilized in this study refer to the year 1977 and are derived from two sources. Statistics on the 100 world largest textiles firms compiled by Textile-Wirtschaft and used in the UNCTAD's study (CNUCED), and relative unit costs data provided by two firms in the sample, which for obvious reasons prefer to remain anonymous.

The gradient vector ($\hat{\lambda}_k$) for the linear programming problem

Table 1

X-EFFICIENCY AND FIRMS' ABILITY TO COMPETE: 1977

k \ ν		*$\hat{\beta}$ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	*Δ_k	R_k	$\hat{\beta}_k$ in %	*E_k
U.S.A.	1	1.00	1.07	1.04	1.17	1.05	1.02	.77	1.05	.97	1.35	1.08	1.31	1.19	1.04	.079	3	39.0	1.03
U.K.	2	.93	1.00	.97	1.09	.99	.95	.73	.99	.91	1.26	1.02	1.23	1.12	.97	.011	8	17.9	.96
Japan	3	.96	1.03	1.00	1.13	1.02	.97	.75	1.02	.93	1.30	1.05	1.26	1.14	1.00	.040	5	17.8	.99
W. Germany	4	.85	.91	.88	1.00	.90	.86	.66	.90	.82	1.15	.92	1.12	1.02	.88	-.080	10	6.8	.88
France	5	.95	1.01	.98	1.11	1.00	.97	.74	1.00	.92	1.28	1.03	1.25	1.13	.98	.025	6	8.2	.98
Italy	6	.98	1.05	1.02	1.15	1.03	1.00	.76	1.04	.95	1.13	1.07	1.28	1.17	1.02	.046	4	1.1	1.01
S. Korea	7	1.29	1.37	1.33	1.51	1.35	1.31	1.00	1.35	1.24	1.73	1.40	1.69	1.53	1.33	.380	1	3.5	1.33
Argentina	8	.95	1.01	.98	1.11	1.00	.96	.74	1.00	.92	1.28	1.03	1.24	1.13	.98	.023	7	.8	.98
Hong Kong	9	1.03	1.10	1.07	1.21	1.09	1.05	.80	1.08	1.00	1.39	1.12	1.35	1.23	1.07	.110	2	.9	1.06
Holland	10	.74	.79	.77	.87	.78	.88	.58	.78	.72	1.00	.81	.97	.88	.77	-.190	13	1.1	.76
Canada	11	.92	.98	.95	1.08	.97	.93	.71	.97	.89	1.23	1.00	1.21	1.09	.95	-.008	9	1.2	.95
Belgium	12	.76	.81	.79	.89	.80	.78	.59	.81	.74	1.03	.82	1.00	.90	.79	-.170	12	.5	.78
Sweden	13	.84	.89	.87	.98	.88	.85	.65	.88	.81	1.13	.91	1.11	1.00	.87	-.090	11	.9	.86
Switzerland	14	.96	1.03	1.00	1.13	1.02	.98	.75	1.02	.93	1.30	1.05	1.26	1.14	1.00	.040	5	.3	.99

* rounded off figures.

growth rates for the six countries with the highest and three with the lowest ranks was made for 1980 (Table 2); and it supports the general trend predicted by the scheme. It is also interesting to note that during that period output fell in the OECD countries with low rankings and imports increased[6]. When this is considered in conjunction with Table 2, it would seem that some internal reallocation of resources was taking place in these countries.

Table 2

COMPETITORS' ANNUAL GROWTH RATE OF EXPORTS FROM 1977 TO 1980: BY CATEGORY (IN %)

Competitor \ Category SITC	651	652	653	841
Korea	49.7	18.9	86.2	12.5
Hong-Kong	36.1	25.4	62.7	21.7
U.S.A.	27.2	9.6	47.6	36.2
Italy	22.9	16.7	24.9	26.5
Switzerland	18.6	22.7	10.9	23.8
France	13.2	18.6	20.8	18.2
Sweden	18.3	—	—	15.4
Belgium*	9.5	19.6	13.1	11.1
Holland	9.5	13.6	8.8	20.7

*including Luxemburg
Source: United Nations, *Statistical Yearbook, 1981,* United Nations, N.Y. 1983.

As a consequence of the situation depicted in Table 1, one would normally expect a series of defensive moves in OECD countries to protect market shares. In that sense, most of the mergers

6 The efficient Asian NICs were also increasing their distance vis-à-vis other developing countries. In 1977, three Asian Countries, Taiwan, Korea and Hong Kong accounted for 43.9% of the total developing countries exports of apparel to OECD markets; in 1980, the percentage had climbed to 65.9% (Keesing).

Our results have a deeper implication for world trade in general. Because, the NICs have tooled their economies for exports to OECD countries, pretty much the way they were encouraged to do in the early 1960s. Protectionist measures such as the Multifiber Agreement of 1974 can either frustrate their export growth rates or else encourage rerouting or false labelling in the intermediate run. And since the case of textiles can easily be extended to most labor intensive goods, measures similar to the Mulifiber Agreement could, in the long run, thwart not only their development process but the growth of world trade as well.

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