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DOMESTIC INDUSTRIAL STRUCTURE AND EXPORT QUALITY*

BY SHIH-CHEN CHIANG AND ROBERT T. MASSON[1]

1. INTRODUCTION

We show in this paper how information imperfections may cause consumers to practice "statistical discrimination" against imports from developing countries.[2] Products from such countries often lack internationally well-established brand names. Consumers often associate the quality of such goods with their country of origin. If consumers are, on average, correct about their perceptions of the quality of products from a country then a "Lemons[3]" effect emerges. A firm which pays the full cost for quality improvement will receive only diluted benefits in return, while all competitors gain by free-riding. This creates adverse selection, as product quality is endogenously determined. The resulting international trade equilibrium is suboptimal for the developing country. However, the country may be able to raise its welfare by using export quality standards or by internalizing the externality by pursuing a policy of industrial consolidation or by limiting export licenses to only a few firms.

Trade in differentiated products has recently been examined by Jaskold Gabszewicz et al. (1981) and Shaked and Sutton (1982, 1983, 1984). They too examine quality or "vertical differentiation." A good is said to have higher quality if *all* buyers prefer it to another good of the same general type, prices being equal. This is distinct from "horizontal differentiation" where buyers differ as to their most preferred choice, when all goods in question are offered at the same price (Shaked and Sutton 1983). In this vertical differentiation literature, increasing returns play an important role and each specific quality is produced by, at most, one firm. We model a situation in which (1) at the equilibrium output, no firm enjoys scale economies, (2) no firm ever has any market power, and (3) no firm makes any effort to differentiate its products from those of other firms with the same quality. In short, firms operate like those in Rosen (1974). Ours is a model of vertical product differentiation under what would be, but for the imperfect quality information, perfect competition. Our choice of a Rosenesque model arose from observing Taiwan where many small exporters coexist producing like goods with no perceptible difference in quality from each other.[4]

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[2] The "theory of statistical discrimination" of Arrow (1973) and Phelps (1972) was applied to show that grouping of potential employees by race, sex or creed, may discourage a disadvantaged group's investments in human capital and perpetuate the practice of discrimination in a vicious circle. We present a quality investment analogue.

[3] See Akerlof (1970).

[4] For example, Taiwan has about 1,000 highly competitive cotton spinning and weaving firms. In

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The model we use here is designed to capture one aspect of the development problem faced by Newly Industrialized Countries (NICs). We suppose our NIC to be a "small country," with firms operating using constant returns-to-scale production functions. We exploit two attributes of a "small" NIC. First, our country's output, when added to world output (of any quality), will not affect world prices. Second, the initial equilibrium is not one with factor-price-equalization: the NICs pay lower wage rates. If profits can be made at a higher quality level, it is because the NIC has lower labor costs than its competitors at that quality level. As the small NIC expands production of profitable products, wages will be bid up towards world levels, so, in the "long run," the firms earn zero profits and the exporting country's social welfare is enhanced through the wage effect. In the context of our model, if quality can be made to rise then wages will be bid up, raising welfare. We note how consolidation of exporters or a policy establishing minimum export quality can lead to this welfare gain.

A brief glance at Taiwan is used for motivation in Section 2. The model and results are presented in Section 3. In Section 4, we consider our study in the context of current international trade theory and policy.

2. SOME EMPIRICAL FACTS

Our study is especially relevant to the NICs. Although they have been successfully expanding,[5] their output and exports continue to concentrate almost exclusively on low quality/low price items, despite the technology to efficiently produce higher quality products.

To convey the general empirical situation which motivates this study, we summarize below some typical observations by officials, academicians, and businessmen in Taiwan about the relevant aspects in that economy. No attempt is made to conduct a full-fledged empirical inquiry here. Such a task qualifies as a major project in its own right.

It is commonly perceived in Taiwan today that:

(1) It is in the national interest to improve the quality, and the quality reputation, of its products.[6]

(Continued)

international markets their numerous brand names are generally unknown, but they are all labeled "Made in Taiwan." Their output, taken together, is only a small fraction of the world supply including exports from Korea, Hong Kong, and Singapore.

[5] See Ian M. D. Little (1979). During the 1960s, Hong Kong, Korea, Singapore, and Taiwan became recognized as the new miracle economies of the Far East. (Japan had achieved this status a decade earlier.) From 1951 to 1975, national income per capita in Taiwan grew at 4.4 percent per annum without benefit from mineral exports.

[6] See, for example, the keynote address of the former Taiwan Minister of Finance K. T. Li to the International Symposium on Productivity titled "The Need for Higher Quality in Industry." (November 1975). See also the address of Y. T. Chao, the former Taiwan Minister of Economic Affairs, to the third National Symposium on Marketing and Development, December 1983 (*The Economic Daily News*, January 1, 1984, p. 11). He stated that Taiwanese exports are thought to be cheap goods by foreign consumers, just as the products made in Japan were a few decades ago. He emphasized the urgency for Taiwan to improve their quality image. M. T. Wu, a Taiwan Vice-Minister of Economic Affairs, also stated in the International Conference on Quality (September 1984) that the future of Taiwanese industries lies in building of a good quality image (*The Central Daily News*, September 19, 1984, p. 2).

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(2) Low product quality is somehow related to a highly fragmented industrial structure.[7]
(3) Industrial consolidation should be promoted.[8]

However, these notions have never been integrated into a simple theory. Nor have they been rationalized from a theoretical viewpoint. To these we add the following observation.

(4) Using "country of origin" as an index of quality has always played a role in foreign commerce. In fact, even goods bearing the same brand, but produced in different countries, are sometimes sold for different prices.[9]

The above four statements suggest a plausible theory. Labeling of country-of-origin is mandated in the United States and elsewhere because it is seen as providing consumers with useful information. If consumers accurately perceive economy-wide differences in average quality then a firm which bears the private cost of improving product quality may not attain a price commensurate with its true quality. But, by enhancing quality, a firm also creates a social benefit by enhancing the image of its country's products more generally. The direction of bias caused by such an externality is clear: goods will tend to be produced at a lower quality than they would be in the absence of this externality. This may explain statement (1): current product quality is suboptimal. The degree of bias caused by such an externality can also be explained: the more exporters of the products there are, the lower is the private benefit of quality improvement. This explains statements (2) and (3).

What is true for Taiwan is also true for many developing economies. To be more specific, an analytic model is set up in the next section.

3. THE MODEL AND ANALYSIS

We develop the simplest possible model capable of rigorously demonstrating the effects of market structure on quality and welfare in an informational equilib-

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Not only the Government Authorities, but Taiwan economists and businessmen have also recognized the importance of quality upgrading. See, for example, Yu (1983) and Chiu and Lai (1982).

[7] Ibid. Chao notes that it is very hard for a small firm to build a quality image. Further, C. S. Wang, another Taiwan Vice-Minister of Economic Affairs, also announced (*The Commercial Times*, September 23, 1984, p. 1) that the Ministry of Economic Affairs planned to encourage mergers and agreements amongst firms in order to avoid cut-throat competition because this caused them to export lemons at low prices and led to a "lemons" image for Taiwan's exports.

On a more concrete level, the lemons effect was recently exhibited when Colombian clothing exporters generally were severely impacted by the low quality product of a single exporter (Morawetz 1981).

[8] Ibid. See also Yu (1983, pp. 109–111) and the address of K. S. Wu, the former Vice President of the China External Trade Development Council, to the Symposium on Promotion of Industrial Development with Business Development (*The Economic Daily News*, September 26, 1984, p. 3).

Taiwan and most of the NICs have few or no antitrust laws. Even industrialized countries with active antitrust laws do not prohibit mergers of low market share businesses and often allow foreign trade exemptions. (Japan's antitrust act is more permissive during depressed conditions.)

[9] For example, Nikon cameras made in Japan command higher prices than the same model of Nikon cameras made in Taiwan. It is interesting to note, in this light, that a recently purchased IBM printer had "after installation please remove label" on its country-of-origin sticker.

rium. We rule out horizontal product differentiation and we use a constant returns-to-scale technology.[10] In our primary analysis, we analyze the simple case of a single industry's reputation. Swiss watches represent a high-quality product image of an industrialized country. The lemons effect and the effects of consolidation might also apply to an industrial sector, such as textiles or electronics. For NICs, these reputations are more often negative ("their dyes run" or "their watches are not very good"). The industry is assumed to have n firms in symmetric equilibrium. The firms are in a small country producing only for a world market. (This eliminates, by assumption, the possibility of domestic market power.) Initial factor prices are not equalized, and the wage rates of the small country may be affected by the level of its industrial activity.

Consumers in the world market do not have perfect information about each product's quality and cannot judge individual firms' qualities. We assume that consumers can "correctly" perceive the average quality of the country's products in this industry and use the perceived average quality as a proxy for judging the quality of each firm in the industry.[11] Thus, if Q_j represents the quality of products from firm j, the perceived quality from n producers can be written as

$$q = \sum_{j=1}^{n} (Q_j/n). \tag{1}$$

This small country faces a given world price function $p(q)$ which specifies the unit price of a good with the perceived quality q. The function $p(q)$ is assumed to be nonnegative and continuous. The market is competitive for every quality, so price equals marginal cost at every quality equilibrium. (For example, consumers may value products with a uniform trade-off between qualities, as with nickles and dimes, or there may be other competitive suppliers at evey quality level.) It is further assumed that the market demand conditions establish a minimum quality $\underline{Q}$ such that $p(q) = 0$ if $q \leq \underline{Q}$, while $p(q)$ is positive and twice continuously differentiable with $p'(q) \equiv dp/dq > 0$ and $d[p'(q)/p(q)]/dq < 0$ if $q > \underline{Q}$. Note that the last assumption is weaker than concavity.[12]

Let y_j^Q be the output of firm j producing goods of quality grade Q. For

[10] We have analyzed the same basic model under the assumption of U-shaped average cost curves and symmetric horizontal product differentiation (Chiang and Masson 1986). Aside from the increased notational complexity, the number of product variants becomes endogenous. The results on quality are qualitatively similar to the results presented here. The more general model leads to important differences between short–run equilibria and long–run equilibria (with entry of new varieties). The welfare enhancement arises (primarily) from profits in the short run and from the same wage enhancement shown here in the long run.

[11] Perceived quality could be modelled reasonably in numerous ways and the essential results would be the same. The simple average is analytically the cleanest assumption. Other possible assumptions include weighted averages across time or firms. Weighted averages across firms allows for specific firm recognition. If the number of sellers are reduced from hundreds to three or four then the firm-specific weights, or individual brand recognition, seems more likely. Such modifications to the model could lead to richer results, but the central qualitative results would remain the same.

[12] The unit price may increase at an increasing rate as q increases even if p'/p is decreasing. A similar assumption will be made about $(-a'/a)$ (which will be defined below). Our results apply when the system is stable and the second order conditions are satisfied. A sufficient condition for this is our assumptions on p'/p and $(-a'/a)$.

simplicity, we assume that labor is the only input used in production. The output of the j^{th} firm, y_j^Q, is produced from its labor input, L_j, by the constant returns-to-scale technology

$$y_j^Q = a(Q)L_j \tag{2}$$

where $a(Q)$ is a quality-dependent labor productivity parameter. The function $a(Q)$ is assumed to be nonnegative and continuous. Technological constraints set a maximum quality $\overline{Q}$ such that $a(Q) = 0$ if $Q \geq \overline{Q}$, and $a(Q)$ is positive and twice continuously differentiable with $a'(Q) \equiv da/dQ < 0$ and $d(-a'/a)/dQ > 0$ if $Q < \overline{Q}$. The last assumption is again weaker than concavity.

The profits of firm j producing goods of quality Q_j are

$$\pi_j(Q_j, L_j; Q_{-j}, w) = \{p[q(Q_j; Q_{-j})]a(Q_j) - w\}L_j \tag{3}$$

where $Q_{-j} = (Q_1, \ldots, Q_{j-1}, Q_{j+1}, \ldots, Q_n)$, w is the wage rate of the country, and the firms are wage takers. At the noncooperative equilibrium, a profit maximizing firm, j, must satisfy:

$$(1/n)[p'(q)/p(q)] = -a'(Q_j)/a(Q_j) \quad \{\text{for quality choice}\}. \tag{4}$$

In the framework of this model, one must also have the following condition:

$$p(q)a(Q_j) = w \quad \{\text{for labor demanded}\}. \tag{5}$$

Given price-taking and constant returns to scale, the value marginal product condition (5) for the firm is also the industry equilibrium zero profit condition. This condition will determine the wage rate for labor used in this industry.[13] It is clear from the quality condition (4) that all n firms will select identical quality grades in equilibrium, that is, $Q_j = Q$ for all j. Hence, we have $q = Q$ in equilibrium. Substituting Q for q, conditions (4) and (5) become equilibrium conditions (6) and (7):

$$(1/n)[p'(Q)/p(Q)] = -a'(Q)/a(Q) \quad \text{and} \tag{6}$$

$$p(Q)a(Q) = w. \tag{7}$$

Condition (6) determines the equilibrium quality. If any firm considers improving quality by one unit, the perceived average quality will be increased by $1/n$ units and the unit price of the commodity will be increased by the ratio $(1/n)[p'(Q)/p(Q)]$, which is the private benefit from quality improvement in the neighborhood of the equilibrium. But quality improvement also incurs a cost to the firm. The output per unit of labor employed by the firm will decrease by the ratio $[-a'(Q)/a(Q)]$ and the unit cost of the firm will increase by the same ratio. The equilibrium quality will be that quality level such that the private marginal benefit of quality improvement will be equal to its private marginal cost. Con-

[13] With this technology, the output of each individual firm is indeterminate. However, following our assumption of identical technologies and demands, its reasonable to use symmetry as a simplifying assumption. In each equilibrium, each firm produces $1/n$ of the total industry output. If $p(q)a(Q_j)$ exceeded w, all firms would desire output expansion. An equilibrium could then only be obtained if the greater labor demand were to raise w. Thus, demand and supply for labor establishes a wage rate and total industry employment. The total industry employment in turn establishes the total industry output.

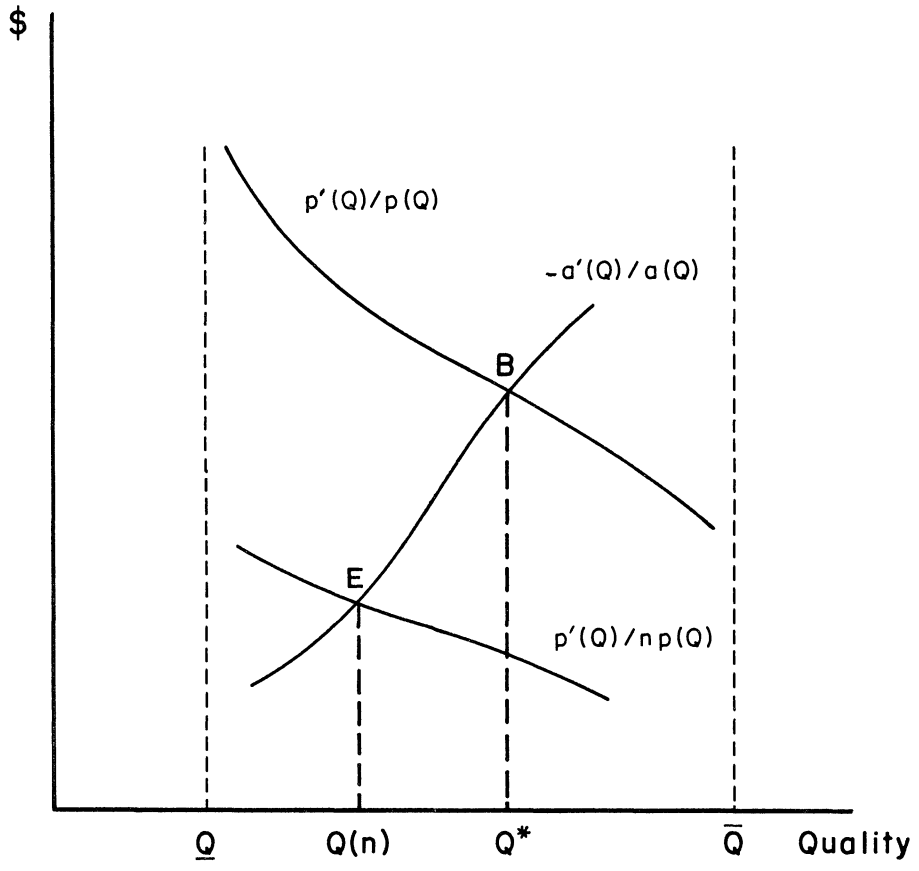

FIGURE 1
EQUILIBRIUM QUALITY AND BEST QUALITY

dition (7) states that, at equilibrium, the wage rate must be equal to the value of marginal product of labor. Otherwise, the economy is not in equilibrium: a higher profit may be earned at a larger (smaller) output if the value of marginal product of labor is higher (lower) than the wage rate. Thus, (7) determines the wage rate.

Figure 1 illustrates the quality decision (condition (6)) for a given number of firms, n. It shows $(1/n)[p'(Q)/p(Q)]$ is decreasing and $[-a'(Q)/a(Q)]$ is increasing with Q for $\underline{Q} < Q < \overline{Q}$. These two curves intersect at point E which determines the equilibrium quality level. It is easy to see that the $(1/n)[p'(Q)/p(Q)]$ curve shifts downward as n increases. Thus, we have the following proposition:

PROPOSITION 1. *There is an inverse relationship between the equilibrium quality and the number of firms, n.*

PROOF. The equilibrium quality is less $\overline{Q}$ and greater than $\underline{Q}$ because (i) $p(q) = 0$ for $q \leq \underline{Q}$ and $p(q) > 0$ for $q > \underline{Q}$, and (ii) $a(Q) = 0$ for $Q \geq \overline{Q}$ and

$a(Q) > 0$ for $Q < \overline{Q}$. Let $F(Q, n) = (1/n)[p'(Q)/p(Q)] + [a'(Q)/a(Q)]$. Since $p(\cdot)$ and $a(\cdot)$ are twice continuously differentiable and p'/p, a'/a are both decreasing for $\underline{Q} < Q < \overline{Q}$, by the implicit function theorem, the equilibrium quality can be expressed as a continuously differentiable function of n. Total differentiation of condition (6) yields

$$dQ/dn = p'(Q)/[p(Q)n^2(\partial F/\partial Q)] < 0, \tag{8}$$

since $p > 0$, $p' > 0$ and $\partial F/\partial Q < 0$ for $Q < \underline{Q} < \overline{Q}$. Q.E.D.

In order to elucidate the impact of the informational externality on product quality, we also consider the case without such an externality. If consumers have perfect information about product quality, the price of a product will depend only on the quality of that product, and the profit of firm j is:

$$\pi_j(Q_j, L_j; w) = [p(Q_j)a(Q_j) - w]L_j. \tag{9}$$

At equilibrium, firms will also select identical quality grades in this case. The associated necessary conditions are (7) and

$$p'(Q)/p(Q) = -a'(Q)/a(Q). \tag{10}$$

The left side of condition (10) represents the private marginal benefit of improving quality in the absence of the externality. As will be clarified below, this is also the marginal social benefit of quality improvement. So condition (10) implies with no information externality that the private and social marginal benefits of quality improvement will equal the marginal cost of quality improvement. If Q^* is defined to be the solution to (10), then Q^* is the socially optimal quality level for the exporting country.

When consumers have imperfect information about product quality, the private and social benefits diverge. This divergence causes firms to produce products of a quality lower than the socially optimal level Q^*, as illustrated in Figure 1. Proposition 1 implies, as the number of firms within the industry is reduced, that the discrepancy between the social and private benefits declines, and firms will produce higher quality products in equilibrium. This quality enhancement raises social welfare. We shall see this welfare enhancement more explicitly after we demonstrate wage effects in Proposition 2.

PROPOSITION 2. *The small country's wage rate rises along with equilibrium quality as the number of firms, n, is reduced.*

PROOF. Let the equilibrium quality $Q = Q(n)$. Comparing conditions (6) and (10), we find that $Q^* = Q(1)$. Since $Q(n) < Q(1)$ as $n > 1$ by Proposition 1, $Q(n) < Q^*$ as $n > 1$.

Condition (7) gives what the equilibrium wage must be for any quality.[14]

[14] Due to wage competition for labor, the model applies for $n \geq 2$. For $n = 1$, the possibility of monopsony occurs, but we do not consider monopsony power here. In applying insights of the model, we do not anticipate that the number of firms would be reduced to one. As a technical point, monopsony need not result in $n = 1$ if interindustry labor purchasing competition meets certain requirements.

Totally differentiating (7) we have $dw/dQ = \{[p'(Q)/p(Q)] + [a'(Q)/a(Q)]\}p(Q)a(Q)$. Since $[p'(Q^*)/p(Q^*)] + [a'(Q^*)/a(Q^*)] = 0$ (by the definition of Q^*) and p'/p and a'/a are both decreasing in Q, we find that $dw/dQ > 0$ for $Q < Q^*$. By Proposition 1 $dQ/dn < 0$, so $dw/dn < 0$. Q.E.D.

The intuition behind Proposition 2 is fairly clear. Due to the informational externality, firms of the small country at equilibrium will produce goods of a quality lower than the socially optimal level, Q^*. As firms are consolidated, quality upgrading occurs, and the value of marginal product of labor in the industry rises.[15] For an equilibrium, the wage rate must be bid up to where the value marginal product again equals the wage rate, raising social welfare.

4. CONCLUSION

In recent years, economists have increasingly gravitated to the position that much of world trade is determined by increasing returns to scale. Ethier (1979) provides a succinct summary of earlier arguments along this line. By postulating a positive fixed cost and constant unit variable costs, Shaked and Sutton (1982) focus upon increasing returns at the firm level, forming the basis for "natural oligopolies" with product differentiation. Research in industrial organization (Scherer 1980) finds evidence, in many real world markets, that firm-level economies of scale will generally occur for the range of output below "minimal optimal scale." After this output level, firms' long-run average cost curves are generally horizontal for some range. Industries can be categorized by whether minimal optimal scale is small relative to the market. If it is, the long-run unit cost function can be approximated as constant returns at the aggregate level. If not, increasing returns may dominate the results. Thus, modern textbooks (for example, Ethier 1983), maintain a balanced stand.

The empirical evidence indicates that for many products of NICs like Taiwan, increasing returns to scale are limited to small output levels. Limited zones of increasing returns in the quality choice problem are analyzed in Chiang (1983) and Chiang and Masson (1986). In this paper, we demonstrate much of the intuition of long-run equilibrium effects by simplifying to constant returns to scale, the technology of the Ricardian and the Heckscher-Ohlin-Samuelson models.

It was our observation of atomism and quality concerns in Taiwan that led to this paper. In North America, we find many who feel that the label "Made in Taiwan" means a product is not as high quality as one from Japan. The result of such statistical discrimination is that individual Taiwanese firms have little incentive to unilaterally upgrade their quality levels. We demonstrate that, under some

[15] After n is reduced, the firms will still produce at the same quality level as each other at a greater level than before. Since consumers correctly assess the new quality level, a higher price will reflect the true value associated with that quality. Although higher qualities require more labor per unit of output, this change in $a(Q)$ is more than offset by the higher price. Therefore, the value of the marginal product of labor (VMP = $p(Q)a(Q)$) will be higher in the new equilibrium after the externality is reduced.

conditions, socially beneficial quality upgrading can be induced by industrial consolidation.

We do not claim that consolidation of firms is always desirable. But if the information structure does lead to statistical discrimination, some policy response may be in order. Several other possibilities exist for dealing with this problem. One possibility, most closely related to the propositions demonstrated here, is the limiting of export licenses. A limit on export licenses might maintain atomism for domestic sales while only a few producers or middlemen, who monitor quality, export the product. Equally obvious is the possibility that industry export quality standards may be the best policy. One of these policies may be more effective in one case than in another, or they might complement each other. Without claiming generality or inclusiveness, we note that Japan has minimum export quality standards, relatively high industrial concentration, and only a few export trading companies in its lesser concentrated industries.

Chung-Hua Institution for Economic Research and York University; Cornell University.

REFERENCES

AKERLOF, G., "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics* 84 (August 1970), 488–500.

ARROW, K. J., "The Theory of Discrimination," in O. Ashenfelter and A. Rees, eds., *Discrimination in Labor Markets* (Princeton: Princeton University Press, 1973).

BUCK, R. C., *Advanced Calculus* (New York: McGraw-Hill Book Company, 1978).

CHIANG, S. C. AND R. T. MASSON, "Exporters Take a Free Ride: Market Structure, Reputation and Welfare," unpublished paper (April 1986).

CHIANG, S. C., *Imperfect Information and Quality Upgrading*, unpublished Ph.D. dissertation, Cornell University (1983).

CHIU, S. M. AND J. J. LAI, "Research on the Strategies of Industrial Development in 1980s (translation," *Taiwan Economy* 68 (1982).

ETHIER, W., "Internationally Decreasing Costs and World Trade," *Journal of International Economics* 9 (February 1979), 1–24.

———, *Modern International Economics* (New York: W. W. Norton and Co., 1983).

JASKOLD GABSZEWICZ, J., A. SHAKED, J. SUTTON, AND J. F. THISSE, "International Trade in Differentiated Products," *International Economic Review* 22 (October 1981), 527–534.

LELAND, H. E., "Quality Choice and Competition," *American Economic Review* 67, (March 1977), 127–137.

LI, K. T., "The Need for Higher Quality in Industry," *Economic Review* (March–April 1976), 1–6.

LITTLE, I. M. D., "An Economic Reconnaissance," in W. Galenson, ed., *Economic Growth and Structural Change in Taiwan* (Ithaca: Cornell University Press, 1979).

MORAWETZ, D., *Why the Emperor's New Clothes Are Not Made in Colombia* (World Bank, 1981), 67–68.

PHELPS, E. S., "The Statistical Theory of Racism and Sexism," *American Economic Review* 62 (September 1972), 659–661.

ROSEN, S., "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy* 82 (February 1974), 34–55.

SCHERER, F. M., *Industrial Market Structure and Economic Performance* (Chicago: Rand McNally, 1980).

SHAKED, A. AND J. SUTTON, "Relaxing Price Competition Through Product Differentiation," *Review of Economic Studies* 49 (January 1982), 3–14.

——— AND ———, "Natural Oligopolies," *Econometrica* 51 (September 1983), 1469–1483.

——— AND ———, "Natural Oligopolies and International Trade," in H. Kierzkowski, ed., *Monopolistic Competition and International Trade* (Oxford: Oxford University Press, 1984).

YU, T. S., *The International Trade of Current Taiwan* (translation) (Taipei: China Culture Service, 1983).