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RATIONALITY, EFFICIENCY, AND ORGANIZATIONAL BEHAVIOR THROUGH THE PRODUCTION FUNCTION, DARKLY*

The discussion of economic rationality has often been polarized around two extreme positions. One is that rational behavior is the "special case" of westernized and developed countries (*16*). The other tests the "poor but efficient" hypothesis to establish the universal applicability of economic rationality (*15*).[1] I submit that the divergence of the two views is largely based on two points. First, the institutional framework to which rationality applies has not been uniquely specified by different observers.[2] This refers to the fact that rationality is not absolute. Second, the analytical tools with which differences in rationality are assessed are deficient. This becomes especially important when rationality is imperfect.

It has, of course, not eluded the attention of the careful observer that rationality is not absolute. F. A. Cancian (*3*) notes that *we have our customs too.* And if they do not seem to hinder our efficiency it is only because we study efficiency within the "givens" of these customs. Imagine, however, the delight of the management consultant who descends from Mars and discovers that by distributing the two days of rest and worship evenly in the week and in the population he could increase plant and equipment capacity utilization by a factor of 40 percent and decrease the number of churches by eliminating every six out of seven.

The fact that rationality is relative to the institutional environment has two implications. First, it makes little sense to judge economic maximization on the basis of some "God-given" norms of rational behavior. Standards of rationality have little cross-cultural transference. Second, to the extent that rationality is subject to fixed economic constraints, it has to be measured on norms endogenous

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[1] The question of rationality is approached from the particular viewpoint of the relevance versus the realism of economic theory by Hla Myint (*11*).

[2] W. O. Jones expresses this point in terms of the difference between the economist's and the reformer's meaning of rationality: while the former accepts the ends and questions the means, the latter questions the ends themselves. For the latter, for example, rationality is ". . . owning more cattle instead of eating more meat, preferring to consume a combination of foods that do not constitute a 'balanced diet,' preferring ceremonials to productive investment, or indeed any pattern of tastes differing sharply from the European" (*8*, p. 109).

to the group. Consider, for example, the concept of X-efficiency (*10*), or M. J. Farrell's (*5*) technical efficiency. The difference in output between the "average" firm and the extreme positive outlier is used to measure the technical inefficiency of the average firm. Another interpretation, of course, could have the "average" firm representing the norm and the positive outlier representing an unusual endowment of some fixed factor of production, such as entrepreneurship, or luck. It may represent the classical source of error in measurement or of noise in the universe, and as such it can imply nothing systematic about efficiency. It certainly makes more sense to view outliers in a stochastic framework rather than as deterministic elements.

Besides being relative, rationality may also be imperfect. This poses problems from the point of view of neoclassical analysis. Suppose we define rationality in terms of the first- and second-order conditions for maximization in the production function. One would be surprised if these conditions happened to be strictly met in the real world. Nevertheless one cannot easily distinguish whether the observed failure to maximize is due to the classical sources of error or to systematic behavior in the universe which deviates from the precepts of maximization.[3] Furthermore, at the present state of the theory of the second best it is impossible to draw efficiency implications when the conditions for maximization are not uniformly met.

The implications that relative and imperfect rationality has for the study of efficiency are explored in the first section. It turns out that some efficiency indices, such as partial productivities and factor intensities, may lead to incorrect policy conclusions. The second section sets up the minimum requirements that a test for economic efficiency must fulfill. An intuitive discussion indicates how the profit function was formulated (*9*) to measure economic efficiency that incorporates two components: technical, which accounts for the fact that rationality is not absolute; and price efficiency, which allows for rationality being imperfect. Finally, and in the last section, I employ the components of technical and price efficiency to study some examples of the behavior of firms in situations of monopoly and in international trade. The basic point that this section attempts to convey is that remedial measures available to combat inefficiency differ, depending on whether the inefficiency is of the technical or the price variety.

PARTIAL PRODUCTIVITY RATIOS AND ALTERNATIVE CONCEPTS OF EFFICIENCY

I have suggested above that rationality should be viewed as both relative and imperfect. These concepts will now be developed in terms of economic maximization and the production function. The institutional constraints within which maximization takes place will be expressed in terms of *technical efficiency*. The conditions for maximization will be shaped into the component of *price efficiency*. The combination of the two constitutes the important criterion for economic decision-making and it will be termed *economic efficiency*. An example from Indian agriculture and a diagrammatic presentation will help illustrate the issues.

The *Farm Management Studies* of the Indian Ministry of Food and Agriculture (*7*) have provided microeconomic data from cost-accounting records of about

[3] For an empirical test of this proposition, see *21*.

three thousand holdings in the six main agricultural regions of India. These data have been a valuable source for the analysis of Indian agriculture as well as an empirical testing ground for economic theory. Part of our discussion of efficiency will draw from these data.

Some of the most celebrated findings of the *Studies* suggest that there exist significant differences in factor intensities, i.e., input-input ratios, and input-output ratios between different size classes of farms. More specifically, it has been observed that:

(1) Output per acre is inversely related to farm size as measured by area;

(2) Input per acre (in terms of a "cost" concept which includes, among other things, both hired and family labor) is inversely related to farm size;

(3) Output per acre is directly related to input per acre;

(4) Labor per acre is inversely related to farm size; and

(5) Output per unit of labor is directly related to farm size.

Different observers have drawn various conclusions, largely contradictory, from the above observations.[4] I will point out that the contradictions are inevitable because such ratios are inappropriate indices for comparison of efficiency. I will also draw the implications of economic theory as it refers to input-input and output-input ratios.

An intuitive notion of efficiency refers to the achievement of maximum output from a given set of resources. Intuition is often misleading. Observation (1) suggests that small farms are more efficient because they produce more output from their land. Observation (5) leads to the opposite conclusion since large farms obtain higher output from their labor input. Observation (2) favors large farms that conserve inputs and have lower costs per unit of land. Or do large farms underutilize their land resources by combining them with too few other inputs? The same problem arises with observation (4). Do large farms underutilize labor, or do they conserve it? Observation (3) favors large farms which utilize land "intensively" by the application of large quantities of complementary factors of production.

Following (4), one can conclude that large farms substitute capital for labor to a larger extent than small farms do. Would it be surprising if the ratio of output per unit of capital favored the small farms? An alternative interpretation of (4) is that costs per unit of land increase with farm size not only because of labor substitution but also because large farms pay their hired workers at a wage rate that is greater than that imputed to small farms which employ family members with (presumed) low opportunity cost. Are then wages or labor days the relevant unit for comparison?

The attempt to quantify economic efficiency through output-input and input-input ratios is measurement without theory. It is not surprising that it becomes ambiguous. Economic theory specifies the conditions under which firms are expected to have identical ratios of inputs and outputs. Even stronger, it is well known that all firms would have the same quantities of inputs and outputs (and as a result only one point on the production surface would be observable) if: (1)

[4] A number of writers have approached the *Studies* with an eye on implications about the efficiency of Indian agriculture, specifically of small versus large (more than 10 acres) farms (*2, 9, 12, 14, 17, 23*).

all firms had the same production function, i.e., the same technical knowledge and identical fixed factors; (2) all firms faced the same prices in the product and factor markets; and (3) all firms maximize profits perfectly and instantaneously.

Nevertheless, we observe in the world firms that produce homogeneous outputs that employ different factor intensities and have varying average factor productivities. It is, of course, sufficient to explain the world if we assume that firms behave randomly. They are ignorant of their production, cost, and return functions and, no matter what prices they have to take as given, they do not behave as if they maximized profits. If this is so, any attempt to measure economic efficiency could as well be abandoned.

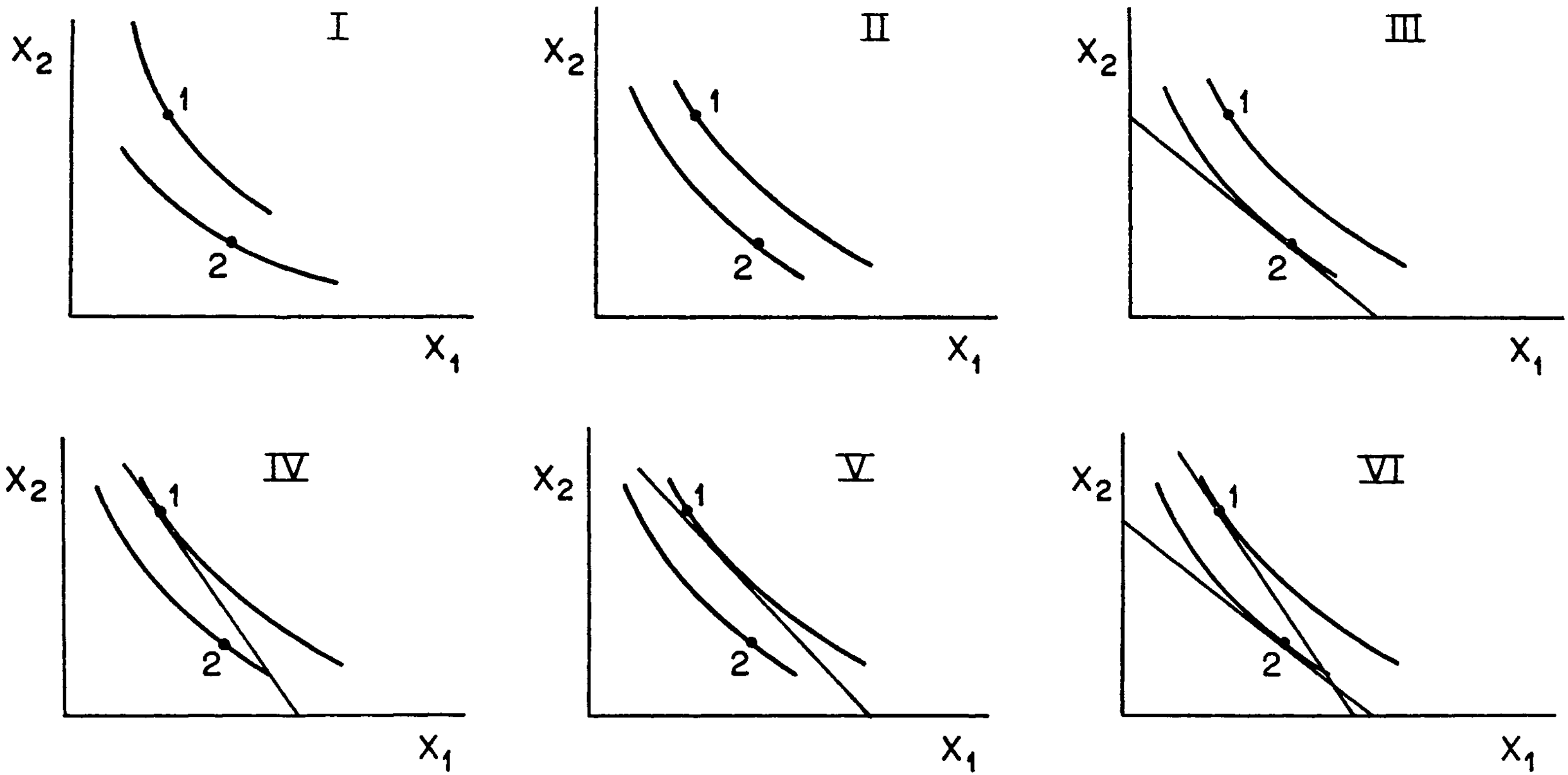
On the other hand, suppose we establish that firms behave according to a certain decision rule which we can conveniently call profit maximization with respect to a set of exogenous variables, such as prices and fixed factors of production. Then the observed interfirm differences in factor intensities and productivities will still need to be explained. The two possible explanations are that (1) firms have different input and output mix because they face different prices; and/or (2) firms have different input and output mix because they have different endowments of fixed factors of production, i.e., they have neutral differences in technical efficiency. This situation is illustrated in Chart 1 and Table 1.

Panels I through VI of Chart 1 present two unit isoquants for inputs X_1 and X_2 with the position of firms 1 and 2 indicated. All panels are drawn so that on the basis of the criterion of output per unit of X_1 firm 1 is more efficient than firm 2; and the converse for the criterion output per unit of X_2, i.e., firm 1 uses less of X_1, firm 2 less of X_2 in each panel. The ranking is shown in Table 1. Besides this obvious conclusion nothing else can be said about the technical and price efficiency components of economic efficiency from Panel I. Efficiency comparisons of any kind are impossible in Panel I because the isoquants as drawn belong to different production functions, i.e., production functions that differ not only by the constant terms but have also different elasticities. In Panel II comparison of technical efficiency becomes possible since the isoquants belong to production functions that differ only by the constant term. This term represents differences in endowments of fixed factors as well as the impact of nonmeasurable inputs, such as entrepreneurship. Technical efficiency is the shorthand notation for such differences. It favors firm 1 since it produces the unit output with smaller quantities of inputs than firm 2. The isoquants are purely engineering concepts. In Panel III the economic information of relative prices is introduced. Firm 2 is technical-efficient, price-efficient and economic-efficient. In Panel IV,

TABLE 1.—EFFICIENCY RANKINGS OF FIRMS

Efficiency concept		Panel I	II	III	IV	V	VI
Output/Input ratio	X_1	1	1	1	1	1	1
	X_2	2	2	2	2	2	2
Technical efficiency		?	1	2	2	2	2
Price efficiency		?	?	2	1	–	1 and 2
Economic efficiency		?	?	2	?	2?	2

CHART 1.—ALTERNATIVE MEASURES OF EFFICIENCY IN 2-INPUT UNIT OUTPUT SPACE



with price efficiency changing in favor of firm 1, the economic efficiency becomes questionable. In Panel V neither firm 1 nor firm 2 is price-efficient anymore. Nor can we tell whether the price inefficiency of 1 is less than the price inefficiency of 2 so that it counterbalances the advantage that firm 2 has in technical efficiency. As a result the economic efficiency of the two firms becomes also unclear. The problem arises because the concept of price efficiency, as developed through the comparison of marginal product to opportunity cost, is an absolute concept. A firm is or is not price-efficient and ranking among price-inefficient firms becomes impossible. The final Panel introduces differences in prices. It so happens that firm 2 employs relatively cheap X_1 inputs while firm 1 has cheap X_2 inputs. In the graph both firms are price-efficient. The result of economic efficiency then favors firm 2 that has the advantage in technical efficiency over firm 1.

The point I have attempted to convey through Chart 1 has relevance for the interpretation of the observations made from the Indian data. These observations are inconsistent with profit maximization within the same production function and the same price regime. If maximization is imperfect, the ratios observed are plausible but still inconclusive from the point of view of efficiency. An alternative explanation for these ratios is that small and large firms have differences in the production function, captured through differences in the constant term and/or operate under different output or input price regimes. This interpretation becomes especially plausible in peasant agriculture of the Green Revolution variety. The new seeds, fertilizers, and insecticides that constituted the base for the increase in yields in recent years have become selectively available mainly to large farms. This factor, if not counterbalanced by other intrinsic technical-efficiency characteristics of small farms, would tend to produce higher output per unit of input for the large farms, other things equal. In addition, small farms are likely to operate with relatively cheap labor (since the opportunity cost of family members in a rural sector that has few alternative employment opportunities will be extremely low); to have relatively expensive capital (because of limited or no access to credit from official sources or institutions subject to interest rate ceilings); and by definition to have little land available. Large farms have more land, access to credit on more favorable terms, and they hire their labor in the market at the going wage rate. These characteristics are sufficient to explain the input and output ratios observed. In the extreme case of labor free for the small farms and land free for the large, optimizing behavior would lead the former to maximize output per unit of land and the latter to maximize output per unit of labor. These ratios are then purely definitional and are far from conveying any information about relative efficiency.

THE ANALYTICAL COMPONENTS FOR THE STUDY OF EFFICIENCY

The preceding sections introduced the concept of economic efficiency and its two component parts, price efficiency and technical efficiency. The study of efficiency relates basically to the common observation that firms which produce homogeneous outputs have different factor intensities and varying average factor productivities. A test of efficiency must provide a theoretically consistent explanation of this phenomenon. Three possible explanations are offered: (1) firms use different input mixes because they operate at different sets of market prices;

(2) firms use different input mixes because they have different endowments of fixed factors of production, measured or nonmeasured; or firms use (3) different input mixes because they succeed in varying degrees in maximizing profits, i.e., in equating the value of the marginal product of each variable factor to its price.

We can control for (1) by introducing prices explicitly in our analysis. We can also partly control for (2) by introducing the quantities of the measured fixed factors of production in our analysis. Then the remaining differences in observable input mixes can be attributed to two factors. First, they can be traced to differences in nonmeasured fixed inputs of production. These can be readily captured through analysis of variance as used to measure management bias. They constitute the component of *technical efficiency*. Second, the results can be attributed to residual differences that are due to imperfect equalization of marginal products to opportunity costs. These constitute the component of *price efficiency*.

This breakdown of the components of efficiency suggests the reasons why efficiency cannot be captured by the production function alone. It is the inappropriate tool, since the production function does not incorporate prices as exogenous variables (factor 1) and does not allow for imperfect maximization (factor 3). It can capture only technical efficiency (factor 2). Through the production function we can see efficiency—but darkly. I will proceed to show in an intuitive way that the profit function can be made to incorporate adequately all three components of efficiency.

The computational form that combines the three elements, technical, price, and economic efficiency, is

$$\Pi^* = A_* c_i^{\alpha_i^*} Z_i^{\beta_i^*} \qquad (1)$$

where Π^* is profits, c_i is the real price of each variable factor of production, i.e., after normalization by the price of output, Z_i is the quantity of each fixed factor of production, and α_i^* and β_i^* are the coefficients of prices of variable factors and quantities of fixed factors, respectively. The advantages of the profit function over the production function, which allow for the unambiguous measurement of efficiency, can be briefly sketched.

Profit is defined as

$$\Pi = V - \sum_i c_i X_i \qquad (2)$$

where V is total value of output, and X_i the quantity of each variable factor of production. Profit is thus the total value of output minus the total cost of the variable factors of production. It is equivalent to the "surplus" that is appropriated by the fixed factors of production.

We note the production function

$$V = pF(X_i, Z_i) \qquad (3)$$

and the profit maximization condition[5]

$$\frac{\partial F}{\partial X_i} \equiv c_i . \qquad (4)$$

[5] We omit p, the price of output, from equation (4) because we defined the prices of the variable inputs in real terms, i.e., normalized by the price of output.

We can express the demand for input i of the maximizing firm as

$$X_i^* = f_i(c_i, Z_i) \tag{5}$$

where X_i* denotes that this is the optimal quantity of factor i. It becomes now clear that by substitution in (2) we can express profit as a function of the prices of the variable factors of production and of the quantities of the fixed factors of production. It follows that two identical firms (to be defined later as firms of equal technical efficiency and equal price efficiency) which have successfully maximized profits would still have different values of profits as long as they faced different prices. We thus account for interfirm differences in prices, i.e. for component (1) of the explanation why firms that produce homogeneous outputs have differences in factor intensities and productivities.

We still have not accounted for components (2) and (3) in the explanation of interfirm differences in factor intensities and productivities: differences in endowments of fixed factors of production (technical efficiency) and differences in the ability to maximize profits (price efficiency). Consider two groups of firms with production functions identical up to a neutral displacement parameter. We may rewrite equation (3) with superscripts to denote groups of firms,

$$V^1 = pA^1F(X_i, Z_i) \;\; ; \;\; V^2 = pA^2F(X_i, Z_i)\,, \tag{6}$$

where A is the technical-efficiency parameter. A firm is considered more technical-efficient than another, if, given the same quantities of measurable inputs, it consistently produces a larger output. Firm 1 is more technical-efficient than firm 2 if $A^1 > A^2$. We thus introduce element (i) from the above list of requirements.

We need now to introduce price efficiency. A firm is price-efficient if it maximizes profits, i.e., it equates the value of the marginal product of each variable input to its price. A firm which fails to maximize profits is, by definition, price-inefficient. Consider now two complications in connection with the definition of price efficiency. First, assume that the prices of inputs are different for each firm. Firms now equate the value of the marginal product of each factor to its firm-specific opportunity cost. Second, firms may not maximize profits. For such firms the usual marginal conditions do not hold. It is assumed that these firms equate the value of the marginal product of each factor to a constant (which may be firm- and factor-specific) proportion of the respective firm-specific factor prices, i.e., and for firms 1 and 2 respectively.

$$p\frac{\partial A^1F(X_i, Z_i)}{\partial X_i} = k_i^1 c_i \;\; ; \;\; p\frac{\partial A^2F(X_i, Z_i)}{\partial X_i} = k_i^2 c_i \tag{7}$$

In this case k_i^1 indexes the decision rule that describes the firm's profit-maximizing behavior with respect to factor i. It encompasses perfect profit maximization as a special case when $k_i = 1$ for all i. Now consider two price-inefficient firms of equal *technical efficiency* and facing identical output and input prices. The firm with the higher profits within a certain range of prices is considered the *relatively* more *price-efficient* firm (within the same range of prices).

Economic efficiency combines both technical and price efficiency. For this purpose consider two firms of *varying degrees of technical and price efficiency* but facing identical prices. The firm with the higher profits within a certain range of prices is considered the *relatively* more *economic-efficient* firm.

We may now return to the profit function of equation (1). The A_* constant encompasses the group-specific factors of technical efficiency, A^1 and A^2, and price efficiency, k_i^1 and k_i^2, in the comparison of the two groups of firms, 1 and 2. As such, A_* reflects the two features of economic rationality that I introduced from the outset: (1) economic rationality is relative and has to be judged within the specific technical and price framework which is taken as given, i.e., A and c_i; and (2) rationality may be imperfect, i.e., we should allow for the possibility that $k_i \neq 1$. Given the prices of the factors that a firm faces, c_i, the two components of efficiency, A and k_i, can be separately identified (22).[6] This is important if one wishes to distinguish in a firm's performance the component of engineering knowledge, A, from the component of the managerial ability to maximize, k.

GENERALIZATIONS REGARDING EFFICIENCY, EXIT, AND VOICE

The discussion of economic efficiency in the preceding sections has drawn attention upon two kinds of inefficiency: the inefficiency that lies in people and the inefficiency that lies in people's stars. By the former I mean price inefficiency. It has to do with managerial decision-making with regard to the allocation of the variable factors of production—factors that are within the control of the firm. Technical inefficiency, on the other hand, is related to the fixed resources of the firm. It is an engineering datum and as such, at least in the short run, it is exogenous and part of the environment that is taken as given.

Once we have separately identified the components of price and technical efficiency, we could put them to use to study the growth and decline of firms in specific and of organizations in general. I will rely heavily on A. O. Hirschman's *Exit, Voice, and Loyalty* (6) to illustrate the distinction.

First let me suggest a case in which the distinction between price and technical efficiency is entirely useless. It is the model of the classical "taut" economy, as incorporated, for example, in the Schumpeterian model of dynamic competition. The genesis in the Schumpeterian world is a surge of innovations that is initiated by the engineer-entrepreneur: he has a technological invention, he takes his risks to make it an innovation in the marketplace, and he is rewarded with increased profits. Profits in the Schumpeterian cosmogony are begotten by technological change. The profit-making firm is technically efficient, i.e., it has lower cost curves than the technically inefficient firm. Technical efficiency giveth, and technical efficiency taketh away. The engineer-entrepreneur sets off a wave of imitators, the field becomes competitive, and profits decline. Should no new technological breakthrough be forthcoming, the firm will fall prey to the more vigorous newcomers. As Galbraith mockingly puts it, the economy is viewed "... as a biological process in which the old and the senile are continually being replaced by the young and the vigorous." This is one view, but not the only alternative.

At the confines of the classical world of the "taut" economy there exists the neoclassical world that allows for imperfect markets, for mistakes in maximiza-

[6] For details on the manner in which this can be done, see 22.

tion and for entrepreneurial inertia. This alternative may be formulated in terms of the "slack" economy concept. The slack exists because of limited information. Instead of maximum profits, firms are on "a systematic temporal search for highest practicable profits" (*4*, p. 334). This is the view that P. A. Baran and P. M. Sweezy (*1*, p. 27) adopt:

> The firm always finds itself in a given historical situation, with limited knowledge of changing conditions. In this context it can never do more than improve its profit position. In practice, the search for "maximum" profits can only be the search for the greatest *increase* in profits which is possible in a given situation, subject of course to the elementary proviso that the exploitation of today's profit opportunities must not ruin tomorrow's.

A. G. Papandreou (*13*, pp. 47–49) holds to a similar view. This description of the slack in the economy is related to technical inefficiency due to a limitational fixed factor, information.

There is more, however, in the concept of the "slack economy" than what Baran–Sweezy and Papandreou notice. In a "slack economy" profits are a cushion that provides the firm with a latitude for deterioration. Profits in a firm's balance sheet act as a beacon to other firms and set in motion the Schumpeterian forces that compete them away. In a monopoly economy, however, there also exists a second kind of profits that cannot be easily competed away by market forces. John Hicks described it: "the best of all monopoly profits is a quiet life." Hirschman brings the point into focus (*6*, p. 57):

> What if we have to worry, not only about the profit-maximizing exertions and exactions of the monopolist, but about his proneness to inefficiency, decay, and flabbiness? This may be, in the end, the more frequent danger: the monopolist sets a high price for his products not to amass super-profits but because he is unable to keep his costs down.

If this view of the world is correct, the Schumpeterian paradigm fails to suggest the important healing forces that may come into play when remediable lapses from technical efficiency occur. This new scenario suggests that, being divested of his technological monopoly by the wave of imitators, the manager-entrepreneur comes to pay attention to the finer aspects of rationalization. The payoff to faltering technical efficiency might be increasing price efficiency. An interesting and as yet unprobed question in industrial organization arises: to what extent a company that introduced a technological breakthrough can adjust and survive in the face of increased competition? And to what extent after the field has become competitive, a change in management is necessary?

The "product life cycle theory" is another variation of the dynamic competition model that renders itself to the distinction between technical and price efficiency that I drew. The product life cycle hypothesis purports to explain world trade patterns on the basis of stages in a product's life. New products emanate from developed countries mainly because of the importance of technology in the early life stages of a product. As products mature the comparative advantage in new products cannot be based solely on technology—itself a commodity easily transferable through international trade. Instead, a higher degree of price-consciousness on the part of the consumer at the later stages of a product's life shifts the comparative advantage to countries that have more-favorable factor-price relations and/or higher ability to rationalize the use of inputs. These are the components of price efficiency.[7]

Hirschman develops the implications of the taut versus the slack economy model in his *Exit, Voice, and Loyalty* (*6*). Exit of customers in the taut economy model, by inflicting revenue losses on delinquent management, "is expected to induce that 'wonderful concentration of the mind' akin to the one Samuel Johnson attributed to the prospect of being hanged" (*6*, p. 21). In this model, exit is a sufficient remedy and a look at the profits of the firm, i.e., its ability to survive, is sufficient to attest to its economic efficiency. In the slack economy, however, market forces alone do not possess these wonderful recuperative powers. Consider, for example, the public corporation (and on occasion even the private) that can dip into the public treasury in order to make up the losses of the exit-competition. Or consider the cases of connoisseur goods that are characterized by quality competition. When quality deterioration occurs, it is the intramarginal consumers—those who have high consumer surplus as a result of quality appreciation—who will drop out first: the residents who value most the neighborhood qualities such as cleanliness, safety, or good schools will be the first to move out as a neighborhood deteriorates (*6*, p. 51). Or, consider the case in which the output or the quality of the organization matters to the customer even after exit, as exemplified by the interest of the Defense Department in a contractor like Lockheed: exit does not stem the deterioration of the organization nor does it guarantee its demise. Market phenomena like profitability or survival are not a testimonial of health of the organization. In these cases, Hirschman emphasizes the importance of loyalty as a remedial mechanism. It holds exit at bay and it activates voice. Voice is the nonmarket phenomenon of consumer interest articulation. For getting an organization "back on the track" he prescribes a choice between articulation and "desertion"—between voice and exit.

Hirschman's analysis is most suggestive and adequately describes the forces that are exerted upon certain organizations. Only exit, for example, is available in a competitive business enterprise. Only voice, on the other hand, is remedial in organizations like the family or the nation. In between the two extremes there is a large gray area where the optimal mix of exit and voice is elusive: the voluntary associations, the political parties and the oligopolistic and monopolistic business enterprises. The distinction we have drawn implies that the effect of voice may be more salubrious on firms that suffer from price inefficiency. Voice works by bringing discomfort upon the managers. They are more likely to respond by attending to the details of rationalization, which is within the control of the firm, rather than by improving technical efficiency, which in the short run is exogenous and part of the environment that is taken as given.

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