ECONOMIC THEORY, APPLICATIONS AND ISSUES

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Economics of Business Learning:
The Need for Broader Perspectives in
Managerial Economics

by

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THE UNIVERSITY OF QUEENSLAND

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ABSTRACT

While most textbooks in managerial economics now give some coverage to business learning, and this is to be welcomed, their coverage of business learning is limited to a consideration of increases in productivity or cost reductions. Supply-side bias exists. The coverage of leading texts is reviewed. It is found that no attention is given to the underlying sources of business learning nor to phases of such learning. The 'start-up' phase, for example, is not specifically mentioned. Connections with productivity progress are not well explored and the possibility that business learning may depend on the duration of learning as well as the cumulative output of a business is not considered. The duration of learning is treated as an important variable in learning models developed in this paper. These models make it easier to distinguish between effects of learning on productivity or costs, and scale economies. It is also argued that more attention should be given to learning patterns of existing businesses for a change of their technique or major alteration of their product. Models, some of which involve a degree of 'lock-in' to existing techniques, are outlined for this purpose. In addition, other neglected microeconomic aspects of learning are considered. Lack of attention in managerial economics to learning about markets is seen as a grave shortcoming. More attention ought to be given to the alternative strategies available to a business for learning and aspects of motivation and activation for learning should not be neglected. It is then observed that the theory of optimal transfer pricing in multi-divisional firms makes no allowance for learning by the divisions. If learning is important, this is a further shortcoming.

Economics of Business Learning: The Need for Broader Perspectives in Managerial Economics

1.   Introduction

Recognition has grown in economics in recent decades of the importance of business learning for the economic performance of business enterprises. Nevertheless, this dynamic factor has not been given as much attention in managerial economics as it deserves. Furthermore, most managerial economics texts cover business learning from a very limited perspective, concentrating only on productivity progress aspects of it. These aspects are modelled in a mechanical fashion. There is very little attention to the sources of learning and the nature of learning in businesses. This is, conceptually unsatisfactory. In addition, appropriate applications of the economics of business learning to managerial decision-making, such as to that involving optimal transfer pricing in multi-divisional firms, are frequently overlooked.

The purpose of this paper is to demonstrate that a more open and wider approach to considering business learning in relation to managerial economics is needed. This is done by considering the coverage of business learning in several leading Western textbooks on managerial economics and pointing out ways in which consideration of this subject could be fruitfully extended. First, the supply-side bias of texts in managerial economics dealing with business learning is demonstrated. After reviewing ways in which learning in production economics is covered in the relevant texts, several extensions are recommended and specified. Secondly, the importance of examining learning about markets and the marketing of the firm's products is emphasised. This is likely to be especially important for new products and new firms. A general discussion of wider conceptual issues involved in business learning and their implications for business strategies follows. In the penultimate section, it is shown how static conceptions of optimal transfer pricing in multi-divisional firms can lead to faulty managerial decisions. Currently models of optimal transfer pricing ignore learning phenomena. The concluding section provides an overall assessment of the issues raised.

2.   Supply-Side Approaches in Texts

Most managerial economics texts introduce business learning as a part of their production or cost analysis for firms. This is true for example of Salvatore (2004). He introduces it as

Section 7.5 of his Chapter 7, "Cost Theory and Estimation", contained in Part 3, "Production and Cost Analysis" of his book. Similarly, another leading text, McGuigan et al. (2002) introduces the subject as appendix to the chapter on cost analysis. This is merely entitled "The Learning Curve".

Basically, the discussion in most managerial economics relies on productivity progress functions. These were originally developed mainly by engineers to predict increases in productivity of businesses in activities, such as aircraft manufacture, as these cumulative volume of production increased. It was observed that in some industries, output per unit of labour in a business rises with its cumulative production, other things constant. The inverse is also the case: requirements of labour per unit of output fall as cumulative output of the business rises.

It is generally assumed that labour productivity increases as a decreasing rate with cumulative production of a new commodity by a firm. This implies the inverse; namely that labour requirements per unit of cumulative output of the business fall at a decreasing rate as businesses cumulative volume of output rises. This appears to characterise the start-up phase of most new businesses and businesses commencing new production activities.

However, most texts in managerial economics texts demonstrate the effects of business learning in terms of a fall in average per unit cost of production of the firm rather than in terms of rises in its average productivity. See, for example, Hirschey (2003, pp. 303-306), Keat and Young (2003, pp. 356-359), Samuelson and Marks (2003, pp. 289-293), Mansfield et al. (2002, pp. 304-308), McGuigan et al. (2002, appendix to Ch. 9) and Salvatore (2004, pp.287-290). Other things equal, average cost changes will mirror changes in average productivity. For example, a rise in productivity will be reflected in a fall in per unit costs of production.

In all the texts mentioned above, the effects of learning are modelled in terms of falling per unit costs of production as a fraction of the cumulative output of the business. Typically, per unit cost of production is assumed to be of the form.

$$C = a\,Q^{\,b} \qquad\qquad (1)$$

where *C* represents the cost of the last unit of output produced, *Q* is the level of cumulative output and *a* and *b* are co-efficients. In this formula, *a* represents the cost of the first unit of output and *b* is usually negative.

If *b* should equal one that would imply that no cost-reducing learning takes place. The larger is the absolute value of *b* the more rapid is the fall in costs of producing extra cumulative output. Normally, however, the cost-reducing benefits of learning are found to occur at a decreasing rate. Hence, the absolute value of *b* usually is between zero and unity implying that the per unit cost of production falls at a decreasing rate with rises in cumulative output of a firm producing a product new to it, or producing one with a novel technique for it. If the absolute value of *b* should exceed unity, this would result in the firms per unit cost of production falling at an increasing rate.

Formula (1) above has the advantage of easy conversion into a logarithmic form. When that is done, it becomes:

$$\log C = \log a + b \log Q \qquad (2)$$

where the absolute value of *b* typically falls in the range zero to unity. Larger values of *b* indicate greater cost-reduction benefits as a result of learning.

The habit has evolved in managerial economics texts of describing the type of cost curves represented by expressions (1) and (2) as 'learning curves' even though there is little or no discussion of the essence or basis of such learning.

Naturally problems occur when several different factors influence reductions in per unit cost of production of a business as its cumulative output of a new product or a product using a new technique rises. For example, the volume of production per unit of time of a business may expand and give rise to growing scale economies and as well, some of the firm's cost-reduction may arise from learning influences. Determining the separate contributions to its cost-reduction of these different sources can be very difficult (it may be impossible in some cases) and not nearly as straightforward as some texts suggest (eg. Hirschey, 2003, p.304).

# 3.   Extending the Supply-Side Discussions of Learning

There is a need to extend discussion in managerial economics about productivity enhancing consequences of learning in a business. For some purposes, productivity progress function as discussed for example, by Baloff (1966 a, b) ought to provide a useful introduction to the subject Baloff suggested that productivity progress functions are typically of the form

$$Y = a X^b \qquad\qquad\qquad (3)$$

where Y is an index of output per unit of input, X is cumulative output of a new product or an existing product using a new technique. The values a and b are parameters where a represents initial productivity and b is an indicator of changes in it with X. Given learning effects, b typically lies in the range $0 < b < 1$.

In the 'start-up' phase(see, for example, Pegels, 1976), a typical productivity progress function might look like that shown by the portion ABC of the curve shown in Figure 1. This phase is captured by Baloff's specification of expression (3). Once, however, the start-up phase is finished, it may be replaced by an 'established phase' in which learning no longer occurs. The productivity progress function may then become constant, as indicated by line CD in Figure 1, or decline as illustrated by the curve CEF, or after remaining constant then decline. Its decline may be due to such factors as boredom of the work force. For example, tasks may become increasingly tedious with workers taking less care and the frequency defects in their output may increase.
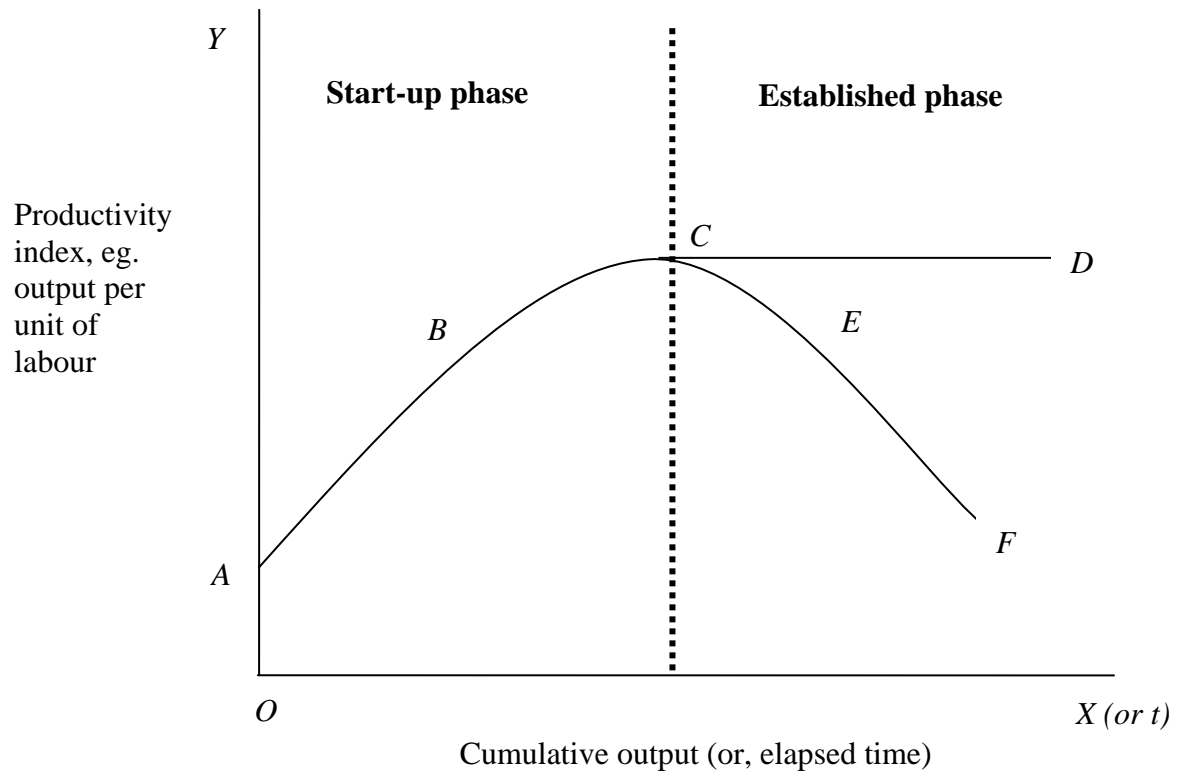
Figure 1: **A productivity progress function, only the start-up phase is considered in most managerial economics texts**

In addition, changes in productivity are not purely a consequence of learning effects. For example, in the early phases of production, productivity increases may result from the 'running in' of new machines resulting in reduced down-time for repairs. As cumulative volume of production grows, machines can be expected eventually to show growing depreciation resulting in a rising amount of down-time for their maintenance and increasing maintenance costs.

The possibility should also be considered that productivity progress of a business does not depend purely on its cumulative output but also on the duration of its production of a new product or an existing product using a new technique. Some types of learning depend on the time available to individuals for assimilation and reflection, not merely the extent of repetition. This would be captured in a productivity progress function of the following form:

$$Y = f(X, t) \qquad\qquad (4)$$

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where t represents the length of time for which the business has produced its new product or used a new technique, and the other variables are as before. In the start-up phase, one would typically expect the partial derivatives of X and t to be positive but declining with respect to Y.

In some cases, it may even be that the productivity progress function can be expressed merely as a function of the length of time, t for which the relevant type of production has taken place. Then equation (4) takes the following particular form:

$$Y = g\ (t) \tag{5}$$

A productivity progress relationship similar to that shown in Figure 1 may apply if X on the horizontal axis is replaced by t. There is evidence to support the use of duration of production *(t)* in place of X (cumulative output) as a useful explanatory variable for productivity progress in some industries (see for example, Fellner, 1969; David, 1970; Zevin, 1975). Kibria and Tisdell (1985) used such an approach in estimating the productivity progress of Bangladesh's jute mills. In some cases, duration of production *(t)* may be a more important explanatory variable than cumulative output *(X)*, or the two variables may be highly correlated. Furthermore, empirical work on productivity progress is restricted by the availability and reliability of data. Data on duration of production operations is easier to obtain and in most cases, more reliable than that available for cumulative production of individual businesses.

Also, potentially, it may be easier if duration is the main explanatory variable, to decompose increases in productivity into 'learning' and scale effects. Learning causes the firm's average productivity curve at a **particular point in time** to shift downwards as a function of the duration of its production.

For instance, the productivity progress function might take the form

$$Y = h\ (x,\ t) \tag{6}$$

where x is the level of production for the current period and t is the duration of previous production. Similarly, per unit cost of current production may take the form

$$C = r (x, t) \qquad\qquad (7)$$

where *t* is as before, and *C* represents current average costs of production. If the effects of the explanatory variables on *Y* and *C* are *independent* in their influences, then the effects of scale economies and 'learning' (duration) can be separated. For example, this would be so if, for instance, equation (7) can be re-expressed as

$$C = v (x) + u (t) \qquad\qquad (8)$$

Similarly, if **previous** cumulative output is considered the relevant explanatory factor rather than cumulative output or *t,* a similar expression to that in (6) or (7) can be derived. If this can be re-expressed in terms of two additive functions as in (8), separate effects on productivity (or costs) of ''learning' (previous cumulative output) and current scale economies can be identified. Otherwise, no precise decomposition of these separate effects may be possible. Current formulations in texts that illustrate decomposition (eg. Hirschey, 2003, p.304) fail to point this out. Students should at least be warned of the difficulty.

No discussion occurs in the main texts of the phases of learning or productivity progress. Nor is there discussion of different types of learning curves. For example, it is assumed that productivity increases (or per unit cost reductions) occur at a decreasing rate with cumulative output. But in some cases rates of change in learning rates may vary. The productivity progress function in the start-up phase could sometimes be logistic. This would indicate that learning occurs first of all at an accelerating rate then at a declining rate. Learning may also not be discontinuous. It may display jumps at various points, that is learning 'break throughs'.

4.   Learning and Technical Change or Product Alteration
There is no discussion in managerial economics texts of how the firm's cost of production or productivity progress function alters as it changes from one technique to another or varies its product. If learning is important, learning factors could make it costly initially for a business to switch techniques or alter its product.

At least two types of situation can be envisaged: (1) cases in which switch to a new technique initially depresses the productivity of the business and (2) that in which no such depression occurs. Each of these cases is illustrated in Figure 2. Their productivity progress is assumed merely to depend on the duration of use of a technique by the business. A firm with its initial technique may be moving along curve ABCEF when at time t_1 a new technique becomes available. If adopted, the new technique can eventually give the firm a higher level of productivity than the initial technique. However, if it is adopted at t_2, the firm's productivity falls at first and the business moves along the productivity progress function DEG. Because the new technique is fairly different from the initial one, the firm must engage a considerable amount of new learning or relearning if it adopts the new technique. Consequently, in the case illustrated, the business is less productive with the new technique than the initial one in the period $t_1 \leq t < t_2$. After t_2, its learning is sufficient to make the new technique more productive, if it is adopted in t_1.
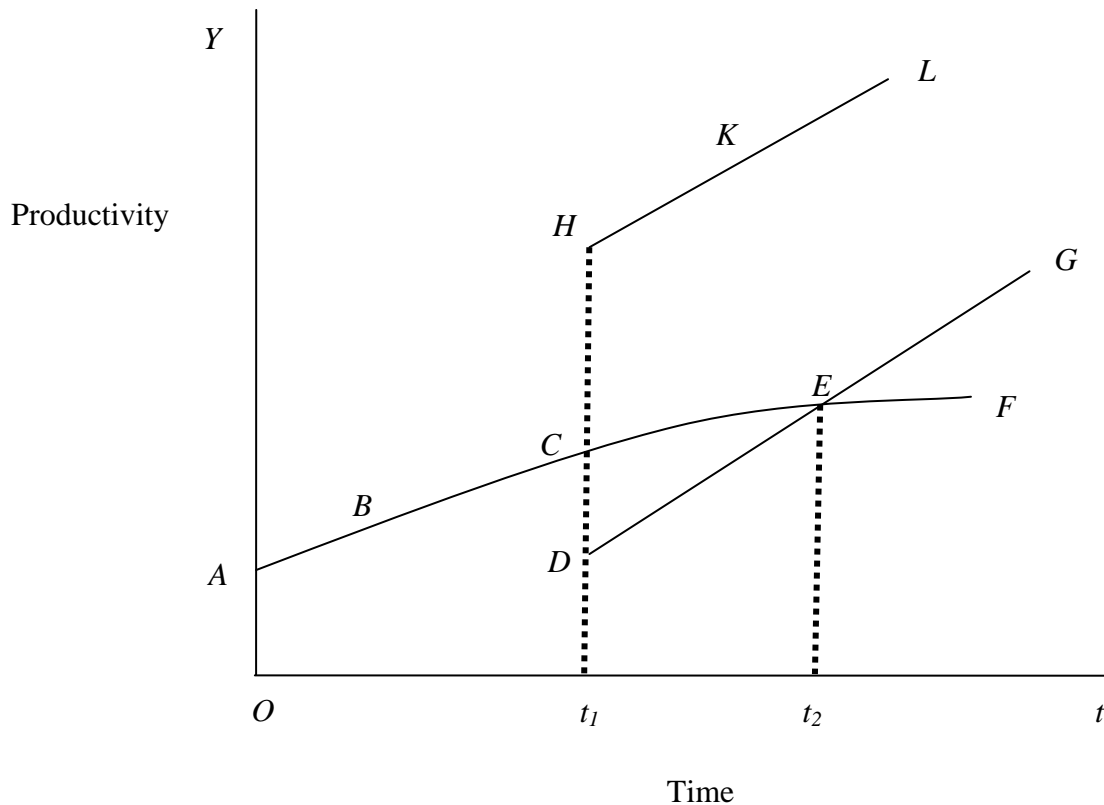
Figure 2: **Sometimes, business learning locks firm's into existing techniques for longer than otherwise would be the case**

When the above phenomenon occurs, it reduces the economic incentives for the firm to switch techniques. If on the other hand, the productivity progress function for the new technique if it is adopted at t_1 is HKL, no such lock-in effect occurs.

There is also another interesting aspect: will productivity tend to be higher for existing firms adopting new techniques or for entrants doing so? This probably depends on the extent to which existing firms can transfer their existing knowledge and experience to production using the new technique. Often they will have an advantage over entrants who intend to use the new technology because of such transfer possibilities. However, cases can also occur in which previous business knowledge and experience is not transferable and is actually an impediment to the productivity of existing businesses using the new technique.

5. Some Other Neglected Microeconomic Aspects of Business Learning

As mentioned earlier, a serious bias exists in discussions of business learning in managerial economics texts because learning about market demand for a businesses' product is ignored.

Learning about how, where and to whom the firm's product can be told can be just (or even more important) that cost reductions made possible by learning and experience in production.

In a business, the nature and sources of learning can vary greatly. Some types of learning merely reflect repetition and on-the-job experience. Other types are much more cognitive in nature.

Furthermore, a business has several alternatives to relying on in-house learning. It can, for example, buy information, hire individuals with experience, observe (to some extent) the behaviour of other businesses, and provide formal training and education to employees. As a result, its productivity progress may occur at an enhanced rate. All such possibilities should really be considered by management from an economic viewpoint.

In addition, rates of learning are often influenced by the motivation of those learning (Champion, 1969). By appropriate rewards and incentives, management can encourage learning by employees and thereby accelerate productivity progress. Such encouragement should be a part of efficient management. No mention is made in managerial economic texts of ways in which business learning can be accelerated. Learning curves in managerial economics follow a fixed pattern. That is a rather limited perspective.

Another area in which there is lack of attention to implications of learning for managerial decision-making is in relation to transfer pricing (Tisdell, 1996, Ch. 11; Williamson, 1975; McGuigan et al., 2002, pp. 649-656). Optimal transfer prices in multidivisional firms are estimated in managerial economic books using a static conception of the firm, even though market transaction costs may be taken into account.

Take a vertically integrated firm consisting of two divisions, a primary division and a secondary division. Assume that the secondary division is well established but that the primary one is relatively new. If learning, is likely to be important for the primary division and is partly a function of its cumulative output, it may pay for the business to give some preference to the primary division in purchasing its input for the secondary division. That would facilitate learning by the primary division and eventually reduce its cost. That could benefit the secondary division. The argument is similar to the infant industry one. Thus the

economic theory of transfer pricing needs to be modified to allow for learning by the divisions of a firm.

6. Concluding Comments

Business learning can be a very important determinant of the comparative competitiveness of firms. Firms that have more experience or which learn faster usually have a competitive edge. While most managerial economics texts now give consideration to learning as an important influence on the productivity progress of a business, treatment of the subject is mechanical and does not adequately allow for diverse possibilities. Furthermore, in the context of business learning, inadequate attention is given to the implications of technical change and product alterations requiring extra learning by the business or "re-learning". Hence, 'lock-in' effects are not mentioned.

A glaring deficiency in the coverage of learning in managerial economics texts in their failure to mention the importance of learning in relation to marketing the firm's product(s). Learning may also be important in relation to purchasing inputs. Furthermore, different ways in which business may learn are not explored nor is the influence of motivation on the degree of learning by employees considered. Again, there has been a failure to adjust optimal transfer pricing theory for multi-divisional firms to allow for learning by the divisions. This shows a failure in managerial economics to follow-up the implications of economic learning theory.

To conclude, the fact is to be welcomed that most texts in managerial economics now give some consideration to business learning as an influence on business success and a factor in managerial decision-making. This paper, however, contends and demonstrates the need for further coverage of this topic in such text books.

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