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SOME OBSERVATIONS ON THE USE OF THE THEORY OF THE FIRM

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I WISH to make a few remarks about effectively using and evaluating agricultural resources. In doing so I wish to approach it as a problem in the application of the theory of the firm. I want to limit my discussion to two problems of farm management to which the theory of the firm could make a greater contribution than it has. The first of these is with respect to changes that can be made within a given farm organization and is usually spoken of by theoretical economists as short run changes. In dealing with that I want to make a point on what I believe is a fundamental difference in production conditions faced by a farmer as compared with those faced by many non-agricultural producers. The second problem concerns the quality rating of certain important factors of production used in agriculture.

The short run concept is important in production economics because certain resources which are used are fixed for a period of time, during which they may be used more or less intensively. The significant fact is that as they are used more intensively there should appear a pattern of output which conforms to the law of diminishing returns in its various phases. That is to say, as intensity of operation changes, the gross product does not vary in direct proportion to the amount of the variable factors used. In the ordinary operating range the gross product increases as more of the variable factor is applied, but it grows at a decreasing rate. This is usually thought of in connexion with intensity of land use, but it is true of other factors as well. For example, dairy cows increase output of milk as they are fed more heavily or with more expensive feeds, but the additional feed becomes less and less effective in adding to the output of milk. The feeding period of livestock raised for meat production is another example. As the animals become more nearly mature, it becomes increasingly difficult to add the additional weight.

The examples just given, drawn from experience in agricultural production, illustrate the phenomenon of diminishing returns from which in turn is derived the theory of the firm. This theory shows phases of rising and falling average and marginal cost functions as the

fixed resources of a firm are used more intensively. The most important deduction is that profits reach a maximum when the cost of an additional unit of variable factor equals the value of the additional product produced.

This conclusion emphasizes the two measures of MC and MR, and infers that production managers should adjust the amount of variable resources used with the fixed resources as variable costs and price of output change. It implies that business men need to know the marginal productivity of the variable factors of production over a reasonable operating range. They would need to know this in addition to the average return for the factors of production.

In view of this one might expect that a technique of measurement would have been developed in the business world which would give a more precise measurement of marginal cost on which decisions could be based. The fact is, however, that a good deal of effort has gone into developing and improving technique for calculating average costs and comparatively little towards methods of calculating marginal cost or marginal productivity. Apparently this is left largely to the intuition and judgement of the production manager.

It has been my observation, however, that there is a reason for this apparent lack of concern over marginal cost on the part of accountants for non-agricultural firms. I believe that many non-agricultural firms do not need to contend with diminishing returns in the form that it appears in the preceding examples drawn from agriculture. They are concerned with a special case of the law in which output is directly proportional. Empirical studies of manufacturing firms by Andrews, Nicholls, and Dean seem to substantiate this idea.

The implication, then, is that under actual operating conditions marginal cost is almost constant over a wide range of operations ending at a fairly well-defined point of capacity, where marginal cost goes sharply upwards. A consequence of this type of cost behaviour is that marginal cost and average cost are equal over a practical operating range. This seems quite reasonable. On an assembly line, for instance, output must be approximately in direct proportion to the labour and materials used. But when this is true then an average variable cost figure is a good guide to production decisions in the short run since it is also a marginal cost figure. Perhaps most non-agricultural firms have no real need for anything but average cost figures. The practical aspect, then, is that once a plant is established the production decisions are not difficult—the main task is to maintain sales so as to keep the plant operating as nearly as possible to capacity.

It seems to me, though, that there is an almost fundamental difference between the foregoing and the parallel situation in farm management. It is a fact that the nature of many agricultural factors of production is such that they respond to intensive use according to the general form known as diminishing returns. As a result certain very distinct economic problems arise in farm management which are not encountered in the aforementioned special case. In the first place the short run production decisions are more complicated than they are in the case where output is directly proportional to the variable factors used. Most farms sell their product under market conditions where the product of the individual farm does not affect the price. In the special case referred to, this would provide sufficient incentive to produce to capacity. In farm production there is no such well-defined point of capacity, because land and livestock respond to more intensive use with a gradually decreasing productivity. The point of short run maximum profit, therefore, is shifting according to changes in variable costs and prices of the product. In other words, as short run changes occur in prices and costs, production needs to be adjusted if agricultural resources are to be used to best advantage. There is a real task, therefore, to study carefully certain important productivity functions of livestock and land. Part of this task—and by no means an unimportant part—is to spread the idea of a functional relationship which is not a directly proportional one. That is made more difficult because, as I have mentioned, in many types of production it can be ignored for practical purposes. It seems, though, that the idea should be incorporated into the design of purely physical experiments so that the results from them will be more usable under actual production conditions. Many experiments of this type (e.g. on the application of fertilizer and of labour to land) use only one or two combinations of these two factors that are being tested. Such results are exceedingly unsatisfactory in practical farm management, especially if all the measurements are short of the point of diminishing average returns or even short of diminishing marginal returns, as has sometimes been the case.

The other point arising from this is that the quality rating of certain factors of production (e.g. land and animals) is more involved than simply measuring the total output obtained from them. Output would be a perfectly satisfactory measure were it not for this gradually diminishing response to more intensive use. That is to say, if land responded to capital and labour input in direct proportion, then gross capacity would also measure the quality. When the response is not direct, as with agricultural factors, then quality rating

becomes somewhat more complicated. Then it is necessary to express quality in terms of net production or in terms of both efficiency and gross output. Furthermore, the rating might shift as costs and prices change. I feel, therefore, that both these problems, namely, changes within the farm organization and improvement in quality ratings, would be assisted by a more vigorous application of the theoretical model suggested by the law of diminishing returns.

D. L. MACFARLANE, *Macdonald College*

Might I ask Professor Anderson what is the moral of this marginalism which he advocates for agriculturalists, in the sense of participating in the work of government price-fixing programmes such as Professor Thomas outlined. Our agricultural economists have, in some countries, wittingly or unwittingly made themselves servants of government programmes where these devices you suggest are not employed and where they might appropriately be employed.

W. J. ANDERSON

If I have understood the question correctly, I would answer that I start the analysis where the price-fixing leaves off. In other words, I am stating it from the point of view of the individual farm manager who takes his prices as given, whether they are determined by a free market or by negotiation in the political field. The relative prices, whether negotiated or free-market prices, are in any event going to change from time to time, and that is of significance to the farmer who is faced with this sort of production condition in relation to his land and livestock.

D. L. MACFARLANE

I am in agreement with Professor Anderson's address on practically every point, but I want to question the statement that agricultural economists in this type of work take farm prices as given. Have we no contribution to make in the type of work that has been elaborated by way of helping governments in the determination of prices and of price policy?

W. J. ANDERSON

I think that we have. I was dealing with it from the point of view of the farm manager who, as I said, takes his prices as given. If, on the other hand, we were looking at it from the point of view of agricultural economists seeking in some manner or other to influence government to obtain the optimum relative prices for the best use

of our resources, then I agree, of course, that a knowledge of the kind of functions I have been discussing would certainly assist to that worthwhile end.

K. SKOVGAARD

I feel that the whole problem has been a little too much generalized. Agricultural production is composed of two main lines of production: utilization of land, where decreasing returns or increasing marginal costs are typical, and livestock production, where the cost-pattern behaves very much like that of other secondary industries. Take, for instance, hog production. A farmer has a hog house accommodating 100 hogs, and within that capacity the marginal cost of hog production may remain fairly constant, as each hog is fed with a given quantity of feed. The same applies also to poultry production, but to a less extent to cattle production, as the latter is more closely connected with the utilization of land. In the cowshed we have two dimensions of expanding production: the number of cows may be increased, giving constant marginal costs, or the milk-yield per cow may be increased by more intensive feeding, giving increasing marginal costs. In both cases, however, the increased production may be interrelated to an increased intensity in feed-production subject to increasing marginal costs.

In land utilization, too, the principle of decreasing returns must be carefully examined. Increasing wheat production by expanding wheat acreage may, to a certain extent, take place at constant marginal costs, while increasing wheat yields per acre fairly soon leads to increasing marginal costs.

For these reasons the difference of the cost-pattern, inside agriculture and manufacturing industries, is far too often over-emphasized, and it seems to me that for several reasons we ought rather to be concerned with the two lines of agricultural production, that is, to distinguish between the primary or land utilization, in which decreasing returns will prevail, and the secondary or livestock production, which economically behaves very much like manufacturing industries.

W. J. ANDERSON

I do not deny that in certain lines of agricultural production there appears the phenomenon of constant marginal costs. Professor Skovgaard selected one of the very best examples when he suggested hog production, but if it came to a question of raising hogs to higher and higher weights, marginal costs would not be constant. Actually that

is effectively eliminated as a consideration by the fact that the market demands are for hogs within fairly narrow weight limits. But, if in the case of beef production you think of the problem of raising animals to different ages, you would certainly find again that marginal costs are not constant.

L. Loewe

We have had considerable experience in Israel of this problem, because our land is scarce and we have to try to produce more and more food on a small area. We had to adopt intensive methods of farming, and in like degree the cost of production rose very sharply. I think that the Government can influence the intensities of farming and thereby also the intensity of population by adopting some devices which enable the farmer to grow his crop products or to grow his animal products more or less intensively. When we can afford to give the farmers more land we can also by that method reduce in a large degree the cost of production.

G. L. Burton

I am anxious to get the correct implication from the exchange between Professor Macfarlane and Professor Anderson. It seems to me that if we accept Professor Anderson's analysis and attempt to apply it to price-fixing, irrespective of the prices which are fixed, the farmers' cost of production will always be equal to that price under two conditions: first, that he knows his own best interest; and second, that economic rent is included as a cost. If that is the case, even though the price is raised the cost of production will still be equal to the price. Am I correct in drawing that inference?

W. J. Anderson

Professor Burton has the advantage of having drawn and examined a few curves, and I am not so sure that I can answer without examining them. He is, however, correct that if economic rent is included it is certain the price fixed will always equal the cost of production. There is no denying that long-run phenomenon. My answer to Mr. Macfarlane's question was simply this, that I thought of price-fixing in this way: Suppose we were asking for a greater output, as we did in the War in the case of certain oils and other products, then rising marginal cost would have to be taken into consideration in determining the price that was to be paid to create the necessary incentive.

W. G. MURRAY

Granting the validity of Professor Anderson's approach, I assume that the gap which exists is the responsibility of the technical agriculturalists, who have not produced the type of data which one would like to have on a physical basis. I would like Professor Anderson to illustrate what he would like them to do, and also indicate to us any work along these lines which he knows of.

W. J. ANDERSON

First of all I had better say that one of the chief things where work along this line by the technical agriculturist could be of benefit to us is the use of fertilizers on land. A good deal of the experimental work has been done in that field, but the reports published provide results of only one or two combinations. That is a criticism I would make of the technical work, and one of the most important ways in which this kind of technical work could be improved. As another example, there is a fairly good production function in the case of dairy cows, but it is for high-producing dairy cows. Not all farmers have, or ever will have, high-producing dairy cows, and there is room there for the technical agriculturalist to examine at least two more production functions for dairy cows. Those are two examples which come to mind now. The best one that I know is the one of input–output relationships in dairy cows, sometimes known as the Jensen–Woodward experiment.

D. B. WILLIAMS

In his paper Professor Anderson reviewed the factors of production in agriculture. Is it not important to consider two other things which need to be superimposed on the analysis he has presented to us? The first point is this question of dynamics. I gathered from the paper that Professor Anderson was a little worried about the failure of the analysis so far presented to provide an effective solution of some of these cost relationships. It seems to me that in order to express those costs more accurately we should try and get beyond a mere dollar or pound evaluation of the costs. Instead of assuming that we get an accurate evaluation of costs in terms of dollars, and particularly of future prices (discounted to the present, if you wish), this factor risk is the all-important one—the dynamic factor is the all-important one. I am reminded of a paper which is buried in the *Journal of Farm Economics* of 1932, in which the writer expressed the view that it was all very well to express cost in dollars, mixing up all the different

kinds of costs which are found on a farm; but, after the analysis, it is just as necessary to go back and see whether that complete mixing of costs expressed in terms of dollars (assuming you do get a correct evaluation in terms of dollars) does not lead to trouble. Those two factors on the dynamic side, and the fact that one must look to the effect of expressing all the many different kinds of costs in terms of a unit of money, need to be superimposed on the static analysis which has been presented.

W. J. ANDERSON

The question is simply this: My analysis here is a static one; superimposed on it is the dynamic situation in which risk plays a large part. I would certainly agree that that was very true. Risk does play a large part, and as a result we find in many cases that the marginal cost is a long way below the value of the marginal product, simply because of this risk factor. The farmer is afraid to take the next step or to use certain factors of production because he is not sure what is going to happen to the price of the product over the next few years. He would rather operate, therefore, at considerably less intensity than he otherwise would. That is certainly an addition to this kind of analysis that, as it is developed, cannot be forgotten.

K. SKOVGAARD

When I spoke earlier I omitted to mention that in the Scandinavian countries a fairly comprehensive physical documentation is available to the farmer for the determination of the degree of intensity or utilization of productive agents. It certainly holds true of the application of fertilizers, for which the production curve is fairly well defined from the results of a substantial number of experiments carried out yearly. But in other fields of production, too, physical data are available where the farmer can decide when to stop the inputs and keep within the economic limit.

M. R. BENEDICT

I would like to raise two questions which I think perhaps supplement Professor Anderson's paper. One is an implication in the paper that he was dealing with a specific enterprise rather than the whole business of the firm. I put the question this way: would Professor Anderson agree that to be realistic in handling that issue he would have to deal with the resistances to production which arise from the opportunities offered by alternative products in the same way as with direct cost? If one were dealing only with one commodity, one

enterprise, then the analysis given could be dealt with in direct terms; but if there is another enterprise which offers possibilities of greater profits, that possibility operates as a resistance to production in the same way as a cash outlay. Secondly, in order to relate the discussion to the question raised elsewhere on policy, it seems to me that the analysis Professor Anderson has indicated really underlies the thing we need from a policy standpoint. We need to know nationally and area by area, the nature of the supply response curve, and it is the aggregation of these individual response curves which makes up the total supply curve. In other words, it may help us to a more realistic approach to price-fixing itself, leaving out, I would hope, the thing that Burton mentioned, namely, the idea of including economic rents as cost.

W. J. ANDERSON

There is not much for me to add to that except to say that the idea of extending the analysis to include several enterprises is a very valuable enrichment of this whole topic. It is true that I developed this thing as though I were talking about one individual enterprise and thinking of the intensity of the use of the factors with it. In the same way two enterprises would compete for factors of production, and it would be a case of equating the value of the marginal product from the factor under consideration in each of the enterprises. In answer to the second part of Professor Benedict's comment, I would certainly agree that precise knowledge of the nature of supply response functions would be invaluable from a price-policy standpoint.