DEMAND STRUCTURE AND SUPPLY CONTROL OF BANANAS

JOHN PHILLIPS*

1. THE PROBLEM

The purpose of this study is to determine whether supply control in the banana growing industry will raise profits and, if so, what is the most profitable level of production. In order that a useful recommendation may be made to the industry it is necessary that both questions be considered.

2. THE PROFITABILITY AND DEGREE OF SUPPLY CONTROL

The answer to the first question is simple and obvious. Supply control in a competitive industry operating at the equilibrium output will always raise profits in the industry. This fact is readily demonstrated. A competitive industry, which takes no account of the influence of its output on price, equates marginal cost with demand price. The situation is illustrated in Figure 1 where (P_c, S_c) is the competitive price output. But as a result of this failure to consider the effect of output on price, it can be seen that at this output marginal revenue exceeds marginal cost. So a contraction in output will increase net revenue. This increase in net revenue will continue until marginal revenue equals marginal cost. So it is seen that a competitive industry which acts under a single authority, that is as a monopolist able to take account of its influence on price, can raise profits by controlling supply.[1] The optimal supply will be that at which marginal revenue equals marginal cost. The situation is illustrated in Figure 1, where (Pm, Sm) is the monopoly price-output.[2]

* Economics Research Officer, N.S.W. Department of Agriculture.

[1] It is apparent that this statement applies regardless of the elasticity of demand for the commodity.

[2] In this presentation, it has been assumed that monopolization will have no affect on the cost or demand schedules. Since producers will still act as competitors in their factor markets, the cost curve will be unaffected. It is unlikely that the demand curve will change radically either. For a fuller discussion of this whole question see Joan Robinson, *The Economics of Imperfect Competition* (London: Macmillan and Co. Ltd, 1961), Ch. 11.

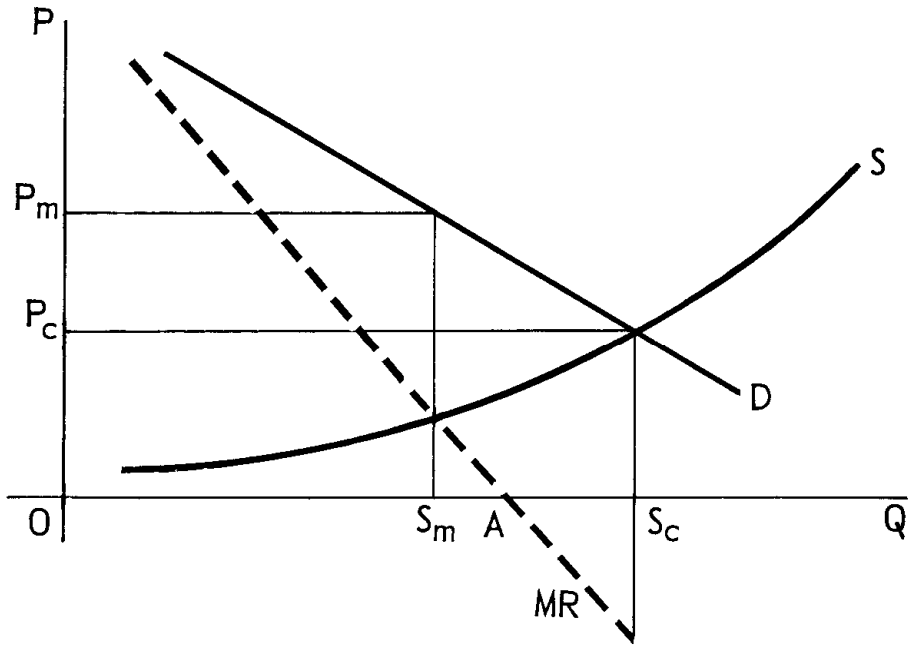

Figure 1. Comparison of Monopoly and Competitive Output

From the foregoing it is seen that knowledge of the parameters of the demand and supply curves for bananas would enable the determination of the most profitable (monopoly) output, that is, the optimal degree of supply control. However, even without knowledge of the supply curve, it may be possible to go part of the way in estimating profitable supply control from a knowledge of the demand curve alone. Should the marginal revenue be negative for the output produced at present, then it will pay to contract output at least to the point where marginal revenue is zero. In Figure 1, supply would be restricted from OS_c to OA. The remainder of the paper is an attempt to estimate the supply at which marginal revenue is zero.

3. THE ECONOMIC MODEL OF DEMAND STRUCTURE

In describing the structure of demand, two questions must be answered. What are the factors which affect the price of bananas; are the variables related by a single equation or a system of equations, that is, are the variables other than price predetermined or is the relation a simultaneous one? The main factors expected to affect the price of bananas are banana production, consumer income and prices of other fruits. Of these variables production is essentially predetermined since is it affected only in extreme circumstances by current prices. Consumer income is also a predetermined variable as banana purchases represent a very small porportion of total expenditures.[3] However, the relation between banana price and the price of other fruits is a simultaneous one.[4] Hence, a single equation model will not accurately describe the structure. It is now necessary to proceed to a statistical estimation of this model.

[3] For a fuller discussion see K. A. Fox, "Structural Analysis and the Measurement of Demand for Farm Products", *Review of Economics and Statistics*, Vol. 36, No. 1 (February, 1954), pp. 57-66.

[4] This fact is emphasised in K. W. Meinken, A. S. Rojko and G. A. King, "Measurement of Substitution in Demand", *Journal of Farm Economics*, Vol. 38, No. 3 (August, 1956), p. 711.

4. STRUCTURAL ESTIMATES AT WHOLESALE AND FARM LEVELS

Using data from the twenty-one year period 1942/43 to 1962/63, the following estimating function was derived:[5]

$$Y = 96{\cdot}50 - \underset{(17{\cdot}61)}{132{\cdot}62X} \qquad (R^2 = 75{\cdot}9)$$

Y is deflated average annual wholesale banana price in shillings per bushel and X is annual per caput supply in bushels.[6] The function is a hybrid one, the co-efficient of X being derived from first differences and the constant from actual data. Preliminary formulations contained eight other variables—income, prices of oranges, apples, peaches, pears, and apricots, and lagged price and income, none of whose co-efficients was significantly different from zero. Furthermore, the collective effect of the first six variables was also non-significantly different from zero.[7] Hence they were excluded from the final estimating function.

Since supply control is normally done at the farm level, it is necessary to derive the demand function at that level.[8] The difference between the two functions depends on the price of wholesalers' services and the cost of transport to the wholesale market. Marketing margins of wholesalers are approximately ten per cent of the value of the crop. The weighted average of transport costs to principle markets, excluding Tasmania, is 6·67 shillings per bushel. So the demand function at the farm level will be:

$$Y - 0{\cdot}1Y - 6{\cdot}67 = 96{\cdot}50 - 132{\cdot}62X$$
$$Y = 114{\cdot}63 - 147{\cdot}35X$$

From this function can be estimated the supply at which marginal revenue is zero.

5. AN ESTIMATE OF SUPPLY CONTROL

To find the output at which marginal revenue is zero, the total revenue function must be derived, differentiated with respect to quantity and equated to zero.

$$\text{Total revenue} = XY = 114{\cdot}63X - 147{\cdot}35X^2$$
$$\text{Marginal revenue} = 114{\cdot}63 - 294{\cdot}70X$$

[5] It is seen that this estimate ignores the simultaneity in the structural system just noted. But lack of data for the many outlets for other fruits precludes simultaneous estimation. However, this procedure need not necessarily vitiate the results. In practice, least squares estimates and predictions based on them, are probably as reliable on balance as those from simultaneous estimation. See R. J. Foote, *Analytical Tools for Studying Demand and Price Structures*, U.S.D.A. Agricultural Handbook No. 146 (August, 1958), pp. 128-141.

[6] Source of data, Commonwealth Statistician, *Primary Industries Bulletin*, Part II. *Non-Rural Industries and Value of Production* from 1950-51; prior to this in *Primary Industries Bulletin*.

[7] The procedure for carrying out this test is described in Foote, *op cit.*, pp. 182-183.

[8] Supply control can of course be effected at the market level by destroying surplus output, but it is unlikely that producers would use this method. The welfare implications of both forms are discussed in Marc Nerlove, *The Dynamics of Supply: Estimation of Farmers' Response to Price* (Baltimore: The John Hopkins Press, 1961), pp. 222-235.

Marginal revenue is zero with a supply of 0·3890 bushels per capita.

This supply is considerably less than that which has been available over the past few years (average of five years to 1962–63 of 0·4616 bushels per capita). Thus there appears to be a case for restriction of banana supplies.

6. ADEQUACY OF THE ESTIMATION

But before attempting to base any recommendations as to supply control on this function, it is necessary to examine its adequacy as an estimator. There are two main problems, each of which concerns the range in which the estimate lies.

In the previous section, the estimate of supply at which marginal revenue is zero was given as a single value without confidence limits. But, with a 95 per cent confidence interval, it is found that the estimate is within the limits 0·3087 to 0·5258 bushels per capita. Since the upper limit is greater than the present supply, it is not possible after all to recommend, even in part, by how much supply should be controlled. This problem is aggravated by the presence of serial correlation in the residuals.[9] Serial correlation results in underestimation of the variance.[10] Hence the range of the estimate is in fact even wider than that derived above.[11]

7. CONCLUSION

Initially it was shown that supply control in the banana industry would raise profits. The problem then was to determine the degree of supply control. As a partial solution to this question, an attempt was made to ascertain whether the present supply exceeds the point of negative marginal revenue. The answer was inconclusive. Hence no recommendation can be made to the industry on this question.

[9] The Durbin-Watson statistic is 0·90 which shows positive serial correlation at the 5 per cent level of significance.

[10] J. Johnson, *Econometric Methods* (New York: McGraw-Hill, 1963), Ch. 7, pp. 179-192.

[11] An additional problem concerns the accuracy of the data. Errors in the independent variable bias downwards the co-efficient of this variable and so result in further underestimation of the upper limit of the estimate. The degree of error is unknown, so it is not possible to adjust data for error. Incidentally, multicollinearity in the explanatory variables, which exaggerates variance, was not a problem. In no case was the partial correlation co-efficient greater than 0·7.