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Economics of Controlling Livestock Diseases: Basic Theory

by

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Economics of Controlling Livestock Diseases: Basic Theory[†]

by

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Economics of Controlling Livestock Diseases: Basic Theory

Abstract

Extends the simple model of the economics of controlling livestock disease as first presented by McInerney (1991) to take account of start-up costs which give use to thresholds effects. A further extension is given to allow for economics of such in disease control which can also have a threshold effect. The problem of uncertainty about the costs and benefits of disease control in livestock is also discussed.

Economics of Controlling Livestock Diseases: Basic Theory

1. Introduction

Economic analysis of the optimal control of livestock diseases is complex. This is because of the diversity of diseases, differences in their epidemiology and in their nature of occurrence as well as considerable variation in preventative measures, treatments and responses. Economic analysis takes account of the monetary benefits and costs of controlling diseases. To do this, it has to combine biological and veterinary knowledge with financial considerations. Consequently, inputs from both economists and non-economists are required for this economic analysis.

Cost-benefit techniques are widely used in economics for determining optimal economic choices at the farm-level and on wider scales, such as at regional or national levels. Using this approach, optimality is achieved where net benefits, that is economic benefits less costs, are maximized. McInerney (1991), McInerney, Howe and Schepers (1992), Tisdell (1995) and others have advocated its use for obtaining the economically optimal control of livestock diseases. Some simple economic models are outlined here which illustrate its use. They draw on and extend some of the models in Tisdell (1995).

2. Economic Benefit from Controlling a Disease as Economic Loss Avoided

The economic benefit from controlling a livestock disease can be measured by taking into account the reduction in economic loss from the disease corresponding to different levels of expenditure on its control (McInerney 1991). In Figure 1, for example, OA is the economic loss from the disease if there is no expenditure on its control and ADF represents the economic loss as a function of control effort measured by variable expenditure on control of the disease. Therefore, the difference between line AG and curve ADF, shown by the shaded area represents the economic benefit from controlling the disease for possible levels of expenditure on its control. Given available knowledge it is assumed that for any level of expenditure on disease control that expenditure is undertaken in a way that maximizes economic benefits. To ensure this, however, is not always an easy task.

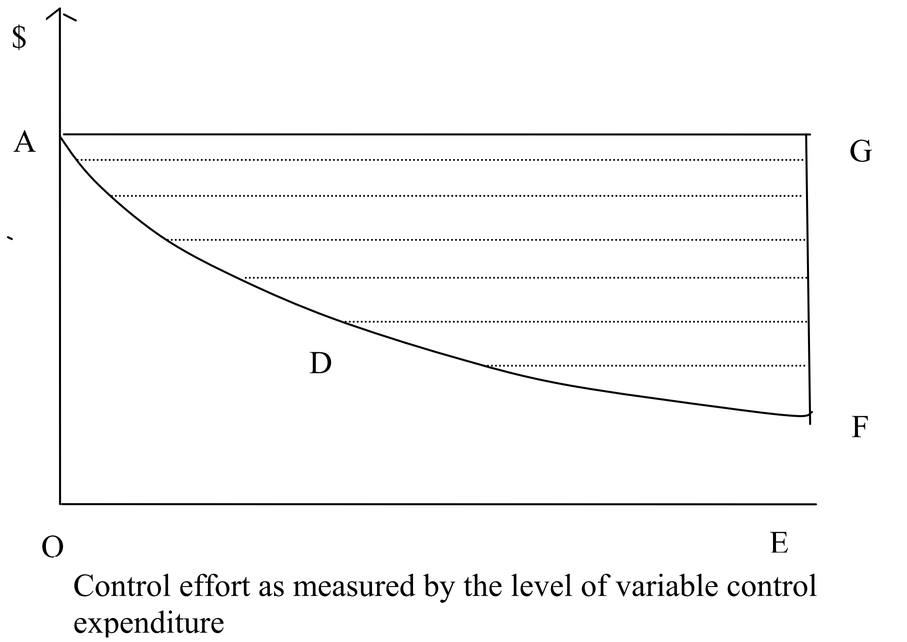

Figure 1. An illustration of the economic benefit from the control of a livestock disease by the level of economic loss avoided.

3. Optimality in a very Simple Economic Model and Threshold Possibilities

A very simple economic model can be developed from the above. Mathematically, the type of economic benefit relationship illustrated in Figure 1 can be expressed as:

$$B = a - g(E), \tag{1}$$

where B is economic benefit, a is the level of economic loss in the absence of control of the disease, and E represents the level of variable cost of (expenditure on) control of the disease. The total cost, C, of control of the disease, can be envisaged as consisting of possible start-up, fixed or overhead costs, k, and variable outlays, E. Thus:

$$C = k + E, \tag{2}$$

where $k \geq o$. Therefore, the net benefit from disease control is:

$$NB = B - C = a - g(E) - (k + E) \tag{3}$$

$$= f(E) - (k + E) \tag{4}$$

If the benefit function increases at a decreasing rate, that is if $f' > o$ and $f'' < o$, net benefits from disease control will be maximized when the value of E, expenditure on control, is such that the extra economic benefits from control equals the extra costs of control, that is for the value of E for which:

$$f'(E) = 1 \tag{5}$$

This is so provided that for this value

$$f(E) - (k + E) > o, \quad (6)$$

that is total benefits exceed total cost. Otherwise no expenditure on controlling the disease is optimal. Other things equal, the higher is *k*, the more likely is it that no control is optimal. However, even if k = o, it is possible that no control of a disease is optimal because the marginal benefit of control of the disease, $f'(E)$, is always less than its marginal costs of control.

The presence of start-up or overhead cost for controlling a disease, k > o, creates a control threshold. If it is economic to control the disease, control must be on a minimum scale before benefits cover costs. This can be illustrated by Figure 2. In this figure, start-up costs are shown as OH and line OHJ (a 45 degree line) represents the total cost of controlling the disease. The curve marked OLMP shows the total benefit of controlling the disease, and OA is the loss caused by the disease in the absence of its control.

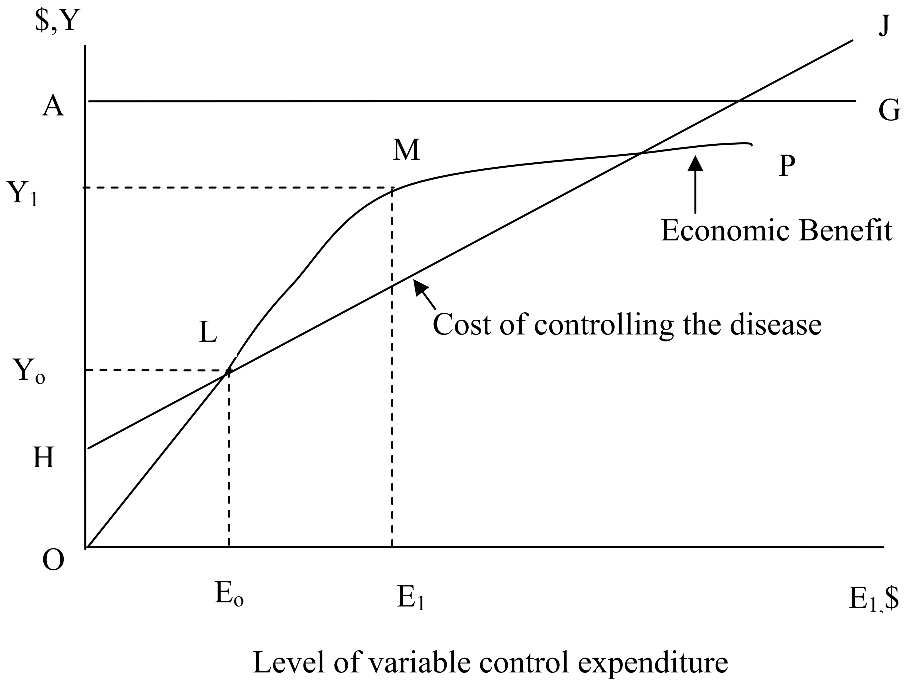

Figure 2 A cost benefit model for livestock disease control in which start-up costs give rise to a threshold effect.

From Figure 2, total expenditure of less than Y_o on control of the disease, involving a variable expenditure of E_o, can be seen to be uneconomic. At least this level of outlay on control is required before benefits cover costs. However, net benefits are maximized for a total outlay of Y_1, or an operating outlay of E_1, and the optimum corresponds to point M in Figure 2. Other things equal, the larger are start-up costs, the larger is the control outlay required before benefits cover costs.

4. A Second Economic Source of a Disease Control Threshold

The economic benefit curve from expenditure on the control of a livestock disease may not be strictly concave everywhere unlike in the model considered above. It may, for example, take a logistic form like that shown in Figure 3 by curve OKLMP. In this example, start-up or overhead costs for control of the disease are assumed to be absent and therefore, the 45 degree line OLJ represents total outlay on control of the disease.

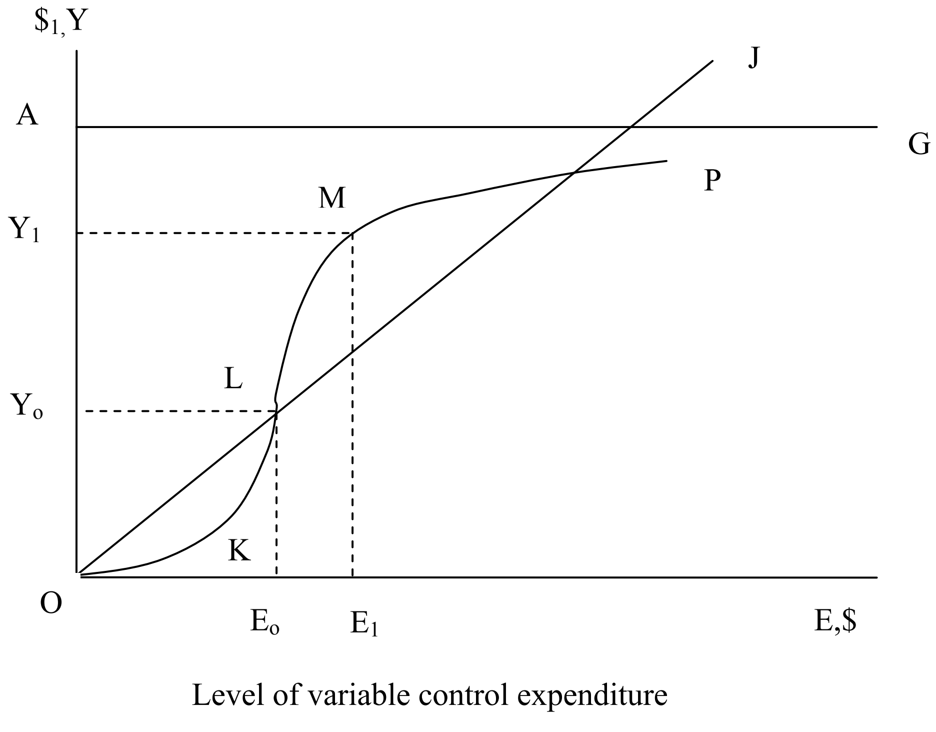

Figure 3 Another cost-benefit model in which economies of scale rather than start-up costs of control give rise to a threshold effect.

The net benefits of control are maximized when $E_1 = Y_1$ is spent on controlling the disease. Furthermore, a minimum of $E_o = Y_o$ must be spent on controlling the disease before the costs of its control are covered by the benefits gained. This threshold, created by initially increasing returns from undertaking control on a greater scale, arises in the absence of start-up or overhead costs.

5. Discussion

Empirical evidence is of course needed to establish which types of benefit and cost functions are relevant to the control of particular livestock diseases. There may even be some cases where it is economic to eliminate all losses that could arise from a disease by eradicating it. In such cases, the benefit functions would actually meet line AG in Figure 2 rather than merely approach it. The modelling can also be extended to take account of the simultaneous control of several diseases as suggested in Tisdell (1995) and more specific allowance can be made for time. Nevertheless, the above simple models provide policy insights.

They highlight the potential importance of thresholds for the control of livestock diseases. When such thresholds arise, they can be lowered by reducing fixed, start-up or overhead costs of control or by increasing the productivity of control outlays in securing benefits, depending on their source.

It is also important to realize that the benefit and cost curves for disease control do not remain stationary in time. For example, if the economic value of particular types of livestock increase, then greater benefits are obtained by controlling diseases that afflict these livestock. The models outlined can also be used to show that diseases causing great economic loss maybe less economic to control than those that cause less economic loss. Often the presence of a large loss from a livestock disease is used as a political argument in favour of its control and for spending more on its control than a disease that causes smaller economic loss. However, this may not maximize net economic benefits from the control of livestock diseases.

A major problem in deciding on levels of optimal expenditure in controlling livestock diseases is uncertainty about the economic cost and benefits involved. Trial-and-error may be used to search for the economic optimum but this will be risky if large thresholds occur before benefits exceed costs. The search procedure can, however, be undertaken by small steps in the case illustrated by Figure 1 if *k* = o or is small, that is if start-up costs are zero or very small, (see Tisdell,1996 Ch.3).

More information may also be collected about the nature of the benefit and costs curves; for example from trials or experiments. However, even the collection and processing of information has an economic dimension. Baumol and Quandt (1964) suggested that it is only economic to collect and process information up to the level where the extra cost of this equals it expected extra economic value (see also Tisdell 1996, Ch1; Ramsay et al, 1999). Thus, even if it were possible to collect enough information to obtain perfect knowledge of the benefits and costs of controlling a livestock disease, it may not be economic to do that. Or in the case of public administration, less funds may be provided to obtain information about the benefits and costs of control of livestock diseases than is optimal. Consequently, much decision-making about the economically optimal level of control of livestock diseases must be made under conditions of uncertainty. Therefore, it is also important to analyse the optimal control of livestock diseases under conditions of uncertainty, for example, by drawing or decision-making models, some of which were stimulated by the development of the theory of games (Tisdell, 1968, Ch2, von Neumann and Morgenstern,1953).

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