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The economic implications of animal diseases and disease control at the national level

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Summary

The authors examine the economic implications of animal diseases and control programmes at the national level, including the role of government in animal health, the effect of regulations and the use of cost-benefit analysis. Special attention is paid to the role of economic analysis in government decision-making processes. Economics provides a framework for gathering information and for the presentation of that information in a methodical manner, thereby providing a method for the decision maker to examine policy alternatives. In addition, assumptions underlying the analysis must be clearly laid out and explained by the person undertaking the analysis. Economic reasons for government intervention in animal health programmes include externalities, natural monopolies, public goods, coordination failure, information failure and distribution issues. An integrated holistic approach that includes national and international policy objectives is outlined in the paper. In the approach outlined, government coordinates the activities of stakeholders in animal health, including producers, consumers and researchers.

Keywords

Animal health – Control programmes – Cost-benefit analysis – Economic analysis – Economics – Externalities – Public policy.

Introduction

National animal health authorities are operating in a changing environment which is becoming more demanding. The new environment has been brought about by limitations in public funding and more critical examination of publicly funded projects. In addition, consumers in developed countries are better informed (and occasionally misinformed) about health issues related to the consumption of animal products. As a result, alternative funding methods for national animal health programmes are required (e.g. 'user pays' or privatisation of services). In many countries, changes in funding methods have already occurred. In addition, economic analysis is becoming an important element in the development of animal health programmes to determine the benefits gained from programmes and the return from investment in those programmes. However, economic analysis in animal health has generally been undertaken within an animal health framework that has limited the application of the wider methodologies provided by economics.

Economics offers a framework for analysis of animal health problems which can be used to assist in setting animal health priorities and in decision-making in animal health programmes. Economic analysis provides a broad framework which enables the implications and impacts of decisions to be considered. Externalities, or flow-on effects to other members of the community are incorporated, in addition to the direct effects of a policy action or event. A holistic approach to analysis of publicly funded animal health programmes enhances the role of government as a promoter of economic efficiency.

Furthermore, economics provides a framework for gathering information in a structured manner. The information collected is analysed and presented methodically, thereby

enhancing the knowledge of the decision maker. Economic analysis should not be seen as providing an 'automatic' solution to a problem but rather as a tool which assists the decision maker in understanding the complex interactions and likely effects of the decision. In some cases, analysis provides a means for the decision maker to rank policy alternatives using a common methodology. An important aspect is that economic analysis requires that the assumptions underlying the analysis be explicitly laid out by the person undertaking the analysis. Ultimately, the decision about a policy or programme is made using a combination of economic, political and technical information in association with knowledge on resource limitations and risk. In some matters, economics will almost certainly take second place to political considerations, for example in affairs involving intergenerational equity or the extent to which the beneficiaries of a new policy are required to compensate those disadvantaged by the policy.

It is important to note that economics is not free of value judgements. Judgements can differ between economists. What one economist regards as a problem may be perceived to be an issue of little consequence by another. In addition, the policy recommendations and the role ascribed to government may vary substantially depending upon the value system of the economists involved in the analysis.

This paper provides information on national animal health programmes and demonstrates how animal health activities fit into the agricultural production system and the economy as a whole. To achieve these aims, the paper outlines the role of government in animal health and examines the effects of animal health on the efficiency of production, trade, income distribution and asset values at a national level.

Role of government in animal health

The question of whether or not government intervention is required in animal health should be raised. This question is an important one in the current economic climate where public expenditure is generally being reduced. To provide readers with an understanding of current economic thinking, this section examines economic arguments for government involvement in the market, with specific reference to animal health.

In the extreme case of absence of government intervention, market processes would determine the types and quantities of the products produced, the methods of production and prices paid for those products and the incomes earned by those producing the products. While the general tendency has been for governments to withdraw from the market (13), a number of defensible justifications for government intervention can nonetheless be cited. These include externalities, natural monopolies, public goods, coordination failures, information failure and income distribution issues. The following section will examine these externalities, focusing on the more important issues. The complexity of many of these issues means that while some may be resolved after detailed economic analysis, others will not be resolved through the use of these methods.

Externalities

Externalities arise when, in the course of producing, marketing or consuming a commodity, harmful or beneficial side effects arise that are borne by a third party who is not directly involved in the production or consumption of the goods. An animal health programme designed to control a communicable livestock disease is likely to be most successful if all farmers in the area where the disease is present, and where the programme is being introduced, participate in the programme. The non-participation of some producers – which may be the best strategy from the viewpoint of the producer – could result in a reservoir for the disease remaining, with the result that the disease could reappear in the livestock that were involved in the control programme. This is an example of a negative externality. Many other examples exist, including the possibility that incorrect use of a chemical by a few producers could result in a mutation or counter-resistance of the targeted organism, thus reducing the usefulness of the chemical to producers who have not yet used the chemical or have used the chemical appropriately (12, 20).

A legal solution could be used in the case of the disease control example outlined above, with the producers participating in the programme seeking damages from the non-participants. However, legal solutions involve the use of economic resources and might not be practicable in some cases (for example in a developing country where those involved may have few resources). The textbook solution to an externality problem would be for the parties to negotiate among themselves. One possibility is that the non-participants in the programme would be 'paid' to participate by those involved in the programme. For example, in a developing country, a large commercial operator could undertake to provide vaccines and administer the vaccine to the animals owned by smallholder livestock producers.

In practice, the negotiated outcome might be difficult to achieve since the agreement of several different parties would be required. Government legislation may be required to ensure that all producers in the livestock industry participate in the disease control programme. Alternatively, government may need to provide funding for the disease control programme. In the case of the 1980s brucellosis eradication programme in Australia, the government provided interest rate subsidies to assist farmers in improving fencing to facilitate the health management of herds.

When a herd of animals is vaccinated to control a disease, a positive externality can arise: neighbouring herds will have a reduced risk of contracting the disease, even if these herds have not been vaccinated. In this case, the neighbours benefit from the vaccination programme, without contributing to the cost of the programme. Positive externalities often occur in animal health, leading to a situation where animal health services are often under-supplied from a social point of view.

Natural monopolies

A natural monopoly arises if goods or services can be provided at the lowest possible cost by a single firm. The most common example of a natural monopoly is the local provision of telecommunication services or railway services. Quiggin points out that under conditions of natural monopolies, unregulated markets are unlikely to yield satisfactory outcomes (18). Firms may under-invest in certain areas and over-invest in others. Governments in Australia, the United States of America (USA) and Western Europe have moved against natural monopolies in a number of industries by regulating prices or by adopting the common carrier principle. The classification of a firm as a common carrier means that it must provide services to all customers at non-discriminatory prices. Merger and acquisition activity in the USA and Europe has led to a relatively small number of large agricultural input and pharmaceutical firms dominating research and technology in biotechnologies. On the one hand, this will allow massive expenditures on the development and dissemination of technology, but on the other hand this raises questions about access to the technology and the pricing practices used by the firms (20). Newly developed products such as vaccines can be protected from competition by patents, allowing the firms that produced the product to recoup the investment.

The problem facing governments is to what degree the natural monopoly should be regulated. The development of a new drug or vaccine may involve high risk and require substantial investment. Too much regulation will be a disincentive for firms to develop new drugs, while too little regulation could lead to a small number of firms in the animal health industry (possibly colluding with one another) charging prices that are too high from a social viewpoint.

Public goods

Economics classifies goods and services as either public or private. Public goods have two characteristics. Firstly, the consumption of goods or services by one individual does not reduce the amount available for consumption by others. Secondly, once the public goods are provided, to exclude others from consuming the goods would be impossible or prohibitively expensive. Private goods provide the opposite result: consumption of private goods by one individual means that the goods are not available for consumption by another individual, and others can be prevented from consuming the private goods. An example of a private good is artificial insemination of a cow by a livestock technician. The fact that the technician is inseminating the cow means that the technician has less time to provide animal health services to others. Similarly, only the farmer who owns the cow that has been inseminated will benefit. Agricultural extension services are viewed by some as public goods, but examples of pure public goods are rare (the standard textbook example of a public good is national defence).

A 'free rider' problem arises with public goods since individuals believe the goods will be provided whether or not a contribution to the cost is made by each individual. If a sufficient number of individuals decide not to contribute to the cost, less than the optimal amount of the public goods will be provided. Umali *et al.* discuss aerial spraying to control the tsetse fly and explain that an individual livestock farmer will not be prepared to pay for the spraying because spraying would be required not only of that farm, but also of all other adjacent farms, wildlife reserves and other habitats where the fly can survive (26). Therefore this activity may be best funded by the government using tax revenue, since the activity is a public good.

The decision by the government regarding the proportion of the public good to provide is not easy. If the government provides free or heavily subsidised animal health services, farmers have a disincentive to adopt practices that will improve or maintain the health of animals. Poor animal nutrition increases the probability that animals will become sick, while poor hygiene in the dairy may lead to health problems such as mastitis. Similarly, the provision of free or heavily subsidised animal health services may encourage poorly motivated producers to enter the livestock industry since it might appear that any animal health problem would be resolved by the government. (This class of problem is referred to as moral hazard and adverse selection and has been extensively studied by economists. These phenomena also occur in the insurance market and the used car market [27].) On the other hand, the presence of animal health problems coupled with a lack of government involvement in disease control may discourage producers from entering the livestock industries because the risks associated may be judged by the producer to be too high.

Coordination failures

Individual firms trying to maximise profits will adopt management practices that will provide the most benefit. The practices adopted by these firms may not be in the best interests of the industry or the nation long-term. The role of the government may be, therefore, to set priorities for different industries that could be different from those set by individual firms. The government would be playing a coordination role. In the animal health industry, the government could encourage pharmaceutical firms to undertake basic research through the provision of subsidies or grants, or this research could be undertaken by the government itself through publicly funded research institutes. At the farm level, the government might target particular

diseases or animal health problems. In making decisions regarding these issues, the government would need to consult with industry and the broader community. The results of economic analysis such as cost-benefit analysis (CBA) should be used in setting priorities.

Without the government coordination of animal disease control programmes, there is a danger that resources will be allocated to different livestock industries without regard to the costs and the benefits of the control programme. A mastitis control programme in the smallholder dairy industry of Indonesia may be achieved at relatively low cost but with a high pay-off through an extension programme. On the other hand, the development of an embryo transplant programme for beef cattle introduced into a developing country might provide a low pay-off in relation to the level of investment necessary. Governments also have a coordination role to play in the area of national and international harmonisation of standards relating to such issues as disease control methods, chemical residue levels in foods and genetic modification of organisms. The role of government is vital in the international harmonisation of standards to ensure that concerns about animal health do not become non-tariff barriers to trade. In principle, such issues could be dealt with through the market, but in practice, government intervention is likely to be more efficient. An important benefit to consumers from trade is that it reduces the risk of a livestock product becoming unavailable because of disease. If a disease reduces local production of an animal product, as was the case in the United Kingdom (UK) following the outbreak of bovine spongiform encephalopathy (BSE), then the product would still be available through international trade from other producing countries not affected by the disease.

Information failure

Information is an area where the case can be made for government intervention. The use of products that are technical and novel to the farmer imposes a cost upon users in addition to the purchase cost of the product. These costs arise because users must acquire information on the product, for example, how to use the product and the merits of the product relative to competitive products. This information is likely to be costly to acquire and individuals may not have the skills to process or interpret the information. If acting independently, firms may provide less than an optimal amount of information on the product. Government intervention through the provision of information on the effectiveness of competing products in controlling an animal disease may therefore be warranted. For smallholders and the rural poor, access to user-friendly information is likely to be a severe problem. Government standards should also be set relating to the level of information provided by manufacturers on the expiry date, the mode of application and the side effects on human health of particular drugs. Government involvement in these areas will reduce the cost to users of the product.

Government intervention could also be needed in relation to issues of certification to ensure that animal health professionals (including veterinarians and paraprofessionals such as field technicians) are appropriately trained and keep abreast of the latest professional developments. The extent to which this intervention will be required will depend upon the level of professional regulation and the requirements of the clients of health professionals. Sturgess reviews issues associated with competency standards for agricultural professionals (24).

Distribution of income and asset values

Diseases affect the quality and the quantity of livestock products and the extent to which diseases are controlled therefore affects the incomes of producers. For the same level of inputs, a disease-free herd of dairy cattle will produce higher levels of output compared to the output from a herd in which animal health problems are present. Similarly, the presence of a disease can affect consumer acceptance of animal products, as demonstrated by the outbreak of BSE in the UK in the mid-1990s. Both of the above factors will affect producer incomes, not only in the country in which the disease outbreak occurred but also elsewhere. Japanese consumers, for example, purchased less beef in 1996 and 1997 partly because of concerns about BSE. This affected beef producers in Australia and in the USA as Japan is a major importer of beef from these countries. The value of the land and other fixed assets used in the livestock industry will also be affected by disease. An outbreak of a disease such as Johne's disease in sheep increases the risk facing individuals or firms considering entering the sheep industry, even in areas where the disease may not be present. This will reduce the value of land used in the industry, which will be of concern to those in the industry whose major asset is the land.

In developing countries, livestock programmes are seen as a way of improving the income situation of the rural poor, including landless rural labourers and women. The dairy industry in Indonesia is one example. For such groups to benefit from livestock programmes, disease monitoring and control measures need to be in place and ideally should be a part of any livestock programme that targets these groups. These individuals are stakeholders in livestock industries even if they do not own livestock. Intensive poultry production in Thailand, focused at the export market, is an important employer of rural workers with few marketable skills. Poultry processing plants operated by private companies employ many thousands of workers in rural Thailand and the loss of export markets through a health problem in the poultry industry of Thailand could result in a loss of employment for these workers. The effect would spill over to other suppliers of inputs, including poultry feed and transport services. Livestock industries in one country are not isolated from developments in the livestock industries of other countries. The outbreak of foot and mouth disease (FMD) in the pig meat industry of Taipei China in 1997 led to the loss of export markets, particularly in Japan, but this created opportunities

for the livestock industries of other countries. However, to the extent that this event reduced consumer acceptance of livestock products generally, livestock producers in industries (and countries) in which the animal health problem did not exist may also have been affected. These linkages are important but difficult to identify, and still harder to quantify. However, the existence of such linkages casts doubts on recommendations such as that made by the Centre for International Economics (CIE) in Australia, that producers are the major beneficiaries of programmes designed to eradicate ovine Johne's disease (4).

Disease may be more important to those producers with few animals since for such producers the loss of a single animal has a greater relative impact. As mentioned earlier, the loss of an animal can affect the income situation of the farm, possibly for many years, with potentially severe consequences if the farmer has a loan outstanding on the purchase of the animal. Conversely, in areas where animal diseases have been controlled successfully, livestock farms would be expected to increase in value because the risk associated with livestock farming in such areas would be reduced.

Effect of animal health on resource use in a country

The presence of disease in a livestock population can have several major effects, including the following:

- a reduction in efficiency of production (and hence overall production) through, for example, death of stock, reduced reproductive rates and reduced growth and milk production (these effects can persist for many years)
- the prevention of the use of highly productive livestock or any livestock within an area, region or country (for example, the presence of tsetse fly and the associated trypanosomosis in parts of Africa)
- the creation of a barrier to trade, reducing the size of the market that can be accessed by producers and the price received for the product by producers (for example, the presence of FMD in a country).

In determining the impact of livestock disease, animal health must be placed in perspective as part of the agricultural production system and the economy as a whole. Such a perspective is needed at a national level to enable appropriate decisions to be made to implement general government policy and to ensure public funds are spent in the most effective manner.

Diseases form part of the livestock production system and when present, reduce the efficiency of production. Livestock disease can be considered similar to other parts of the production system. For example, poor soils lead to poor pasture growth which will reduce livestock production. Similarly, severe drought can lead to widespread livestock deaths, as can an outbreak of a severe disease. It is possible to reduce the effects of poor soils on production by applying fertiliser and the effect of disease on production can be reduced by preventive measures. In each case, the benefits from increased production need to exceed the costs of the measures implemented. Furthermore, the most appropriate economically efficient solution may not be to produce highly fertile soils, or to eradicate a disease. Rather, the solution may be non-intervention, the application of an intermediate level of fertiliser or limited disease control measures. The decision regarding the amount of fertiliser to use, or the level of disease control to be implemented is an economic decision.

The analogy used above is simple yet serves to demonstrate that animal health must be examined as part of the system of animal production and the economy, not as a separate issue that requires special treatment.

Effect of animal diseases on trade and market access

Animal health status can play a major role in access to specific markets. For example, freedom from FMD enables access to higher priced markets for beef and live cattle, often producing a substantial increase in price of the product. Animal health status is generally provided by governments on the basis of disease status at a national or regional level.

Development of specific codes by the Office International des Epizooties is leading to a situation where specific, quantitative information on animal health status is required.

The effects of collection and reporting of information that enables trade and market access without improving productivity have not been examined. However, the CIE did examine the distribution of benefits arising from the collection of information demonstrating freedom from transmissible spongiform encephalopathies (TSEs) in Australia (5). The effects of disease-free status on trade and prices have been examined by several authors; two examples of the effects of disease eradication on trade are examined later in this paper (11, 23).

Cost of regulations

In the presence of externalities and public goods which result in the sub-optimal allocation of resources in a free market, the case for government intervention is generally warranted. In such circumstances, the generally accepted forms of government intervention are taxation (of negative externalities), subsidisation (of positive externalities), information coordination (via extension and education services), regulations, or the establishment of a system of

property rights. Stigler has commented that 'The state has one basic resource which in pure principle is not shared by even the mightiest of its citizens: the power to coerce. The state can seize money by the only method which is permitted by the laws of a civilized society, by taxation. The state can ordain the physical movements of resources and the economic decisions of households and firms without their consent' (22).

Notwithstanding the well-rehearsed arguments of market failure, government intervention can clearly have a significant impact on resource allocation within a particular sector and in the economy at large. As a result, the efficacy of government intervention is an important subject in the consideration of public policy. This consideration extends far beyond the traditional cost-benefit framework of any individual activity of government, to the contextualisation of the activity within the perspective of the entire government. Individual interventions need to be assessed within a matrix of government stakeholders which include taxpayers, producers, consumers, and the international community.

In determining policy regarding any particular aspect of animal health, consideration of the wider national objectives of government is therefore important. This consideration is fundamental in the context of budget constraints on governments. Although the free market may fail to provide a socially optimal level (and quality) of goods and services in certain circumstances, the automatic provision of these services by government cannot be assumed. National priorities within budget (and political) constraints will ultimately determine both the nature and scope of interventions in any particular sector.

In assessing the economic impact of policy interventions at the national level, governments have mainly concerned themselves with fiscal responsibility. Given the impact that national fiscal policy can have on a range of domestic and international macroeconomic variables, fiscal responsibility is a major criterion in assessing policy interventions at the national level. Thus, economists have sought to advise governments primarily on curbing expenditure programmes and reducing the overall level of taxation in developing economies. However, the emphasis on fiscal responsibility has focused attention only on the outcome of government activities with respect to the impact of policies on immediate government expenditures and revenue and not the economic effects of policy as a whole. In a climate of budgetary expenditure reductions, policy makers have turned increasingly to regulations as a means of instituting policy as a way of escaping budgetary scrutiny. The use of regulation in this way has been augmented by the relative lack of accrual budgeting by governments. In recent times, the economic impact of 'off balance sheet' interventions such as tax expenditures (i.e. tax concessions) has been recognised and steps have been taken to make such interventions transparent.

At the national level, the evaluation of costs of government interventions in the form of expenditures and taxation (including tax concessions) is well advanced. As discussed elsewhere in this paper, governments also possess regulation-making powers as a means of intervening in the economy. In general, the regulation of sectors can mean the following:

- control (direct or indirect) of those who are permitted to provide certain goods and services (e.g. through licensing arrangements)

- determination of the terms and conditions of production (e.g. through tariffs and safety requirements).

In this way, governments can affect the market as follows:

- directly or indirectly influence prices

- directly or indirectly influence the number of firms/individuals in the market

- bestow benefits (and costs) on certain market participants.

In a period of global deregulation through trade liberalisation, governments have also sought to use regulations to serve as non-tariff barriers to imports. As the usefulness of fiscal policy is diminished as a flexible economic tool, economic and social regulations have been increasingly used by governments as a means of engineering various outcomes. As the costs of such regulations are less apparent and do not appear in government accounts, these expenses have become a relatively neglected area of public finance for policy makers.

Regulations are not without cost; often significant costs are imposed on both regulators and the regulated. The costs of regulations include the following:

- the enforcement cost to governments

- the informational and compliance (including paperwork) costs to both regulators and the regulated

- the mis-allocation of resources arising from resultant lobbying activities to preserve and/or abolish regulations.

The relatively new mechanism of 'regulation impact statements' is thus important in determining both the extent of the benefits (and costs) of regulations and in identifying the winners and losers. The widespread use and further development of regulation impact statements, including reviews of existing regulations, should be encouraged to the extent that public policy-making is enhanced.

Government interventions in any sector are primarily aimed at internalising social costs and benefits and these interventions are not without cost. The purpose of this section is to raise awareness that different forms of government interventions compete against one another and, where possible, must be prioritised within budgetary contexts. Notwithstanding the need for further research in this area, the authors argue that just as government expenditures and taxes

are assessed against national objectives and in the context of budget constraints, the same rigour and expenditure analysis need to be applied to assess the efficacy of regulations.

Animal health and production

An economic analysis of animal health requires analysis of the effects of additional livestock goods produced as a result of the intervention. The following questions need to be asked regarding these additional products:

- where will the additional product be consumed?
- who will consume these products?
- how will the products be transported?
- does government need to assume a coordination role?

Increasing production can have a number of flow-on effects, for example on prices. Increased production could result in a domestic surplus leading to a need to export the product. Alternatively, a domestic surplus could lead to a reduction in prices to producers who will receive a lower price per unit of production and to consumers who will benefit from lower prices. In addition, the market expansion caused by increased production may entail requirements for increased infrastructure such as transport and handling facilities. Another effect of improved animal health is an increase in nutrition needs for livestock that have increased production or are now surviving rather than dying.

Public policy decision framework

In viewing animal health and animal production as part of the one policy continuum, an integrated systems perspective is necessary. Such a perspective turns attention away from the traditional purely direct interventions to include more systemic and process-oriented policy considerations such as those that revolve around the government as coordinator. This is one means of overcoming the difficulty of considering 'long-term versus short-term' effects of a programme in cost-benefit analysis. A systems perspective would ideally represent the principal direct stakeholders in the animal health and production process (e.g. producers, consumers and researchers). Furthermore, incorporating national and international policy dimensions by considering national social and economic agendas, competing national priorities, and international requirements, overcomes the public policy limitations presented when policy options are considered outside a broader public policy perspective. A schematic representation of an integrated systems perspective is provided in Figure 1.

As illustrated in Figure 1, a primary objective of government is the establishment of networked channels of communications – or sub-systems – at a local level. The prime purpose of developing such local interactions is to generate feedback loops between the relevant stakeholders such that the differing time horizons of the different stakeholders can be

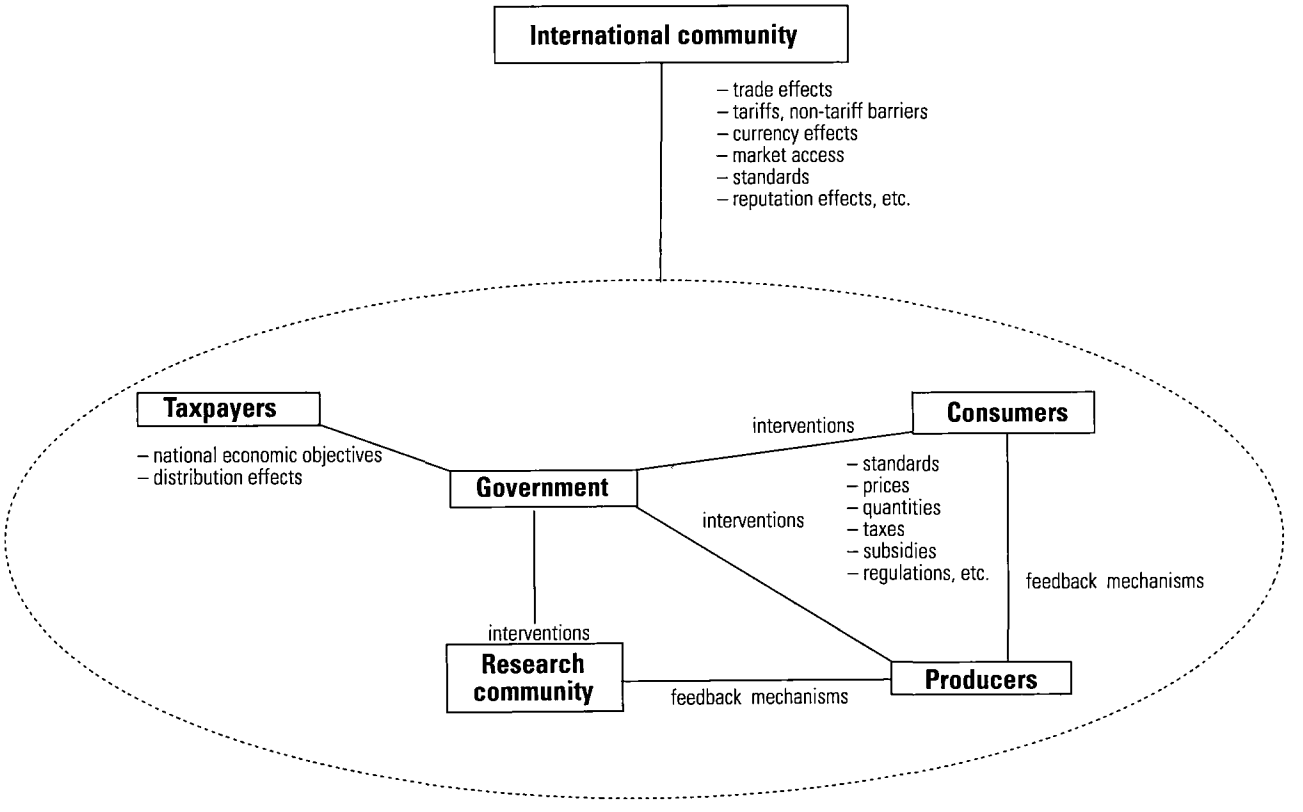

Fig. 1
Diagrammatic representation of an integrated economic system

more fully comprehended by all involved, and that problems and solutions can be determined at a local level, where possible. Governments need to establish processes of communications which are local in nature, such that global objectives (e.g. animal health strategies) are both developed and adhered to, not through (untimely) punitive government interventions, but through (timely) self-reinforcing local interactions.

Aims of government intervention and appropriate methods for analysis

It is important to recall the reasons for government intervention in the market and the information required from economic analysis. Therefore, before an analysis of a programme takes place, the aims of the analysis should be clearly stated. For example, if poverty alleviation is a major government objective and many of the poor live in rural areas, livestock may have a role in meeting that objective. However, a national programme to control FMD may not be the most appropriate method to achieve the objective of poverty alleviation, as the major beneficiaries from such a project could be larger-scale (and often politically influential) commercial producers. Therefore, distribution of benefits within the livestock production sector, as well as between sectors of the livestock industry (such as producers, livestock agents, meat processors, exporters, animal health professionals and consumers) needs to be examined in an analysis.

Economic analysis of specific disease control programmes

Once the choice of disease control activity has been made, the economic viability of that activity should be determined. Many examples exist in the literature to demonstrate economic analysis of specific disease control programmes and some examples are examined in this section.

Cost-benefit analysis is the most commonly used method to determine whether economic benefits derived from a specific animal health programme exceed the costs of conducting the programme. However, CBA is only one of many economic methods. An outline of CBA is provided in this section, a more detailed description is provided in the paper by Rushton *et al.* in this volume (21).

Cost-benefit analysis

Cost-benefit analysis originated in nineteenth century France in the analysis of bridge construction. Since then, the technique has been refined and applied to the analysis of many individual activities or projects which are usually complex. The analysis attempts to estimate the costs and gains resulting from different courses of action. The complexity of CBA can vary from simple calculations to the use of detailed computer models.

As outlined by McKean (15), an analysis involves working with a number of common elements, as follows:

a) objectives (benefits to be achieved)

b) alternatives (possible systems or arrangements for achieving the objectives)

c) costs (benefits that have to be foregone if one of the alternatives is adopted)

d) models (the set of relationships that help one trace the impacts of each alternative on benefits and costs)

e) a criterion involving both costs and benefits to identify the preferred alternative.

Each of these elements involves several difficulties which must be considered.

McKean makes an important observation on the technique of CBA, namely: 'One should recognise too, that cost-benefit analysis necessarily involves groping and the making of subjective judgements, not just briskly proceeding with dispassionate scientific measurements' (15).

Cost-benefit analysis can be applied in a variety of situations, the majority of which are *ex ante* (i.e. carried out before a project commences). However, *ex post* analysis can also be carried out using CBA. The technique can be used to help answer such questions as whether an existing project should continue; whether an activity or number of activities should be carried out; and to assist the choice between alternative activities (often activities with similar objectives).

A major strength of CBA lies in the examination of costs and benefits associated with an activity and the reduction of those costs and benefits to a single unit, money, to enable comparisons to be made. These comparisons may involve competing animal health programmes as well as projects in other areas, such as education, road construction or human health and welfare. However, the feasibility and appropriateness of assigning monetary values to costs and particularly benefits from a project is a major problem of CBA. Difficulties occur because the market prices needed to perform CBA may be absent or are distorted and therefore fail to reflect the opportunity cost of resources involved. Examples of valuation issues in CBA include valuation of externalities, goods affected by subsidies or taxes and goods affected by trade restrictions.

Another weakness of conventional CBA is that costs and benefits from a project are compared in aggregate without considering the specific groups in society that will benefit or accrue costs. Often it is important for decision makers, particularly at the political level, to know which groups in society will benefit and which will lose, in addition to the size of the losses and gains. In many cases, costs and benefits that accrue to lower income groups are underestimated in the analysis, as CBA implies that the marginal utility of income is

the same for all people affected by the programme being analysed.

The steps outlined by the Department of Finance of Australia provide a useful guide for performing a CBA (7), as follows:

a) determine scope and objectives
b) identify the constraints
c) identify the alternatives
d) identify costs and benefits
e) quantify/value costs and benefits
f) calculate economic performance criteria
g) conduct a sensitivity test for uncertainty
h) consider equity issues and intangibles.

If the steps outlined above are conducted and the process fully documented, a useful analysis will be produced which can be critically examined.

Discounted cash flow analysis

The distinction between discounted cash flow analysis and CBA is important. Discounted cash flow analysis does not constitute CBA but rather is the part of the analysis shown as steps *e)*, *f)* and *g)* above. The aim of discounted cash flow analysis is to reduce the costs and benefits of a programme to a common unit, money, at a set point in time (usually the present) by the use of discounting, thereby enabling comparison of the costs and benefits. A project generates cash flows where cash flow refers to any movement of money into or away from a project. Cash outflows consist of payments including capital outlays and annual operating costs while cash inflows are the revenues or cost savings that the project produces. The net cash flow in each year is the difference between total cash inflows and total cash outflows. The cash flows predicted for the control programme are compared to those in the absence of intervention. In this case, the cash flows are also referred to as incremental cash flows.

Discounting is used to estimate the present value of a future value. The technique is used because project costs and benefits occur at different times in the life of the project. For example, in a vaccination programme, the cost of vaccination is incurred before the benefits of vaccination are received in the form of increased productivity. The value of the costs or benefits in current terms is called the present value. The process of discounting is the reverse of compounding interest and principal calculations (7, 9). Discounting is performed separately for each year of the programme.

The discount rate can be estimated as the cost of capital – a weighted average of borrowing rate and opportunity cost of individual funds. However, if the farmer owes money, the rate of interest the farmer is paying is generally higher than that received from the bank if the money had been invested. Therefore, the appropriate discount rate may vary with the circumstances of the farmer, but the use of a real interest rate rather than a nominal rate is usually appropriate when using real prices.

Future costs and benefits can be valued using either real (also referred to as constant) prices or current prices. If constant prices are used, all variables are expressed in terms of the price level at a fixed point in time. This approach assumes that inflation will affect all costs and benefits equally. If particular costs or benefits are unlikely to follow general price movements, then changes in relative prices can be allowed for in the analysis. The less commonly used current price approach uses the estimated prices at the time the cost is incurred or the benefit received. This is a more complex approach because inflation rates must be estimated for the duration of the project (7). While the current price approach provides the advantage of allowing for the impact of inflation on the cash flow projections, cash flows are usually calculated in terms of real prices.

Economic performance criteria

Several criteria can be used to compare the performance of a project. Some of the commonly used criteria are benefit-cost ratios (BCRs), the net present value (NPV) and the internal rate of return (IRR). Although economic performance criteria are sometimes referred to as decision criteria or decision rules, these titles are inappropriate. The criteria indicate economic performance but are not the only factors on which a decision is based. For example, the criteria alone cannot be used to determine the distribution of benefits and costs from a programme. Each of these criteria is examined in this section.

A BCR is the ratio of the present value of benefits to the present value of costs for a programme. This ratio can be calculated as either a gross or net BCR, defined respectively as follows:

$$gross\ BCR\ ratio = \frac{PVB}{PVC}$$

$$net\ BCR = \frac{PVB - PVCO}{PVCC}$$

where:

PVB is the present value of benefits
PVC is the present value of operating costs plus capital costs
PVCO is the present value of operating costs, and
PVCC is the present value of capital costs.

For a programme to be acceptable, the ratio must be greater than or equal to one. Where the costs and benefits occur at different times during the programme, the BCR can be highly sensitive to the discount rate that is used to calculate present values. The BCR can be used to rank disease control strategies, with priority being given to those diseases for which the control programme yields the highest BCR. However, to

determine the optimal scale of a programme or to choose between alternative programmes by maximising the BCR is not necessarily logical (14, 25).

The NPV of a programme is the sum, for each year of the project, of the total benefits received in the year minus the total costs incurred during the year (that is the annual net cash flow) discounted by the appropriate discount factor to convert each annual total to present value terms. The formula to calculate the NPV is as follows:

$$NPV = \sum_{t=0}^{t} \frac{(B^t - C^t)}{(1+r)^t}$$

where:

B^t is the monetary benefits received in any year t
C^t is the costs incurred in any year t
r is the discount rate.

A project is economically viable if the NPV is positive. In comparing projects, some studies suggest that the project that maximises NPV is preferable (7). However, this is not necessarily so, as NPV does not provide an indication of the rate of return on invested funds. For example, a project may have a high NPV but use a large amount of capital and provide a low return on invested funds. The NPV was used as the criterion in the CBA carried out on FMD by Power and Harris (17).

The IRR is the discount rate that would give a NPV of zero. The IRR suffers from a number of limitations, in particular the IRR may not exist or may not be unique in certain cases. For example, where the net cash flow of a project is positive for each year of the project, the NPV will never be zero regardless of the discount rate. In this situation, calculation of an NPV is impossible. Where the net cash flow varies from negative to positive several times during the life of the project, the IRR can have a number of values. In this case, determination of a single IRR is not possible. In addition, when used to compare two projects, the IRR can be misleading when the projects differ in scale (7). The IRR can be determined by trial and error (9) or by using Newton's approximation to solving a polynomial equation (10).

The BCR and the IRR indicate a rate of economic pay-off while together with the NPV these values indicate whether or not a project is economically viable. A project is economically viable if the BCR is greater than one, the IRR is greater than the cost of capital and the NPV is greater than zero. None of the criteria alone is sufficient to make a decision on whether to conduct a disease control programme. Nonetheless, these criteria serve as a valuable guide, providing the limitations are understood.

Measuring distributional impacts of animal health programmes

Cost-benefit analysis does not usually identify the groups that gain and lose as a result of the activity being examined. However, decision makers should be informed of the distribution effects of a programme and hence the social implications of such decisions.

Several methods exist to identify the groups affected and the size of gains and losses for those groups. One method involves assignment of distributional weights to the costs and benefits that accrue to specific groups. This approach has several flaws, in particular, the subjective judgements of the analyst affect the result. Alternatively, distributional judgements are made by the decision maker, in this situation analysts are able to avoid the subjective bias inherent in attaching distributional weights to cost and benefit streams.

An additional technique to determine the distribution of benefits within society is estimation of economic surplus. The calculation of economic surplus usually includes both the distribution and the magnitude of benefits. Economic surplus comprises two parts, namely: benefits to producers (or producer surplus) and benefits to consumers (or consumer surplus), and is defined as the sum of the two components. Economic surplus has been used by several authors to examine the distribution of benefits from specific animal health activities (1, 2, 3, 8, 16, 19).

Consumer surplus arises when the market price is less than the consumers are prepared to pay, while producer surplus occurs when market prices exceed production costs. Producer and consumer surplus can be demonstrated by the use of supply and demand curves. The efficiency of livestock production will increase with improved animal health decision-making leading to a shift to the right in supply of the product. The type of shift in the supply is an important factor in determining whether producers gain from an increase in productivity, while consumers always gain if the shift in supply results in a decrease in price.

Application of cost-benefit analysis in animal health to issues at a national level

Cost-benefit analysis has been the most widely applied economic technique in animal health and considerable discussion has been focused on the most appropriate way to apply the technique.

The quality and scope of economic analyses in the field of animal health has improved in recent years with a variety of suitable frameworks being developed and applied. To demonstrate the different aims and methods available, this section provides a brief overview of some of these analyses. In some cases, a programme has been implemented before an economic analysis is performed, with the analyses being used to assist in making the decision to continue the programme.

The first two examples given below demonstrate analysis to determine the economics of continuing the programme while the third provides an example of a study to examine the distribution of benefits from an animal health programme as a step in determining funding arrangements for that programme.

Case 1

Harrison and Tisdell provided a comprehensive study in 1997 of the FMD control and eradication programme in Thailand, offering a useful example of the application of CBA in animal health (11). The analysis includes a review of the literature with emphasis on CBA of FMD. Data needs for economic analysis and limitations in available data are examined, followed by detailed analysis of the FMD control programme in Thailand with emphasis on the perspective of Asia versus that of Europe of the benefits from FMD eradication. The method of analysis, social CBA, is then outlined. The analysis examines the programme as a public sector programme and costs and benefits are estimated on a national basis and take into account trade and social impacts.

As in most animal health economic studies, Harrison and Tisdell found severe data limitations, especially in valuing benefits from eradication (11). Data limitations included shortage of information on the number of cases of clinical disease and the number of cases avoided due to the control programme. Data on the effect of disease on production was also lacking and a high level of uncertainty existed concerning the importance of draught power, in particular the impact of disease on performance and the benefits from control of disease on draught power.

Sensitivity analysis was carried out as part of the analysis, including variation of the three most critical parameters, namely: the discount rate, under-reporting of cases of disease and price changes resulting from access to new markets. Sensitivity analysis is a useful tool to examine data limitations, and simulation modelling has been used by a number of authors to overcome data limitations in economic analysis. In addition, the 'break-even' performance of the programme can be estimated in order to provide information on the minimum level of specific benefits required to make the programme economically viable.

Case 2

Stoneham and Johnston examined the Australian brucellosis and tuberculosis eradication campaign in 1987 (23). The aim of the study was 'to examine what the future extent of the program should be and the allocation of assistance to producers'. An epidemiological model was used to simulate the costs of control and an econometric model of the Australian beef industry was employed to estimate benefits from different control procedures (23).

Retaining access to international markets was seen as the major benefit of the programme, in particular avoiding dislocation of the beef industry following loss of a major market. In addition, eradication of the diseases would allow free movement of stock within Australia and reduce the risk posed to human health.

The study concluded that the risk of market closure was a major factor affecting the result of the analysis. However, the authors also concluded that determining the risk was more political than economic, thus, to assist in assessment, political processes in beef importing and exporting countries were examined as part of the study.

Case 3

A number of studies were carried out in Australia by the CIE to examine funding arrangements for national animal disease control programmes (4, 5, 6). In one study, the CIE examined the proposed National Transmissible Spongiform Encephalopathies Surveillance Program and determined appropriate methods for the funding of that programme (6). This study is used as an example of the CIE approach.

As Australia is free of TSEs, market access and trade were determined to be the sole motivations for the programme. Analysis of funding arrangements was carried out using the principle of 'beneficiary pays'. However, it was also noted by the analysts that practical aspects of cost sharing and revenue collection must be considered to ensure efficiency of operation. For example, in a small programme, the cost of collecting funds could exceed the cost of the programme.

An unfortunate aspect and significant flaw of the CIE studies is the poor documentation explaining the assumptions made and methods used to reach the conclusions. For example, while the CIE proposes that a proportion of the benefits from the national programme will be public benefits, the specific proportion suggested is not accompanied by an outline of how that figure was derived.

Conclusions

Given the interactions which occur in animal health at the national level, there is a need for an integrated holistic approach to decision-making which includes externalities. National level decision-making involves development of policy which often requires value judgements to be made at the political level and operational planning and analysis of specific programmes to be developed within policy guidelines. One of the major difficulties in decision-making at any level is that no unique correct decision exists because of the uncertainties that are present in almost every situation. Economic analysis provides support for decision makers but does not necessarily identify the ideal solution.

Economic analysis provides assistance at several different levels of the decision-making process with different techniques required in different situations. However, no single method of analysis is appropriate for all conditions. Each situation needs to be analysed individually as the analysis approach that performs best in one set of conditions may not be as effective under a different set of conditions.

Cost-benefit analysis is a useful technique provided the analysis is carefully documented and is interpreted in accordance with the assumptions made and data deficiencies. However, this is not the only method of economic analysis and indiscriminate use of economic performance criteria is not suitable for interpretation of a CBA. As with any analysis, awareness of the advantages and disadvantages of different methods of economic analysis and the selection of the appropriate techniques is vital.

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Les conséquences économiques des maladies animales et de leur prophylaxie au niveau national

G.C. Ramsay, P. Philip & P. Riethmuller

Résumé

Les auteurs examinent les conséquences économiques des maladies animales et des programmes nationaux de prophylaxie, y compris le rôle de l'État dans la santé animale, les effets de la réglementation et l'utilisation d'une analyse coût-bénéfice. Ils s'intéressent tout particulièrement au rôle de l'analyse économique dans la procédure de prise de décision par les pouvoirs publics. L'économie fournit un cadre pour la collecte des informations et pour une présentation raisonnée des données, offrant ainsi au décideur un outil de comparaison permettant d'examiner les mesures alternatives. Les hypothèses utilisées dans ce cadre doivent être clairement exposées et expliquées par l'auteur de l'analyse. Les raisons économiques en faveur d'une intervention de l'État dans les programmes zoosanitaires sont les suivantes : effets externes, monopoles naturels, biens publics, mauvaise coordination, manque d'information et problèmes de distribution. Les auteurs proposent une méthode intégrée globale comportant des orientations nationales et internationales. Dans le cadre de cette méthode, l'État assure la coordination des activités des diverses parties concernées par la santé animale, notamment les éleveurs, les consommateurs et les chercheurs.

Mots-clés

Analyse coût-bénéfice – Analyse économique – Économie – Effets externes – Politique publique – Programmes de prophylaxie – Santé animale.

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Repercusiones económicas de las enfermedades animales y el control sanitario a escala nacional

G.C. Ramsay, P. Philip & P. Riethmuller

Resumen

Los autores examinan las consecuencias económicas de las enfermedades animales y los programas de control a escala nacional, incluyendo, entre otras consideraciones, el papel del Estado en la sanidad animal, los efectos de medidas

normativas y el uso de un análisis de la relación coste/beneficio. Prestan especial atención al papel del análisis económico en los procesos de decisión de las instancias públicas. La economía ofrece un marco para obtener información y presentarla de modo sistematizado, proporcionando así al responsable público un método para estudiar soluciones alternativas. Por otro lado, es preciso que la persona que realiza el análisis exponga y explique con claridad las premisas de las que parte dicho análisis. Entre las razones económicas que justifican la intervención pública en programas zoosanitarios cabe citar la existencia de externalidades, monopolios naturales, propiedad pública y fallos de coordinación, así como la falta de información y cuestiones relacionadas con la distribución. Los autores exponen las grandes líneas de un planteamiento integral, que aúna objetivos políticos de ámbito nacional e internacional. De acuerdo con esa propuesta, la administración debe coordinar las actividades de todas las instancias interesadas en cuestiones de sanidad animal, incluyendo a los productores, los consumidores y los investigadores.

Palabras clave
Análisis de la relación coste/beneficio – Análisis económico – Economía – Externalidades – Política pública – Programas de control – Sanidad animal.

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