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On the Economics of Maintaining the Health of Livestock with Thai Examples

by

Clem Tisdell

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The Commissioned Organization is the Queensland Department of Primary Industries. Collaborating institutions in Australia are CSIRO-ANHL, Geelong, Victoria and the University of Queensland (Department of Economics; Department of Geographical Sciences and Planning). In Thailand, the collaborating institutions are the Department of Livestock Development (National Institute of Animal Health; Disease Control Division), Chiang Mai University (Department of Agricultural Economics; Department of Animal Husbandry) and Thammasat University (Faculty of Economics). The collaborating institution in Laos is the Department of Livestock and Veterinary Services. Dr F.C. Baldock, Senior Principal Epidemiologist, Queensland Department of Primary Industries is the Project Leader in Australia and Dr P. Chamnanpood, Senior Epidemiologist, Thai Department of Livestock Development is the Project Leader in Thailand. Professor Clem Tisdell and Dr Steve Harrison, Department of Economics, University of Queensland are responsible mainly for the economic component of this project.

'The overall goal of this project is to develop and evaluate the .necessary tools to provide decision-makers with reliable animal health information which is placed in context and analysed appropriately in both Thailand and Australia. This goal will be achieved by improving laboratory diagnostic procedures; undertaking research to obtain cost-effective population referenced data; integrating data sets using modern information management technology, namely a Geographical Information System (GIS); and providing a framework for the economic evaluation of the impact of animal diseases and their control.

A number of important diseases will be targeted in the project to test the systems being developed. In Thailand, the focus will be on smallholder livestock systems. In Australia, research will be directed at the northern beef industry as animal health information for this sector of livestock production is presently scarce.'

For more information on *Research Papers and Reports Animal Health Economics* write to Professor Clem Tisdell (c.tisdell@economics.uq.edu.au) or Dr Steve Harrison,(s.harrison@uq.edu.au) Department of Economics, University of Queensland, Brisbane, Australia, 4072.

ON THE ECONOMICS OF MAINTAINING THE HEALTH OF LIVESTOCK WITH THAI EXAMPLES

ABSTRACT

Livestock are of growing importance in agriculture. Global populations of livestock have increased significantly in recent decades, and East Asia has recorded major increases in its livestock numbers. Thailand's stocks of poultry, cattle and pigs have expanded with its economic development. Per capita consumption of red meat and milk by Thais shows an upward trend and its livestock industry is becoming more commercialised. Nevertheless, most cattle are still present in Thai villages and village poultry still account for around one third of Thailand's poultry. The type of animal husbandry practised in Thai villages influences the incidence and spread of livestock diseases.

The economics of private decisions about livestock health interventions are discussed. Vaccination of livestock against foot-and-mouth disease is taken as an example and the private economics of treating a sick animal is considered. Methods for measuring the social economic benefits from control of livestock diseases (and their distribution) are outlined along with some of their policy implications. The usefulness of using the price of livestock as a guide to the value of maintaining their healthiness is examined. It is suggested that increases in the healthiness of livestock be looked upon as an addition to livestock capital, as in the case of human capital.

Keywords: Animal husbandry, control of livestock disease, foot-and-mouth disease, Thailand

JEL Classification: Q160

ON THE ECONOMICS OF MAINTAINING THE HEALTH OF LIVESTOCK WITH THAI EXAMPLES

1. Introduction

With increases in human population and economic growth globally, the importance of livestock, cattle and buffaloes, horses, pigs, poultry and goats plus other types of livestock has altered. In general population levels of domesticated animals have risen to meet increased global demands for red meat and for products such as milk and eggs; whereas their use for draught and transport purposes has declined in many countries. According to the FAO (1996) there were 941.4 million head of cattle in the world in 1961 and by 1996 this had increased to 1,311.3 million. Significant increases occurred in Asia where the number of cattle rose from 318.7 million in 1961 to 432 million in 1996. Between 1961 and 1996 the world's population of goats almost doubled and buffalo increased from 88.4 million to 152 million.

These changes are evident in East Asia where Thailand provides a good example. In Thailand, cattle numbers have risen both for supplying meat and milk whereas buffalo numbers have fallen (Murphy and Tisdell, 1996c). The latter are now rarely used for draught purposes. With Thailand's rapid economic growth, buffaloes have been mostly replaced by two-wheeled tractors in fieldwork. Cattle previously used for pulling carts are now mainly kept for beef even though some are still used in carts. They are being replaced in their roles by utility trucks.

Thailand has experienced rising per capita consumption of beef and chicken meat as its per capita levels of income have risen, and declining per capita consumption of fish has occurred in Thailand.

The development of dairying in Thailand and rising consumption of milk products by Thais is interesting. Traditionally East Asians have not been consumers of milk. It was initially believed that many East Asians were intolerant to lactose (Crotty, 1980). However, this does not seem to be the case.

The Thai Government has taken active steps to encourage milk consumption in Thailand

believing that greater milk consumption is likely to improve the health and nutrition of Thais. In addition, it has taken measures to encourage the domestic production of milk. While the major part of Thailand's milk supplies are imported, importers are required to absorb a percentage of domestic milk. Their import allowances are geared to their levels of use of domestic milk (Murphy and Tisdell, 1996a).

In recent decades, Thailand's livestock industries have become more commercialised even though village production remains important. The extent to which commercial-industrial type of livestock production has developed in Thailand differs between types of livestock. Thailand has a large commercial poultry industry and is a major exporter of frozen chicken. About two-thirds of its poultry are raised by large commercial enterprises and the remainder are village poultry. Pig production has also become highly commercialised and few pigs are raised on farms now. On the other hand, most cattle and buffalo production is at the village level. Farmers typically have two to four cattle or buffalo as a sideline. Large herds are very rare. The size of dairy levels is also very small.

2. Health of Livestock

The health of livestock depends on many factors. As in the case of humans, nutrition is important. Poorly nourished animals are more liable to ill health and mortality. There is some evidence that morbidity and mortality rates are lower for cattle and livestock owners with higher incomes (Murphy and Tisdell, 1996b). This may be because their cattle obtain greater care and nutrition.

The environmental conditions under which livestock are kept affect the incidence and spread of diseases. Contagious diseases spread more quickly when there is possibility for contact between many different livestock. In Thai villages cattle make considerable use of communal lands for grazing especially during the wet season and communal water supplies are utilized by cattle and buffalo in the dry season. This means that if an infectious disease is present in a village it can spread quickly. Village chickens are left free to roam around the villages - they are semi-feral. This means that infectious diseases of poultry can spread rapidly in a village. Furthermore, it is difficult to catch village chickens for any regular medication.

Environmental conditions affect the prevalence and spread of diseases. However, it is not always easy to modify these in a way favourable to animal health. For example, to rear cattle

entirely on private pastures is not an available option for most Thai farmers because they need most of their land for food crops, such as rice and can use little of it for pasture.

Some diseases can be prevented by vaccination, e.g. foot-and-mouth disease, and by drenching, e.g. worms of some types. Other diseases can be treated when they occur. For most farmers, the veterinary care which they take of their livestock is a commercial decision. Therefore one would expect more to be spent on the health care of high valued stock such as cattle than on low valued stock such as poultry. The public or collective net benefits of care of livestock health may, however, exceed private net benefits. Let us consider this matter further.

3. Private and Public Benefits and Costs of Livestock Health.

To decide whether a livestock health intervention is profitable, a farmer must deduct his/her expected income in the absence of the intervention from that should the intervention take place. If the difference exceeds the cost of the intervention, the intervention is profitable. If a number of alternative types of intervention relating to the same disease are possible, then from a profitability point of view the farmer should select the one showing the highest profitability. This will be the one showing the highest net present value and intervention will be profitable if this exceeds net present value in the absence of the intervention. This much is clear from the application of standard microeconomic analysis as clearly set out by Sir John Hicks (1939). ,

Yet in reality the situation is much more complicated than may appear to be so from the above. This is because uncertainty is present. Most of the variables involved in the decision are not known with certainty so decision-making under uncertainty (or at the very least, risk) is involved. The way in which the farmer decides will be influenced by the farmer's attitude to risk-taking or to uncertainty.

Consider a farmer's decision about whether to vaccinate cattle against foot-and-mouth disease (FMD). The following should be taken into account:

1. The cost of the vaccine and of administering it.
2. The effectiveness of the vaccine

3. The likelihood that the animal(s) to be vaccinated will contract the disease in the absence of vaccination
4. The economic loss if animals do contract the disease.

If

U =probability of FMD infection if no vaccination occurs times loss if infection occurs

and

V = probability of FMD infection if vaccination takes place times loss if infection occurs,

then vaccination is profitable if

$U - V > C$,

where C is the cost of vaccination. Thus, U is the expected loss from FMD if livestock are not vaccinated against it, and V represents the expected loss if they are vaccinated bearing in mind that vaccination is not always completely effective in preventing a disease. In other words, the above inequality indicates that the expected loss avoided if vaccination occurs should exceed the cost of vaccination if vaccination is to be worthwhile. Other things equal, the more effective is vaccination and the greater the loss if infection occurs, the more likely is vaccination to be worthwhile.

Indigenous Thai cattle and buffalo appear to be little affected by FMD whereas imported strains of dairy cattle are highly susceptible to it. Losses from infection of dairy cattle are liable to be greater than for infection of beef cattle of the indigenous variety or other relatively resistant varieties. Therefore, it is likely to be more economic to vaccinate dairy cattle. With increasing numbers of dairy cattle in Thailand and a greater presence of imported improved breeds, control of FMD is likely to become more economic than in the past.

In the case of animals which have developed a disease, decisions have also had to be made about what to do from a veterinary standpoint. Is it worthwhile trying to have the disease diagnosed, if the farmer is uncertain about the disease? Is it worthwhile trying to cure the animal(s) affected? From a profitability point of view, this will depend on the cost of treatment, the likely impact of the treatment on the animals and the extra gains to be made

with this impact compared to the situation with no treatment. For example, suppose the disease of an animal is known and that in the absence of treatment, the animal will die and be of no value. Treatment is available which gives an 0.5 probability of cure within a few days but in the other cases does not prevent mortality. The expected value of the treatment is approximately 0.5 times the market price of the animal. If the costs of treating the animal are less than this sum, net expected gains from treatment are positive. As discussed below, market prices of livestock can be important factors to take into account when determining the private economics of prevention or treatment of a disease.

The benefits to the wider community of disease prevention or treatment may be greater than to individual farmers because of spillovers or collective benefits to a group in excess of their individual benefits obtained in isolation (Tisdell, et al., 1994). In the case of livestock, benefits from disease prevention of livestock by an owner may provide benefits to other owners of livestock.

Take, for example, vaccination against FMD. The greater the proportion of the cattle and pigs vaccinated against the disease the less likely is the disease to occur and spread. Indeed, if the vaccination rate is high enough in the country concerned, the disease may be eradicated in the country because the population of possible carriers of the disease becomes insufficient for the continued viability of the population of FMD. If, for example, a maximum 85 per cent of susceptible livestock must be vaccinated to eradicate FMD and this is done, the owners of the 15 per cent of livestock not vaccinated get a free ride. In addition, consumers of products may benefit, even though they do not contribute to control of the disease. Their benefits can come from greater consumer surplus as a result of a reduced price for livestock products.

The above is so for a livestock industry confined to the home market; that is in the absence of international trade as Figure 1 illustrates. Before the elimination of the disease the supply curve of livestock products e.g. beef or milk, might be as indicated by curve S_1S_1 and after elimination of the disease, S_2S_2. This means that the market equilibrium alters from E_1 to E_2. There is a net gain in consumers' plus producers' surplus equivalent to the area of the dotted quadrilateral. Consumers' surplus rises because the price of the livestock product involved has fallen and its increase can easily be measured. Furthermore, in this case, producers' surplus increases because the triangular area representing it becomes larger. The relevant triangular area is that bordered by the relevant supply curve between the market equilibrium point and the vertical axis and a horizontal line from the equilibrium point and the vertical

axis.

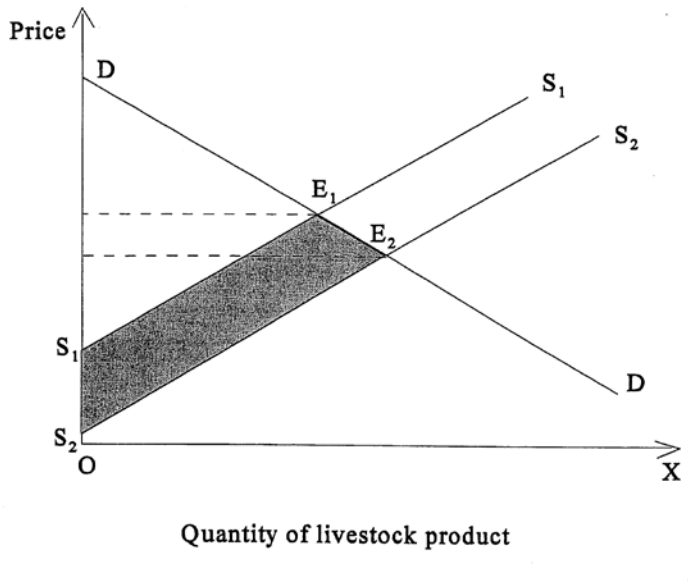

Figure 1: A case in which consumers and producers both benefit from the elimination of a livestock disease. A divergence between private and collective benefits results in private decisions by holders of livestock being socially suboptimal.

While in the case shown in Figure 1 both domestic producers and consumers of livestock benefit from control of livestock diseases, sometimes the sole beneficiaries are domestic producers in the livestock industry. Take the following theoretical case: Thailand is a small producer of beef and a substantial importer of beef (Murphy and Tisdell, 1995). It does not influence the world price for meat. The same is true for its dairy products. In this case, improved health in Thailand's cattle herd benefits Thai holders of cattle only as illustrated by Figure 2.

In Figure 2, the initial Thai supply curve of the relevant livestock produce, e.g. beef or milk, is shown by S_1S_1 and after the eradication of FMD (or similar diseases or reduction in a similar disease) is shown by curve S_2S_2. This world price of the product is P_w. Thailand is assumed to have no effect on the world prices because the small country assumption applies. Furthermore, it is assumed that Thailand permits free trade in the livestock product.

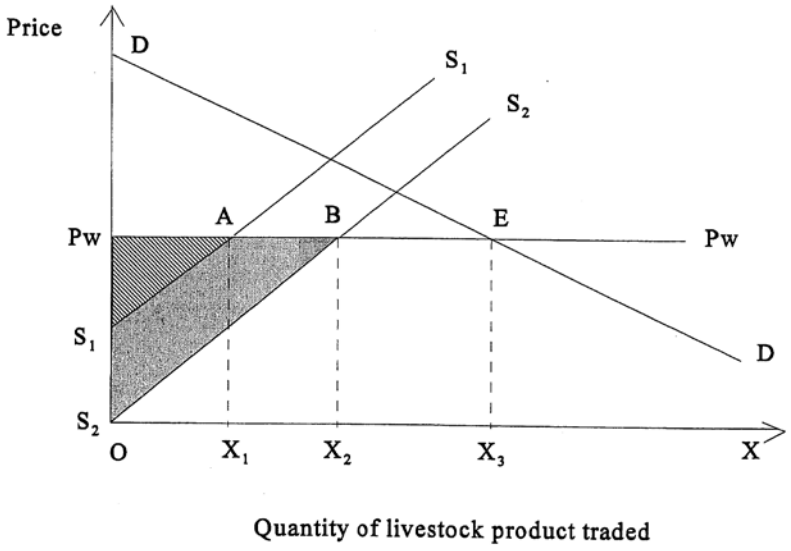

Figure 2: Distribution of economic gains to Thailand of eradicating or controlling a livestock disease where substantial impacts on the quantity of livestock product occur, e.g. beef or milk.

Before eradication or reduction in the incidence of the disease, Thai producers supply X_1, of the product to the Thai market but afterwards they supply X_2. Imports decline from $X_3 - X_1$ to $X_2 - X_1$ given that curve DD represents the demands of Thai consumers for the product. The producers' surplus obtained by Thai suppliers of the livestock product rises from the equivalent of the hatched area in Figure 2 by the dotted area to become equal to the hatched plus the dotted area. Thai livestock producers are the sole beneficiaries of improved livestock health since the surplus of Thai consumers is unaltered.

In relation to FMD, Thailand's situation is more complicated than the above indicates. While Thailand is a net importer of beef and dairy products, it is a net exporter of pigmeat. The presence of FMD restricts the areas to which Thailand's pigmeat can be exported. If, however, we ignore such restrictions on international trade (which cannot in practice be ignored for several diseases including FMD) all gains from improvement in livestock health may go to livestock holders if the country is an exporter of the livestock products concerned.

If changes in supply of livestock products from a country do not alter the world price of the livestock products concerned and world demand can be considered to be elastic at the world price, all economic gains from improved livestock health are appropriate by domestic holders

of livestock. This can be illustrated by Figure 3.

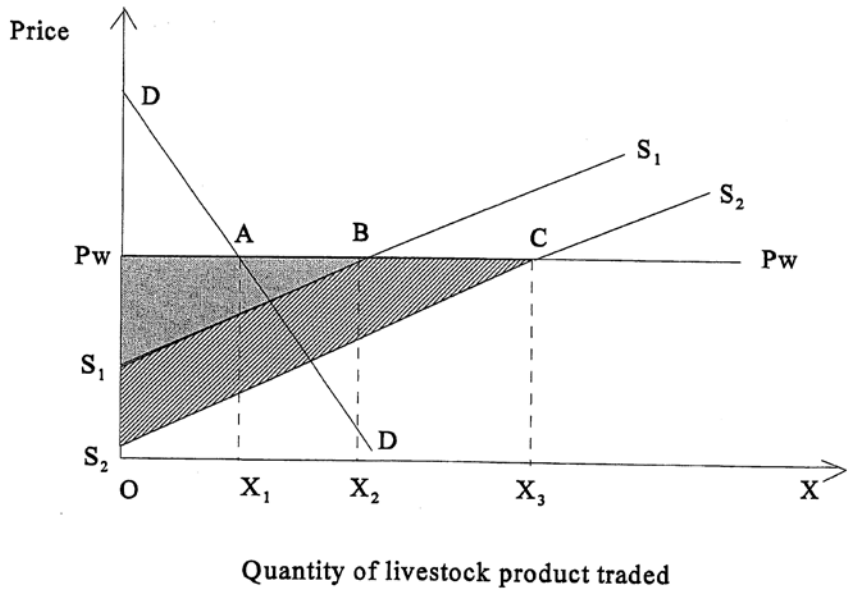

Figure 3: National benefits from improved livestock health for a country exporting livestock products, e.g. Australia. National benefits are appropriated by livestock owners.

In Figure 3, DD represents the domestic demand curve for the livestock product concerned and Pw is the international price of it. Before improved control or elimination of livestock disease e.g. FMD, the domestic supply curve of the product is S_2S_2. Initially X_2 of the livestock product is produced domestically and X_1 supplied to the domestic market and X_2 - X_1 is exported. After the shift in the supply curve, domestic production of the product increases to X_3, exports rise to X_3 - X_1 and the same amount is supplied to the domestic market as initially. Producers' surplus increases from an amount equal to the dotted area to an amount equivalent to the dotted plus hatched area. All domestic economic benefits of the improved control of livestock health are appropriated by domestic holders of livestock.

In the free international trade case, all the collective domestic benefits from improved health control of livestock are appropriated by domestic livestock owners. It makes no difference whether the country is a net exporter or net importer of livestock products. If the principle is adopted within a country that beneficiaries should pay for public policies which improve their economic position, then a case would exist for livestock holders paying for these policies e.g. via a levy on livestock. Several issues in public economics are involved but the cost to

livestock owners of any such scheme must be less than the economic benefits involved. The method of collection of any funds or a levy to cover the cost of public policies to improve animal health should be such as to impose the least economic burden on owners of livestock.

4. The Price of Livestock as a Guide to the Value of Maintaining their Healthiness.

Given limited information, it is interesting to consider the extent to which the price of livestock can act as an indicator of the value of maintaining their healthiness. Surprisingly this matter has been little considered, particularly treating livestock as capital assets.

From the point of view of economic analysis, a commercial animal can be regarded as an asset or a form of capital. The price of this asset should theoretically be equal to its present discounted value as estimated by buyers and sellers of this asset. If market participants are well informed, the market price of the asset, in this case a commercial animal, should be close to its real discounted net value.

Expenditure on livestock health can be regarded as an investment in livestock capital which should sustain or increase the market price received for an animal if sold. All of this suggests that there is an analogue to human capital theory as far as livestock health is concerned.

As mentioned earlier, the market price of an animal can be used to determine the net economic benefit of avoiding the death of that animal. In addition, it may provide some guide to avoiding morbidity or illness in animals. If a market exists for morbid animals, the price of such animals will be lower than that for healthy animals. Taking account of uncertainty, the market price should affect the net present value of a sick animal. The difference between the market price for a sick animal and a healthy one is the value forgone by not maintaining a healthy animal. If the cost of maintaining a healthy animal is less than this difference, it is economic to adopt health interventions that maintain the health of the animal. This is the situation in bald terms. In reality, the position is complicated by the presence of uncertainty.

In Thailand, the market price of dairy cattle is higher than for beef cattle which in turn have a higher price than buffalo (Thummabood and Morathop, 1993). It is therefore worthwhile for owners of livestock to spend more per head of livestock to sustain the health of dairy cattle, compared to beef cattle and in turn more on beef cattle than on buffalo. Small livestock e.g.,

poultry and pigs are of lower market value than large livestock so one expects lower levels of expenditure per head on the health of these animals.

Uncertainty about whether marketed animals are healthy or not and to what extent investment in their healthiness has occurred complicates the situation. Asymmetry of information exists between buyers and sellers and so the types of market difficulties referred to by Varian (1996), Akerlof (1970) and others can be present. These, however, are not such as to cause the collapse of livestock markets, even though they cause imperfections in their operation. There are however ways in which sellers of healthy livestock e.g. vaccinated livestock, can signal this to sellers. Market aspects of this issue are worthy of further investigation.

5. Concluding Comments

The economics of maintaining the health of livestock has many dimensions only a few of which have been touched on here. However, with increasing livestock populations, the issues involved are becoming of increasing importance. This is particularly so in East Asia including Thailand where incomes are rising due to economic development and demands for livestock products are growing. Assessment of the economics of maintaining or improving the health of livestock involves both private and public dimensions. The public dimensions have implications for state or collective interest in disease prevention and spread and the distribution of economic benefits from public policies for animal health have implications for public finance, some of which have been outlined above.

The possibility of adapting human capital theory to develop a theory of livestock capital has been broached. It has been suggested that this could provide a promising new approach to the analysis of animal health economics. Furthermore, there is scope for additional study of the extent to which market prices can provide a useful guide to the economic benefit to livestock owners of investing in the maintenance or improvement of the health of their livestock.

6. References

Akerlof, G. (1970) 'The Market for Lemons: Quality, Uncertainty and the Market Mechanism', *The Quarterly Journal of Economics*, **84**, 488-500.

Crotty, R. (1980) *Cattle, Economics and Development*, Commonwealth Agricultural

Bureaux, Surrey.

FAO (1996) *FAOSTAT Database Results*, Food and Agriculture Organization, Rome.

Hicks, J.R. (1939) *Value and Capital*, 2nd edition. Oxford University Press, Oxford.

Murphy, T. and Tisdell, C.A. (1996a) 'An Overview of Trends in the Development of the Thai Dairy Industry'. *Animal Health Economics* No. 26, Department of Economics, The University of Queensland, Brisbane 4072.

Murphy, T. and Tisdell, C.A. (1996b) 'Livestock and Livestock Health in Northern Thailand: A Socio-economic Analysis of a Cross-sectional Survey of Villages'. *Animal Health Economics* No. 11. Department ofEconomics, The University of Queensland, Brisbane, 4072.

Murphy, T. and Tisdell, C.A. (1996c) 'Thailand's Economic Development and the Changing Nature of its Livestock Industry' *Asian Profile*, **24**(3), 207-222.

Murphy, T. and Tisdell, C. (1995) 'Specific Livestock Industries, Livestock Diseases and Policies in Thailand: An Overview of Bovines (Buffalo/Cattle)' *Animal Health Economics* No.9. Department of Economics, The University of Queensland, Brisbane, 4072, Australia.

Tisdell, C.A., Harrison, S. and Baldock, F.C. (1994) 'Assessing Public Programmes for Control of Animal Diseases in Developing Countries: General Economic Issues with Thai Examples', *The Kenya Veterinarian* **l8**(2), 236-238.

Thummabood, S. and Morathop, S. (1993) *Livestock as a Component of Rural Development*, Department of Livestock Development, Bangkok.

Varian, H.R. (1996) *Intermediate Microeconomics: A Modern Approach*, Norton, New York.

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