Chapter 4

Incentive Compatibility in Risk Management of Contagious Livestock Diseases

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Introduction

One of the most difficult challenges in designing mechanisms that address the risks posed by contagious livestock disease is the potential conflict between encouraging producer herd health management and biosecurity measures while maintaining incentives for early disclosure of suspected health problems. This chapter addresses the importance of the incentives present in the livestock production and animal health systems. When considering the design of policy and market instruments, the focus must be on incentive compatibility as a major determinant of the potential success or failure. Producers face multiple objectives in the course of managing their farms or ranches and must strike a balance between production, financial obligations and animal health. While this book is about systems that involve both the public and private sector for improving risk management and livestock disease management, a key to the success of designing such mechanisms must involve full recognition of the sometimes competing incentives that influence individual producer behaviour.

The intent of this chapter is not to propose specific solutions to address incentive compatibility in livestock disease management, but rather to clearly emphasize the importance of incentives when designing animal health policy or risk management instruments. An underlying theme and concern is that improperly designed livestock insurance solutions could increase the disease risk problem for the entire sector. Livestock disease has great potential to cause widespread economic damages. If the individual producer incentives are not considered when designing regulations, offering government disaster payments or developing insurance products, the result could be a weakening of the animal health system that worsens the effect of an outbreak.

This chapter focuses specifically on those diseases with the greatest potential to cause widespread or systemic losses. Animal diseases with the potential to cause a range of socio-economic problems or public health consequences are classified by the Office International des Epizooties (OIE is also known as the World Organization for Animal Health) as either List A or List B diseases. Unless otherwise noted, all reference to animal disease in this chapter refers to List A diseases, where risk of transmission is irrespective of national borders. Included in this category are diseases such as Foot and Mouth Disease (FMD), Classical Swine Fever (CSF), Newcastle disease and highly-pathogenic avian influenza.

 The Economics of Livestock Disease Insurance (eds S.R. Koontz *et al.*)

Recent events have clearly demonstrated the devastating impact that a livestock disease can have on the entire sector within a country – trade restrictions follow and market prices are severely impacted. Consequently, the benefits of disease-free status are shared by all participants in the market. These benefits are non-exclusive in the sense that any individual engaged in livestock production benefits from an unimpeded market for their products. With the emergence of a highly contagious disease (and some less contagious ones), export demand often decreases as trade partners ban imports from the infected country in an attempt to prevent human illness or the spread of the disease to their domestic herds. Depending on the nature of the disease, demand from domestic consumers may decrease as well. All domestic producers in the market, not just those with infected animals, suffer from the resulting lower market prices. In this way, a single producer's actions that cause a disease outbreak can jeopardize the value of production as well as investments made in production and processing for all market participants. The non-exclusive nature of an unimpeded market for livestock products has characteristics similar to those of a common property resource where access and consumption of the resource are not restricted by property rights. Disease-free status maintains consumer confidence and keeps export markets open, but is heavily dependent on individual behaviour of livestock producers.

The focus of government agencies such as the Animal and Plant Health Inspection Service (APHIS) in the USA has largely been to protect against incursion of disease at national borders through inspection, quarantine and other methods, as well as to identify, contain and eradicate animal health threats if they emerge from within the country. These are vital activities in maintaining disease-free status and are provided by the government based on their "public good" dimensions (see Grannis and Bruch, this volume). Much attention has been paid to government compensation to producers when their animals are slaughtered in response to an outbreak. However, herd depopulation represents only one cost to producers and does not account for economic losses incurred by other market participants. If a major objective of public or private risk management programs is to mitigate and prevent a potential disease outbreak, policy makers must understand the full set of consequences and the individual incentives of producers. The old adage that it is best to "shoot and bury an infected animal" still haunts those who wish to design effective discovery programs in the name of early detection.

Considerations for Insuring Contagious Livestock Disease

Livestock disease insurance is typically available only for companion or sporting animals, breeding stock and other high-valued animals. High cost typically precludes the purchase of livestock disease insurance for production animals. The limited availability of insurance for production animals has typically been only for named peril coverage (i.e. specific diseases). The fact that only limited insurance for production livestock has been offered by insurers may point to the complexity of disease-based coverage or even the lack of demand for such coverage from producers. While it is not the goal of this chapter to determine why private sector insurance for livestock disease has not been available, it is useful to reflect on this question when considering public policy and insurance designs that will mitigate and prevent contagious disease outbreaks in the livestock sector.

Asymmetric Information

Insurance purchasers will almost always know more about their risk exposure than the insurer. In addition, they will know more about their efforts (or lack of efforts) to mitigate their exposure to loss risk. This asymmetric information creates important challenges for those designing insurance products.

Hidden information will lead to adverse selection in insurance. If insurers are unable to properly classify potential policyholders according to their risk exposure, those who have been classified as having low risk when they actually have high risk will buy the insurance. The converse is also true – those who have low risk but are classified as having high risk will not purchase. As indicated by Shaik *et al*. (this volume) livestock disease insurance poses difficult risk classification challenges. If someone has insurance that is underpriced relative to their risk, they may also expand production to generate further expected benefits from the insurance product. Thus, in addition to inequities that follow hidden action and adverse selection, the availability of an insurance product with misclassification problems can actually increase the risk-taking behaviour of individuals. As indicated previously, increased risk-taking by the individual can put the entire sector at increased risk given the nature of catastrophic animal diseases and the link back to markets.

Hidden action (also called "moral hazard") is another problem caused by asymmetric information. It occurs when, subsequent to purchasing insurance coverage, policyholders change practices so as to increase their risk exposure. Hidden action is most problematic when loss risk is highly conditioned on management or production decisions rather than on random events that cannot be influenced by the policyholder. Such is the case with many contagious livestock diseases where loss risk is often dependent on sanitary practices and other disease control measures (see Shaik *et al*., this volume). Once again, if hidden action cannot be controlled, actions of the individual will put the entire system at increased risk.

External Effects

For contagious livestock disease insurance, the implications of asymmetric information problems are more significant than they are for crop insurance. This is because of the external effects associated with livestock disease, especially those diseases that have human health implications.

Unlike crop insurance for most risk events, livestock producers with contagious disease in their herds are not the only individuals affected by an outbreak. With the exception of contagious crop disease problems, when crop insurance policyholders act in ways that increase expected losses, the production losses (reduced yields) incurred as a result of the change in behaviour are generally confined to the policyholders' farms or ranches. Once again, the hidden actions taken by a producer can increase the risk of a disease outbreak where both economic losses and risk to humans extend well beyond the individual producers.

The individual production losses from animals quarantined and slaughtered to contain and eradicate diseases represent only a fraction of the economic cost of an outbreak. A crude numerical example taken from the December 2003 case of Bovine Spongiform Encephalopathy (BSE) in the USA illustrates the widespread economic effect of the presence of a disease classified as being a socio-economic or public health threat within countries (World Organization for Animal Health, 2004). While BSE was found only in a single herd of cattle in one state, all farmers, ranchers, feedlots and processors in the entire country

were affected. When the BSE case was confirmed, US cattle prices decreased as several countries, most notably Japan and South Korea, ceased importing US beef. By comparing the December 2003 live cattle futures prices for the first quarter of 2004 with the observed cash prices (fed cattle) for those months, a loss in market value of $566 million is revealed (calculations based on market data from the Livestock Marketing Information Center).[1] The loss in market value indicates how the individual loss of animals to eradication may pale in comparison to the magnitude of the market losses across all producers.

Systemic Risk

Livestock disease epidemics and natural disasters, such as drought or flood, represent what are known as "systemic risks". Distinct from independent losses that are well-suited to insurance applications, systemic risks result in correlated losses and pose a significant challenge to financing insurance. The distinctions between the systemic risks in agriculture created by natural disasters as compared to livestock disease are found in the respective income and inter-temporal effects.

When a drought occurs it affects a large number of producers in an entire region who suffer economic losses because of reduced yields. If the drought affects a large enough quantity of production, the supply of a commodity or commodities may be affected and producers in areas of the country unaffected by the drought may receive higher prices for their crops. If the drought is localized, affecting the yields of a relatively small number of producers, commodity prices will remain unaffected and the impact of the drought will be confined to those who suffer production losses.

There are both similarities and differences when you consider the income effects from livestock disease. These similarities and differences arise largely from the characteristics of the particular disease in question. Diseases such as rabies, brucellosis or tuberculosis are classified as List B diseases (World Organization for Animal Health, 2004) and are not deemed a threat beyond the borders of the country in which they are present. These types of diseases are generally considered acute risks and as such are a localized threat similar to a drought or flood that affects only a small share of production and does not have implications for widespread income effects because of trade restrictions or widespread quarantine. A small number of List B diseases, such as BSE, are considered systemic risks because of associated human health concerns. Because this chapter focuses on those diseases that pose threats irrespective of national borders and because these diseases present policymakers with the greatest risk management challenges, emphasis remains on List A diseases here.

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[1] Based on December 23, 2003 live cattle futures prices and the actual cash prices received (Nebraska only for comparison with USDA projections) in the first quarter of 2004, multiplied by the live weight of cattle (heifers and steers only) actually slaughtered during that time period, a loss in value of $566 million or 8.11% has occurred in the aftermath of BSE (Livestock Marketing Information Center, 2004). All losses are not attributed to BSE alone. It should be noted that because the market had been experiencing strong prices for the past year or more, the futures prices prior to the confirmed case of BSE already indicated an expected decline in prices starting in early 2004. USDA market estimates prior to the confirmed case compared to observed cash prices indicate a loss of over $1 billion in value based on actual slaughter over the same period (USDA-ERS, 2003-4).

As described in a previous section, in many cases no producers in the specific livestock sector affected by a disease epidemic, regardless of the disease status of their individual herd, will be able to avoid economic losses.[2] Income losses can result from downward price movements from export losses or a change in consumer confidence that affects domestic demand for longer time periods. Livestock producers in other sectors may benefit from a disease that emerges in another species as export and/or domestic demand for other meat products may increase in response to an outbreak. The full magnitude of demand and price effects depends on the characteristics of the particular disease and the environmental conditions present when and where an outbreak occurs, which may affect the rate of transmission.

Inter-temporal Effects

Drought is generally a single-year event, but even if a multi-year event occurs, drought does not affect the openness of export markets for grains, oilseeds or other commodities. Livestock diseases on the other hand may have substantial inter-temporal effects. There are two dimensions to the duration of impact to livestock markets: the market level and the farm or ranch level.

At the market level, the duration of the impact is determined by the length of time it takes to eradicate the disease and regain the confidence of trade partners and domestic consumers. Determinants of this duration include how quickly a problem is disclosed or discovered and the traceback mechanisms for disease and food-borne illness in the livestock industry. Early discovery and traceback will be discussed in greater detail. Without early discovery the disease spreads, enlarging the task of containment and eradication. The length of time it takes to locate the source of the disease once it is identified in the food system may also impact the confidence of domestic and foreign markets regarding the safety of a country's livestock products.

At the farm or ranch level, the inter-temporal impacts are experienced not only through depressed prices, but also through the time it takes to re-establish herds when depopulation is required for eradication. Investments made over time by farmers and ranchers in herd genetics are real costs that an indemnity based on the market value of the animal does not reflect. It often takes years to recover from depopulation and re-establish a biosecure herd of the same quality as before a disease episode.

The case has been made that for livestock disease risk there are unique ramifications of hidden action and the potential for sustained market effects complicate public policy and insurance compared to other agricultural risks. Also unique to livestock disease as a correlated agricultural risk, is the fact that, unlike drought, which is totally uncontrollable, diligent management can reduce the probability and severity of a disease outbreak in many cases. Bioterrorism (Sumner, Bervejillo and Jarvis, this volume) is one exception to the premise that producer behaviour is a major determinant not only in whether a disease outbreak occurs (management) but also the extent of the outbreak (early disclosure).

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[2] This is not the case for diseases that can be contained within a country and are classified as not being a socio-economic threat "irrespective of national borders" (World Organization for Animal Health, 2004). Wolf (this volume) mentions tuberculosis as an example of this type of disease which is present in some US states. This type of disease has a more geographically limited impact, many times affecting only producers located in areas within a country where the infection is present.

Table 4.1. Summary of Recent Animal Disease Outbreaks.

Disease	BSE UK 1996/97	FMD Taiwan 1997	CSF Netherlands 1997/98	FMD UK 2001	FMD Rep. of Korea 2000	FMD Japan 2000
Disease confirmed	1996	20 Mar 1997	4 Feb 1997	20 Feb 2001	2 Apr 2000	4 Apr 2000
Duration of disease	Ongoing	4.5 months	18 months	7.5 months	1 month	1 month
Number of outbreaks	6,271	6,147	429	2,033	15	3
Control policy	Stamping out	Stamping out and mass vaccination	Stamping out	Stamping out	Stamping out and ring vaccination	Stamping out
Animals slaughtered						
- Infected	6,271	4.03 million	0.7 million	1.30 million		
- Pre-emptive			1.1 million	3.10 million		
- Welfare			9.2 million	5.43 million		
Total	**6,271**	**4.03 million**	**11.0 million**	**9.83 million**	**2,216**	**740**
Direct costs [a]						
- Compensation	2,433	188	1,183	2,223	377	0.5
- Control measures		66	138	1,335	66	14.5
Sub-total	**2,433**	**254**	**1,321**	**3,558**	**433**	**15**
Indirect costs [a]						
- Agricultural sector		2,202	423	489		
- Related industries		3,212	596	267		
- Other		949		4,890		
Sub-total	**1,395**	**6,363**	**1,019**	**5,646**	**n.a.**	**n.a.**
Total costs [a]	**3,828**	**6,617**	**2,340**	**9,204**	**433**	**15**
Impact on GDP	–0.4%	–0.64%	–0.75%	–0.2%	n.a.	n.a.
Cost to public sector	63.5%	3.8%	43.5%	38.6%	n.a.	n.a.
Cost to private sector	36.5%	96.2%	56.5%	61.4%		

[a] $US million

n.a. = not available.

Source: United Nations Food and Agriculture Organization (2002).

Good Management, Biosecurity, and Early Disclosure

The role of good livestock health management is fundamental to preventing the emergence of contagious disease and involves not only vaccination of animals and proper feeding practices, but also farm- or ranch-level biosecurity measures to prevent the transmission of disease. Biosecurity measures play an important role not only in protecting the integrity of a producer's herd health from incursion, but also in controlling the spread of disease from the production unit.

The importance of early disclosure of a disease outbreak or a suspected problem by a producer cannot be overstated. The recent experiences of countries around the world in identifying, containing and eradicating contagious livestock disease is instructive. The data contained in Table 4.1 indicate the country where the outbreak occurred, the details that define the magnitude of the epidemic, the number of animals slaughtered and the direct

and indirect costs incurred. This information demonstrates the finding of the United Nations Food and Agriculture Organization that "early detection and appropriate reaction to a disease outbreak is paramount in minimizing the consequential losses" (UN-FAO, 2002).

There is great disparity in the duration and cost of contagious disease events reported in Table 4.1. The FAO has found that the major determinants of both duration and cost are the length of time it takes to identify (confirm) an outbreak and the deployment of appropriate resources to control the spread of the disease and eradicate it. The outbreaks of FMD in Japan and the Republic of Korea in 2000 provide the best examples of how early detection and timely, effective action to contain and eradicate disease greatly reduce the total cost. BSE in the UK is included in this table to demonstrate how a non-contagious disease can also have enormous financial impacts and how BSE is unique as a livestock disease because it has an incubation period of many years, so that by the time it was confirmed in the UK in 1986 thousands of animals had already been infected (UN-FAO, 2002).

The FMD outbreak in Taiwan had infected 28 farms before the disease was confirmed, in the UK 92 herds were infected before the source of the FMD outbreak was identified, and in the Netherlands CSF spread for over a month and infected 39 herds before being detected. These outbreaks in Taiwan, the UK and the Netherlands cost billions of dollars compared to millions of dollars in Japan and Korea. Complications that affect the duration of the disease have included insufficient slaughter capacity to keep pace with the spread of disease and, in the case of Taiwan, the decision to use mass vaccination rather than pre-emptive slaughter which enabled the disease to persist in diseased vaccinated animals lacking clinical signs of illness.

Management and early disclosure represent two of the biggest challenges to designing effective instruments for risk mitigation and transfer because they are a result of individual behaviour. Verifying that individual behaviour is consistent with either government regulations or contingent claims contracts (such as an insurance policy) is very costly given the number of farms or ranches involved. Structuring incentives so that a producer's actions are consistent both with their individual objectives and those of policy-makers is a difficult task, but this is the essence of incentive compatibility. To add to the complexity of this issue, the desire to hold bad managers accountable is likely to run directly counter to the need for incentives that increase the likelihood of early disclosure.

Compensation for slaughtered animals infected with disease has been a common component of eradication programs with costs into the billions of dollars (see Direct costs – Compensation in Table 4.1), but if early disclosure is an important objective then the incentive effects of compensation need closer scrutiny. Consider a producer who anticipates that disclosure of disease or suspected disease exposes him/her to greater regulatory scrutiny while also having a realistic expectation that if his/her animals are depopulated in the event of an outbreak he/she will be compensated. Equal compensation for lost animals, whether early disclosure occurs or not, fails to create an incentive to act consistent with policy objectives. The incentives for good management (punishment/accountability for bad management) and early disclosure do not appear to be compatible as they currently stand in the USA. As long as producers can expect the same level of compensation for animals, whether disclosure occurs or not, there is little incentive to subject oneself to the scrutiny or other recourse that accompanies disclosure (the management incentive). In an attempt to create incentives for early reporting, Belgium and the Netherlands have instituted compensation programs that no longer pay producers for dead animals and only partial compensation is given for diseased animals (Horst *et al*., 1999). The motivation is that once the animal is dead, too much time

has passed to reward the producers. Creating incentives for early detection is a paramount goal.

The issue of compensation is at the core of incentive compatibility for either government or market risk management mechanisms. Insurance that creates incentives that are at odds with animal health policy may actually increase disease risk. Consistency in insurance design and public policy is only half of the incentive compatibility problem, however. For incentive compatibility to be achieved, either individual behaviour must be observable or the producer is expected to perfectly comply with regulatory and insurance contract requirements *with certainty.*

Public and Private Incentives in Livestock Management

In both the public and private sectors there are incentives in place that influence individual behaviour. Whether designing public or private market mechanisms for risk management, these incentives are important. To illustrate this point, first consider the incentives faced by a farmer or rancher in the private market.

Private incentives likely stem from production, marketing and financial obligations that the producer may have. Under production, consider that the farmer or rancher must produce a certain amount at or below a certain cost per unit of production to be profitable and that net income is likely to be a major incentive in making production and management decisions. Based on the marketing arrangement of the particular operation, producers may be subject to a production contract in an integrated industry or may be responsible for directly marketing what they produce. Under contract production, prices may be known and certain inputs provided by the integrator, but there may also be environmental or food safety provisions in the production contract that represent additional costs of production. If these aspects of the contract are violated, it is likely to cost the producer even more in lost revenue. For an independent producer, there may be greater price risk in the market and the additional costs involved in direct marketing must be absorbed. Any financial debt on equipment or production facilities as well as operating lines of credit further strengthen production incentives to ensure that loan payments are not interrupted.

While none of these private incentives deals directly with animal health, there are clearly private incentives to manage disease and biosecurity when you consider that, in and of itself, the occurrence of disease translates into lost income. How the presence of publicly provided animal health services or indemnities for losses due to disease affects these private incentives warrants consideration.

There are also public incentives that influence producer behaviour. The first class of public incentives takes the form of management guidelines or regulations for animal health and biosecurity. If animal health regulations require measures over and above what producers would do to prevent disease in the absence of regulation, such management requirements translate into additional costs of production and lower profitability. Enforcement of some kind would have to accompany this type of regulation to provide adequate incentives for implementation to occur. A second class of public incentive that is very different from regulation is the desire of all market participants to maintain disease-free status because of the potential cost of a disease outbreak. This is the public extension of the aforementioned private incentives that exist for disease management.

Coase (1988, p. 118) argues that for many public policy problems there is no *prima facie* reason to expect that either government or the market would necessarily achieve a more efficient result (see also Samuelson, 1947, who preceded Coase in making this point). The management of livestock disease risk is no exception. While market failure is often cited as a justification for government intervention in the market, it must be noted that both government and the market are susceptible to failure. Wolf (1988) has provided a theory of government failure, whereby the unintended consequences of government actions result in what he refers to as derived external effects. Two examples of government actions taken that have apparently had such unintended effects on livestock disease management are provided.

Private and public incentives that exist at a given point in time must be taken into account as a whole when new public policies or private market products are introduced. While private management incentives to avoid disease may seem clear, the introduction of a new policy may actually work counter to the desired result. By providing free or heavily subsidized animal health services as a public good designed to facilitate disease control, the government may simultaneously provide a disincentive for private investment in animal health (Ramsay, Philip and Riethmuller, 1999). An example of this is the finding of Bicknell, Wilen and Howitt (1999) that New Zealand's government policies to control bovine tuberculosis removed some private incentives to control the disease. By providing these types of services, the government may also create an incentive for poorly motivated producers to enter the livestock sector based on an expectation that government will resolve livestock disease problems if they arise (Ramsay, Philip and Riethmuller, 1999).

Another example of the unintended consequences of public policy is a provision in the 2002 Animal Health Protection Act (AHPA) (discussed by Grannis and Bruch, this volume) that limits federal indemnity payments to the market value of the animals slaughtered and requires that any indemnity amount received from another source be subtracted from the government payment issued. The intent of this provision in the law was meant to avoid problems experienced in other countries where producers were indemnified by state or provincial authorities as well as the federal government for the same animal. This aspect of the law was well intentioned and should minimize government indemnity costs in the event of an outbreak by preventing "double dipping".

The APHA, however, may have the unintended effect of diminishing the demand for private insurance products to indemnify producers in the future, as well as affecting some private insurance products already available to cover a capped, fixed amount over and above government indemnity levels for animal loss. In addition to affecting livestock indemnity, there is uncertainty about whether the reduction in federal indemnity applies to private coverage for consequential losses from livestock disease. By reducing federal indemnity if private coverage for the value of the animal is purchased, the value of an insurance policy is reduced because the producer has to forgo government indemnity to receive full compensation under private insurance. The government is in effect providing free insurance to producers, albeit that coverage levels won't match the full market value of the animal and the level of coverage is uncertain.

There would be reduced incentive to purchase animal insurance coverage in the presence of government indemnity. In contrast to insurance coverage there is typically no underwriting with a government indemnity program. That is, there is no effort to classify producers according to their risk characteristics and increase premiums or reduce benefits (in the case of a government indemnity program) accordingly. Effective underwriting provides incentives for insured producers to engage in risk mitigation. If government indemnity programs crowd-

out insurance purchasing, the result may be reduced incentives for risk mitigation and thus increased disease risk throughout the animal production system. The question of whether coverage for consequential losses reduces federal indemnity for herd depopulation is another source of uncertainty for the producer. It is critical to recognize that there is also potential for market failure in livestock disease insurance.

The costs involved in designing insurance contracts for livestock disease are a result of data availability and monitoring requirements.[3] The development of new insurance products for livestock disease will require an assessment of the nature of the risk and whether insurability conditions are met (see Shaik *et al.*, this volume). Hidden action in livestock production, variability in contagious disease characteristics (transmission, potential socio-economic impacts) and uncertainty associated with the external effects of contagious disease outbreak (implications for correlated losses) all contribute to the transaction costs involved in designing public policy or insurance for risk mitigation. Specific to insurance design is the impact of these costs on premium rates, and if insurance is unaffordable, demand will not be sufficient to cover financing of the catastrophic risks that are present in these types of insurance products.

Because health management and early disclosure are both dependent on individual behaviour, insurers must monitor insureds to limit hidden action problems and discover fraud. Insuring management in any setting is problematic because of the verifiability problem associated with hidden action (Holmstrom, 1979). Insurers are faced with the same hidden action problem as government regulators with limited enforcement resources at their disposal. Monitoring may have major implications for insurance affordability because of its impact on premium loading. The use of third party auditing in tandem with insurance instruments has been suggested as one method for addressing hidden action when risk is highly conditioned on management (Kunreuther, McNulty and Kang, 2002), but this too comes at a cost to the insured. If affordable insurance policies cannot be designed with sufficient incentives for maintaining good management, the provision of insurance under these conditions may actually create incentives for poor management when there is an expectation of compensation. If poor management is the result of insurance with weak monitoring provisions, this would clearly contribute to the risk of outbreak and may inhibit containment efforts even beyond what would occur without the insurance. Investments in the food safety system may reduce information asymmetry and the transaction costs involved in monitoring.

Public and Private Investments in the Food Safety System

Public and private investments in the food safety system provide resources to minimize the impact of disease outbreak. Information systems and risk management planning are important factors that can help reduce the length of time it takes to traceback food-borne illness or animal disease to their origin in the food production system. The experience of other countries in dealing with livestock disease epidemics (see Table 4.1) demonstrates the importance of response time in minimizing the duration and cost of a disease event to society. There are public and private benefits associated with investment and participation in the food safety system.

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[3] See Green, Driscoll and Bruch (this volume) for detailed discussion regarding data requirements.

Public investments in information systems for traceback represent investments in the public good dimensions of livestock disease control. By instituting a system that may not be provided by the market alone, government can absorb some of the transaction costs and reduce information asymmetry: both obstacles to insurance design. Elements of the information system for traceback include animal identification (premises, group/lot, or individual), animal testing and auditing for *ex ante* mitigation similar to Hazard Analysis of Critical Control Points (HACCP) in livestock slaughter and processing for food-borne illness detection and prevention. Information systems involve all levels of production and processing, and facilitate the discovery and trace-back necessary for a fast response to outbreak.

Information systems like the National Animal Identification System being developed in the USA under the US Animal Identification Program (see http://www.usaip.info/), facilitated by USDA, are partially funded by government and partially funded by the private sector, and can include all stages in the lifespan of a livestock product from the farm or ranch to the consumer. These types of systems provide a vast amount of information that has not been previously available – from producer-level herd health and nutrition management, to transport and movement of animals in finishing and slaughter to domestic or export markets. With traceback ability, a weakness in the food system may be identified anywhere along the path from production to consumption. Auditing similar to what occurs through HACCP provides a method for risk mitigation where technical expertise can be brought to bear to help identify a remedy for any deficiency (Skees, Botts and Zeuli, 2001). In addition to housing information that facilitates the disease identification and eradication objectives of government, private benefits are realized when greater amounts of production information become available through record keeping.

Good managers have firm-level economic incentives to invest time and resources in traceback. There are economic returns to management when improved herd health measures are taken (Buhr *et al.*, 1993; Marsh, 1999; van Schaik *et al.*, 2001). These returns can be achieved through production efficiency improvements identified by utilizing the veterinary, breeding, feeding and animal movement or transport information available through improved record keeping. If farm or ranch profitability can be improved and the desired positive externalities from biosecurity and herd health management are generated, the producer and society can benefit from investments in traceback. Greater availability of information may also help a producer identify a potential or emerging disease problem that may have otherwise gone unnoticed and creates an opportunity for early disclosure to occur.

Public investment in information systems for food safety and traceback is believed to create private incentives for improved health management and early disclosure if public policy and insurance are developed in an incentive-compatible manner. The importance of traceback in the duration of a disease event is as crucial to producers as it is to society as a whole because it determines the response time and, in turn, the ultimate cost of the outbreak to an individual producer.

Financing is Fundamental

Government compensation in the USA for animal loss as a result of mandated depopulation has been *ad hoc* because compensation schedules are developed *ex post*. A government indemnity program that acts as a free insurance policy for producers creates an expectation

of compensation if an outbreak occurs – potentially counteracting the desired incentives for good health management and early disclosure.

An established indemnity pool of a known size with pre-determined compensation rules is desirable so that producers have *ex ante* incentives for good management. Part of structuring incentives for management and disclosure includes creating a reliable expectation for the producer that reduces uncertainty about the outcome of a disease outbreak. One mechanism for creating a dynamic that introduces a tension, similar to that created by the presence of prices in the market, is the establishment of a program similar to a check-off where a per head or per hundredweight assessment is paid by the producer into a standing federal indemnity fund for compensation. This type of funding mechanism links the benefits and costs of the proposed assessment, as distinct from the concentrated benefits and diffuse costs that are characteristic of government subsidization of agriculture. It would be important that assessment amounts vary across regions to reflect differences in risk exposure. Higher (lower) risk regions would pay higher (lower) assessments. While a regional indemnity pool would not generate all the incentive compatibility benefits of very stringent insurance policy underwriting, the transactions costs would be significantly lower.

The animal compensation check-off program may not be considered politically feasible, but it is thought that in the absence of insurance it may represent an improvement in incentive compatibility over the present *ad hoc* government indemnity policy. The economic question is whether a check-off program funded by producers will meet the objectives of public policy and whether or not it achieves those objectives more efficiently than the compensation scheme that already exists.

The efficiency of market insurance that is incentive compatible is inhibited by transaction costs in information collection for insurance design and monitoring to overcome hidden action. Given the perceived political and economic obstacles to a producer-funded assessment, the cost to society of an incentive-incompatible *ad hoc* government compensation scheme coupled with insurance may exceed that of a disease outbreak under *status quo* government compensation without insurance. The cost of operating any social arrangement must be taken into account, including the cost of transition to a new system, when devising or choosing among different arrangements (Coase, 1988).

Conclusion

When designing risk management mechanisms for contagious livestock diseases, a goal is to encourage individual producers to improve management in ways that facilitate herd health and biosecurity measures while also providing incentives for early disclosure in the event of a suspected disease occurrence. Attaining this goal is complicated by the presence of information asymmetry. Frequency and severity of disease outbreak are heavily dependent on individual behaviour, which is costly for regulators or insurers to monitor and correct. Disease transmission characteristics and the effectiveness of containment efforts once an outbreak is discovered are sources of uncertainty in determining the extent of a disease event. Livestock disease epidemics represent a unique agricultural risk that poses challenges for public decision makers and the risk management industry alike.

If it is economically feasible to design public policy and market (insurance) mechanisms that are incentive compatible, the negative external effects from an outbreak may be minimized and society is likely to benefit. If, however, insurance is introduced that is incompatible with

the incentives provided by public policy (regulation and *ad hoc* disaster payments), the effect of a disease outbreak could be exacerbated and result in a larger problem than would occur in the absence of insurance. In addition to incentive compatibility, society must consider whether the transaction costs involved in operating any social arrangement (not just the availability of indemnification for producers) justify the benefits provided.

This chapter has presented a deliberate approach to mechanism design for public policy and market instruments that is well suited to addressing incentive compatibility issues. The goal of animal health public policy has been to reduce the risk of livestock disease outbreak and to have measures in place that will effectively limit the spread of disease if outbreak does occur. If either policy or insurance is designed without consideration of the full scope of incentives present in the livestock production system, it is possible to increase the risk present in the animal health system. Successful *ex ante* risk mitigation must take into account the incentive effects of public and private mechanisms that influence producer behaviour and could:

1. Reduce incentives for individual producers to improve their health management and biosecurity, and
2. Worsen the effect of an outbreak rather than foster early disclosure for timely containment and eradication of a disease or suspected disease.

The economic risks of contagious livestock disease extend far beyond livestock producers and processors, and could potentially impact a number of seemingly unrelated economic sectors, including tourism. Government and market-based solutions that can improve the effectiveness of risk mitigation are desired, but care must be taken so that the combination of risk management tools available to producers are incentive compatible and feasible in the presence of potentially high transaction costs.

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