



A FRAMEWORK FOR IDENTIFYING MARKET AND TRADE IMPACTS OF HPAI AND ITS CONTROL

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1 Introduction

Outbreaks of the highly pathogenic form of avian influenza (HPAI) and measures for their control have resulted in massive losses. The initial 2003-2004 outbreaks occurred in countries of South-East Asia, where some of the largest epidemics have occurred. However, the disease has now spread to other Asian countries such as India, Pakistan, Myanmar and Afghanistan, to Near Eastern countries such as Turkey, Iraq and Egypt, to Europe and to sub-Saharan Africa. The loss of production, due to the high mortality rates and culling to control the disease, clearly affect market supplies of poultry meat and eggs.

The dangers of HPAI outbreaks are exacerbated by the associated risks to human health. World-wide a total of 241 cases of human infection have been recorded, all transmitted from infected birds. Over half of these, 141 victims, have died of the disease. As a result fears have arisen, among producers, about the dangers of working with poultry and more importantly, among consumers in many countries, about the dangers of eating poultry products. This fear among consumers is unfounded, provided that the products are cooked, but it has taken hold quite widely and reduced the demand for poultry products on domestic and global markets.

In addition, the potential exists for avian influenza to develop into a form that both causes severe disease in humans and spreads easily from person to person. Hence there are global concerns to protect public health by controlling the disease in poultry and limiting the scope for transmission to humans. This reinforces the need for disease control in poultry beyond the level that would be justified if the risk to humans did not exist.

Relative shifts in the market supply of, and demand for, any commodity cause movements in the price level. A fall in supply, with no change in demand, will result in a price rise, while a reduction in demand, with a fixed supply, causes a fall in price. When the shifts in supply and demand are out of phase, price fluctuations may result.

These influences have been apparent in the global market for poultry meat. The initial outbreaks of HPAI in South East Asia in 2004-5 caused a fall in global supplies, partly due to the production losses caused by the disease but also as a result of import bans imposed by other countries on the produce of key Asian exporters such as China and Thailand. The resultant fall in global supplies led to a 30 percent increase in international poultry meat prices over the period (Morgan & Prakash 2006).

However, by early 2006 the disease had spread more widely, to previously unaffected countries, in Europe, Russia, the Middle East and Africa. Associated human health concerns have led to a significant fall in consumer demand in these regions that together account for about a third of the global import market. As a consequence world prices for poultry meat have fallen sharply. The two main exporting countries, of Brazil and the United States, still free of HPAI infection and together responsible for nearly 70 percent of global exports, faced falls in export prices, from 2005 to 2006, of between 20 and 50 percent. These changes are expected to lead to a 3 percent decline in the global poultry trade, to 8.0 million tonnes in 2006 (see GIEWS 2006).

The incidence of HPAI has affected the global egg market with production losses and falling demands like those for poultry meat. Quantities traded were increasing up to 2004, but have fallen since.

Input markets, in particular those for hatching eggs, day-old chicks and poultry feeds have also been affected. Due, at least in part, to the falling demand for poultry products, between 2003 and 2004 substantial falls in trade occurred for live birds, coarse grains and soybeans. However, trade in all three inputs, has levelled off since then. This year it has been suggested that "poultry and feed demand in Southeast Asia is getting back on the growth path" (Feedinfo 2006b).

The market impacts of HPAI differ between countries, depending upon their *per capita* income levels, whether or not they are net exporters of poultry products and whether they have suffered outbreaks of the disease. The first step is to summarise the probable impacts of the disease, on national markets for poultry meat, in individual countries.

2 Some empirical findings for individual countries

The impacts of poultry disease and control measures, on the national economy, depend on the relative importance of agriculture and the relative contribution of poultry production to the total agricultural value added. Analysis of data for 12 case-study, poultry-producing countries suggests that these variables are related. The countries are Brazil, Egypt, India, Indonesia, Italy, Nepal, Netherlands, Pakistan, Thailand, Turkey, United States of America, and Vietnam (FAOSTAT 2006: The help of Ellen Geerlings of FAO, in extracting and analysing the data, is gratefully acknowledged).

Results confirm the general finding that the contribution of agriculture, to total GDP and employment, declines with increasing per capita incomes. *Per capita* consumption of poultry products, like that of most 'normal goods', naturally rises with increasing income. In addition it appears that higher average *per capita* incomes are associated with

- a) a larger relative contribution of the poultry sub-sector to the total agricultural value added,
- b) a larger number of poultry per rural person,
- c) greater intensity of poultry-meat production (measured as kg meat produced per bird)
- d) a higher likelihood of the country being a net exporter of poultry products.

In summary it is suggested that exporting countries generally fall into the high income and upper middle income group of countries, where intensive, commercial poultry production is an important contributor to agricultural value added. These high and upper-middle income countries can afford to devote more resources to the control of disease and providing support for the recovery of poultry markets. Furthermore, the high average intensity, or productivity, of poultry in these countries, accelerates the rate of recovery.

In contrast, poultry producers in low-income countries suffer not only from poorer access to financial and technical resources, but also from much lower productivity levels and therefore slower rates of recovery from disease outbreaks.

3 Predicted impacts of an outbreak

3.1 Impacts of an outbreak in a closed economy (no external trade)

Theoretical supply-demand analysis may be used to indicate the market impacts of HPAI outbreaks for poultry meat at the national level (See Annex). In a closed economy¹, with no external trade, the price of poultry meat² is determined where the supply and demand curves intersect. A fall in supply caused by the disease outbreak, with no change in demand, results in a price rise (Annex Figure 1). However, a fall in demand due to perceived human health risks, with a fixed supply, causes a fall in price. Thus quantities produced and consumed are likely to fall, but the overall impact on price is unpredictable, depending upon whether the supply or the demand effect is stronger (Annex Figure 2).

These shifts may not occur simultaneously, in which case price instability results. In addition producers and consumers may be slow in responding to price changes, so lags are involved. Once disease control is achieved, restocking takes place and production will then recover. So too may consumer demand. Rates of recovery of poultry production are generally much faster than those for most other livestock, because of their high rates of reproduction and growth to maturity.

3.2 Impacts of an outbreak in a net importing country

Importing countries include many in Asia and Eastern Europe, where HPAI outbreaks have occurred. In theory domestic price in an importing country should be equal to the import (border parity) price. This is below the domestic price that would prevail in the absence of trade. In short, it is cheaper to rely on imports than to depend on home production for part of the national supply (Annex Figure 3).

Import quantities can be adjusted to replace a fall in domestic supply, or to allow for a fall in domestic demand. Price remains unchanged although, in practice, it will be affected by instabilities in the world market. The overall impact on imports is unpredictable. Quantities may rise or fall depending upon whether the supply or the demand effect is stronger. Changes in the quantities of poultry product imports, and the corresponding foreign exchange costs, have an impact on the current balance of payments.

Import tariffs, quotas and protective border disease controls, generally raise the cost of imports, which benefits domestic producers but raises the cost to consumers. Government revenue is also earned from a tariff, but overall the impact on social welfare is likely to be negative. The market impacts of a disease outbreak are therefore likely to be smaller than under free-trade conditions.

¹ Cambodia and Nigeria are countries where HPAI outbreaks have occurred, but very little net trade in poultry meat is recorded.

² This paper is largely concerned with poultry meat (fresh and processed). Similar considerations apply to eggs and other products.

3.3 Impacts of an outbreak in a net exporting country

Outbreaks of HPAI are particularly damaging to exporting countries that risk losing their export markets as a result of import bans. Thailand and China are net exporters of poultry products, that have suffered recent outbreaks of the disease. In such countries, the export price generally exceeds the domestic price that would prevail in the absence of trade (Annex Figure 4).

The loss of export markets is likely to outweigh the effect of a fall in supply and result in a substantial fall in price, loss of producer earnings and deterioration in the current balance of payments. The area, labelled 'transfer' in the Figure, represents a gain to domestic consumers, resulting from the fall in price, but it is balanced by the losses experienced by producers. The overall welfare loss is shown by the shaded area.

In Thailand, the impacts of a series of outbreaks starting in January 2004, have been dramatic and bigger than in any other country (Brahmbhatt 2006). In 2003 exports accounted for 46 percent of national poultry meat production. Total production fell in 2004 by 26 percent, while exports fell by 46.5 percent. Exports of eggs and chicks fell to zero. Domestic poultry meat utilisation also fell from a daily consumption of 31.2 g *per capita* in 2001 to 26 g in 2004.

This collapse of markets led to falling prices and loss of income to producers, processors and exporters in the commercial and industrial sectors. There was also an adverse impact on the tourist sector. It is estimated that growth of the whole agricultural sector was halved in 2004.

4 Impacts on disease-free countries

4.1 Impacts on consumer demand and trade

Consumer demand for poultry products has declined in many countries, even where no domestic HPAI outbreaks have occurred. Furthermore importing countries have been faced with shortages and fluctuating prices on world markets as a result of outbreaks in other exporting countries.

The two largest export suppliers, Brazil and the USA, which together are responsible for approximately 70 percent of global exports, are both disease free. None the less the fall in global demand and prices, for poultry products, has had a significant impact on export revenue. This is likely to be of greater economic importance to Brazil, with exports accounting for about 30 percent of national poultry meat production, while in the USA the proportion is only about 15 percent.

These broad assessments of market impacts of HPAI, on individual countries, may be summarised in terms of impacts on production and consumption. Loss of production has resulted in countries where outbreaks have occurred, eventually balanced by a fall in consumer demand. However, the falling consumer demand for poultry products has had some impact on most countries, particularly those dependent on export markets.

The longer-term market impacts depend upon the rate and extent of recovery of consumer confidence and demand for poultry products, together with the rate and extent of restocking and recovery of production growth. These conditions are likely to vary between different countries depending, in part, on the control policies adopted. The dynamics of the sequence and duration of shifts in supply and demand are of critical importance in determining the overall market impact. The static analyses outlined above give little indication. More may be learned from records of the impacts in individual case-study countries.

4.2 Preventive and precautionary measures adopted by all countries

Given the high cost of HPAI outbreaks to the poultry industry and the potential for development into a human flu pandemic, every country needs to institute a set of measures to prevent the entry and spread of this disease (Rushton & Upton 2006). These measures include border controls on imports of birds, meat and eggs, overseas surveillance of disease prevalence. Additional precautions may include improved bio-security, industry restructuring and possibly prophylactic vaccination. All countries should adopt at least some of these measures, regardless of whether a domestic outbreak of HPAI has occurred.

All these measures incur a continuous stream of costs. The level of expenditure and provision depends upon the perceived level of risk and the resource availability. The level of provision is likely to be higher where costly domestic outbreaks have occurred, where export earnings from poultry, that may be lost in the event of an outbreak, are important and in higher income countries with relatively more resources.

5 Structure of the poultry sector and market chains

5.1 Alternative poultry production systems

Four main types of poultry production system, have been distinguished; namely 1 industrial and integrated, 2 commercial high-biosecurity, 3 commercial low-biosecurity and 4 village or backyard (Table 1, after FAO 2004). They differ in the increasing risk of HPAI infection between System 1 and System 4, due to poorer bio-security, remoter locations, less likelihood of enclosed housing, more contact with other domestic and wild birds, and less assured access to veterinary services.

Intensity of production, reflected in both the level of purchased inputs, and the output, per bird, is generally highest in industrial and commercial systems and much lower in backyard systems. The rapid growth in global production has come mainly from expansion of the industrial and commercial systems. Ten years ago it was estimated that "Industrial enterprises now account for 74 percent of the world's total poultry production...and 68 percent of eggs" (Seré & Steinfeld, 1996). Today the proportions are likely to be higher. However, in developing countries, the numbers of resource-poor households with backyard poultry systems greatly exceed the numbers of commercial and industrial producers.

Table 1: Summary of overall market impacts of HPAI on different countries

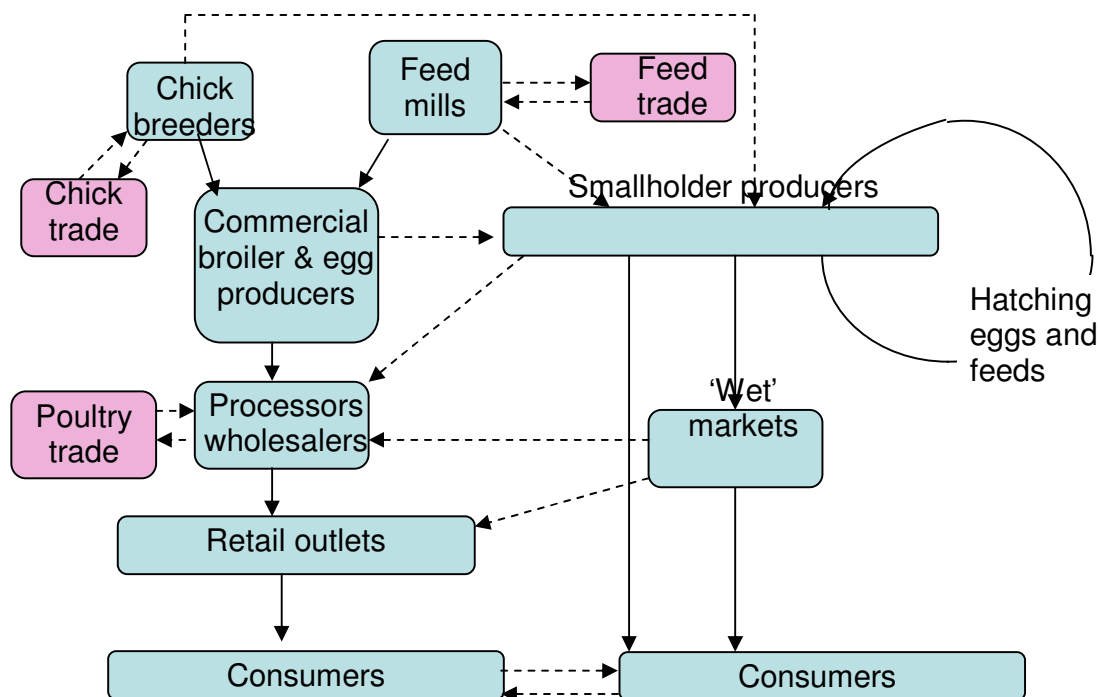
Country status	Market impacts				
	Production	Consumption	External trade	Price	Preventive controls
AI outbreaks No trade	Losses from mortalities and culling. Later restocking & recovery	Food safety fears cause a decline. Demand may recover later if HPAI controlled.	None	Lower if fall in demand exceeds fall in supply: Rises if fall in supply exceeds fall in demand	May be intensified in view of outbreak
AI outbreaks Net importer	Ditto	Ditto	Imports adjusted to meet change in excess demand	Domestic price remains stable	Ditto Greater need to protect borders
AI outbreaks Net exporter	Ditto	Ditto	Export markets closed: trade bans	Domestic price likely to fall with exports lost	Ditto Limited by need to be 'disease free
Disease free Net importer	May respond to decline in demand	Ditto Effect may be smaller without outbreaks	Imports adjusted to meet change in excess demand	Domestic price remains stable	Need to protect borders
Disease free Net exporter	Response to changing world prices.	Ditto	Exports may expand as others face export bans.	Domestic price influenced by	Ditto Limited by need to be 'disease free

Commercial systems are generally based on exotic cross-bred birds, bred specially as broilers or layers. Many smallholder or backyard producers rely on traditional local, dual-purpose breeds. In some cases distinctions may also be drawn between urban and rural smallholder producers, who face different sorts of markets. Differences exist between agro-ecological zones and production systems in the relative importance of different poultry species, particularly as between ducks and chickens. The risks of HPAI infection are thought to be higher in duck producing areas, prevalent in coastal and irrigated areas of South East Asia.

5.2 Market chains

A simple generic description of the poultry market system, is based on identifying just two semi-independent chains, the commercial/industrial and the smallholder/backyard. The former provides for the larger urban and possibly export markets, while the latter supplies mainly rural households through home consumption and local 'wet' or live-bird markets (Figure 1). These are two separate markets, though generally with some linkages between them. Indigenous, "backyard" birds and their eggs generally fetch higher prices than those from commercial enterprises (Acamovic *et al* 2005).

Figure 1: The market chains for poultry products



The commercial chain is generally longer and more complex, involving abattoirs, wholesale traders, food processors, wholesalers and retailers, often integrated and controlled by large companies. Upstream, suppliers of inputs of chicks and feeds are also stakeholders in the chain. Breeding stock and feeds as well as poultry produce may be imported.

The smallholder market chain is shorter and simpler, with limited involvement of intermediaries. Some use is made of local 'wet markets' where live birds are bought and sold.. Inputs of chicks and feeds are largely supplied within the household production system.

This outline only provides a broad illustrative framework. Numbers of different stakeholders in the system, numbers of birds and quantities of produce at different stages of the market chains all vary greatly between countries and would need to be specified for individual case-studies. It is intended to show a) larger numbers of smallholder producers, individually producing a much smaller total product output than the commercial broiler and egg producers³ and b) a longer, but often more closely integrated market chain for the latter group of producers. The arrows with broken lines show paths that may or may not be operational. For instance the boxes labelled 'trade' could represent imports or exports. Impacts on markets for other commodities are omitted from the analysis, despite the possibilities that consumers may switch to substitute sources of animal protein, and producers may switch to other sources of income.

The commercial sector intermediaries include abattoirs, wholesale traders, egg packers, and food processors. This category also includes import or export agencies. They may handle some produce from smallholder producers and 'wet' markets. Retail outlets include local traders, supermarkets, fast-food suppliers and restaurants. The rapid expansion of supermarkets in many developing countries, is widely recorded (Schaffner *et al*, 2005, Reardon *et al*, 2003).

In middle-income countries, where the poultry sector has expanded rapidly it has been mainly due to growth of the commercial sector, along with a general restructuring of food markets (Reardon & Timmer 2006). Within the commercial sector, much of the throughput of processors, wholesalers and retail outlets, such as supermarkets, is controlled by large-scale enterprises. In a few cases these are owned by multi-national companies. They benefit from economies of scale, to produce good quality, disease-free fresh and processed goods at relatively low cost. Although they only command a part of the commercial market, they are gradually replacing the local traders and small-scale wholesalers who bring relatively undifferentiated commodities to small shops or central markets in urban areas.

Independent poultry producers, who are not fully integrated into market chains, may lack bargaining power in negotiating transactions with the few larger traders who control much of the market. Producers contracted to supply birds, or eggs, to large-scale processors and other buyers, may be at a disadvantage, lacking negotiating skills and experience, group organisation and bargaining power.

Smallholder producers: Include System 4, 'backyard' producers and some System 3, small-scale commercial producers. They operate predominantly in rural areas. Production is often mainly for home consumption, and this is shown by direct link to 'consumers'. Hatching eggs and concentrate feeds are often home produced, as shown by the circular link. These producers are largely independent of the 'commercial' chain although they may receive stock from chick breeders or commercial producers and feeds from feed mills.

5.3 Food safety fears induce a fall in demand for poultry products

The distribution of margins and the impacts of avian influenza and its control measures differ between countries and regions. More specific local information would be needed for more detailed analysis. However, some general observations may be made.

A fall in consumer demand is experienced first by retailers, vendors, supermarkets and caterers. Prices must fall to clear stocks. The derived demand for inputs of poultry products is reduced at each stage of the market chain. Urban consumers may switch from wet markets to supermarkets (Evans 2006). Individual country, value-chain studies are needed to identify how disease costs

³ In many low-income developing countries, the smallholder/backyard systems produce most of the national total output of poultry products. However, in most middle and high income countries, especially exporting countries, most of the output comes from industrial and commercial systems.

are distributed. Commercial intermediaries may mitigate the impacts by storage, further processing or reducing imports. Publicity material, emphasising the safety of eating cooked poultry products, should help to restore consumer confidence and demand.

Chick breeders: Changes in consumer demand for poultry products must eventually impact on the demand for day-old chicks. Whether chicks are produced locally or imported, time lags arise and flexibility is needed in adjusting chick supplies to the changes in demand. A fall in demand may leave chick breeders with surplus hatching eggs and day old chicks that must be destroyed. In the longer term, reduction of the breeding flock may be justified.

These problems are recognised by the European Union, which has introduced financial support of up to 50% towards the costs not only of compensation for culled birds and mortalities, but also of adjustment measures, including the destruction of hatching eggs, or chicks and the early slaughter of some of the breeding flock, or point-of-lay pullets. It is expected that national budgets will pay the other half (Europa 2006). There are no similar arrangements in developing countries.

Feed-mills: Another key 'upstream' input market is that for **poultry feeds**. Millers use inputs of coarse grains such as maize and oilseeds such as soybean. A decline in market demand for poultry products necessarily leads to a fall in the demand for poultry feeds. The fall in quantity demanded is likely to be reflected in falling prices and incomes for millers and growers of the constituent crops.

However, falling demand for poultry feed may be countered by an increase in the demand for substitute products such as pig feed or concentrate feeds for ruminants. While large-scale commercial feed suppliers may have the capital reserves and the flexibility to adjust, small-scale millers and mixers may have difficulty in adjusting. They may gradually be forced out of business or taken over by larger firms.

Many developing countries are net importers of feed grains and oilseeds, although Brazil exports both while India and Thailand export maize. For example it is estimated that, 'Egypt's poultry industry is highly dependent on feed imports, with a dependency rate approaching 100 percent for soybeans and 48 percent for yellow corn' (Taha 2003). Since 2003, the global decrease in the demand for poultry products appears to have affected the demand and prices for feed grains and oilseeds on world markets. These markets are now thought to be recovering (Feedinfo 2006b)

5.4 Disease losses lead to a fall in supply

Production losses caused by the disease and its control have an immediate and direct impact on output and incomes of producers, for which compensation may be paid. Processors, wholesalers and retail outlets further down the chain then suffer from reduced supplies, for which compensation is unlikely. However product prices are likely to rise with a possible increase in marketing margins. Producers, whose flocks have not been infected or in dangerous contact, will also benefit from the rising prices.

For chick breeders, a disease outbreak, leading to loss of production, will cause a temporary fall in the demand for replacement stock until the disease is brought under control. Further complications arise in that breeding farms may possibly become infected, and a source of infection on farms supplied with chicks. Imports from infected countries are likely to be banned. Shortages may then arise, in restocking broiler and laying enterprises during the period of recovery after an outbreak is brought under control. Hence in-balances arise in the markets for day-old chicks.

Feed-mills: Feed requirements may also fall as poultry populations are reduced by the mortalities and culling caused by the disease. The industry response will be similar to that caused by a fall in demand for poultry products.

5.5 The smallholder sub-sector

This sub-sector contributes to the incomes, and meat and egg consumption, of large numbers of the rural poor in developing countries. It accounts for the bulk of total poultry production in many low income countries. Susceptibility to HPAI outbreaks is generally greater in this sub-sector where most cases of human infection and consequent death have occurred.

Losses, due to poultry mortality and compulsory culling, have a direct impact on household incomes and nutrition. Supplies in local 'wet' markets and direct sales to local consumers diminish. Alternative income-earning activities may not be readily available, and limited resources are a constraint on restocking after the outbreak has been controlled. Fears of human infection may lead to reduced consumption of poultry products while some households choose to abandon the poultry enterprise altogether. The overall impact, of HPAI outbreaks on the smallholder sub-system, is likely to be highly significant.

In some countries, such as Vietnam, pig production may serve as an alternative source of household income and animal protein. However, pigs are also suspected of carrying the HPAI virus and there are substantial investment costs involved in changing production, marketing and slaughter systems.

The greater susceptibility, of these systems, to outbreaks of HPAI also raises the possibility that producers will be the main losers from control measures, such as the requirement that all birds are permanently housed or the closure of wet markets. They are also the least likely producers to be compensated for their losses. The impacts on the local markets served by these small-scale producers are likely to be important from a pro-poor policy viewpoint.

6 Control measures, government and markets

6.1 The public sector role in controlling disease

Control measures, government and markets

The public sector role in controlling disease:

Transboundary diseases, such as HPAI, represent an important constraint on livestock production. Direct costs arise from production losses due to mortalities and declining yields. Indirect costs are associated with control measures that incur additional expenses or reduce productive capacity. In addition, the losses of producer income caused by declining market demand and falling prices represent additional consequential costs. The consequential and indirect costs often greatly exceed the direct costs, for instance in the case of HPAI as described for Thailand in Section 3.2 above (Brahmbhatt 2006). As another example, the costs of HPAI in the Netherlands are discussed in Box 1.

It could be argued that both direct and indirect costs of disease are components of the total costs of production and should be met by the producers. These additional costs would be reflected in higher product prices and ultimately paid by consumers. In fact producers generally bear the direct costs of disease, and the indirect costs of implementing some control measures such as surveillance and biosecurity. As suggested in Table 1 standards of disease control provision are highest in industrial Type 1 production systems and lowest in Type 4, smallholder systems, where as a consequence the risks of outbreaks and their spread are greater.

However, as is widely recognised, '**market failures**' are likely to arise in the delivery of veterinary services, so public sector interventions are needed. The case for public sector intervention in providing for specific disease control measures, such as border controls, surveillance, movement controls, quarantine services, food safety and drug quality control, has been argued on the basis that they yield **public goods** and **externalities** (Holden 1999, Umali, Feder & de Haan (1992), Leonard 1993).

Public goods provide benefits from which no-one can be excluded and there is no rivalry between beneficiaries. Border control, against entry of HPAI, is a good example, since all poultry producers benefit and the benefits derived by a new producer have no impact on the benefits derived by other producers. Given the risk of a possible global pandemic, HPAI control benefits the whole human race.

Externalities arise where actions by one individual or group, have an impact on the welfare of other members of society for which no payment is made. A producer who effectively controls an infectious disease in his own flock benefits neighbours whose flocks would otherwise be at risk.

Additional reasons for market failure, and therefore justifications for public sector intervention are a) **economies of scale** in the provision of disease control measures, that might lead to **market imperfections**, such as the development of private monopolies and b) high **transaction costs** that result from risk and uncertainty, **lack of information**, and information asymmetry. Inadequacy of information makes the efficient allocation of resources to disease control very difficult.

Box 1. The Netherlands experience (*Information provided by Ellen Geerlings, private communication*)

Although the Netherlands only contributes 7.2% of the world's poultry meat exports it has a share of 19% in live bird exports and 25% of poultry egg exports. Within the European Union (15 members) the Netherlands contributes nearly a third of exports of all three items, mainly to other EU members.

An outbreak of avian influenza, identified as a highly pathogenic strain, occurred in February 2003. The following control measures were introduced; a nation-wide standstill on the transport of live poultry and hatching eggs, a prohibition on exports of live poultry, increased monitoring of wild birds and poultry and mandatory indoor housing of commercial and backyard or hobby flocks. This last measure was relaxed in February 2006 when vaccination was introduced as a voluntary alternative control measure.

It took four months to control the epidemic, and the country was declared disease free and the export ban was lifted in July 2003. In the process 30% of the national poultry stock had been culled and 130 million table eggs, 45 percent of total production, and 60 million hatching eggs had been destroyed. Direct costs were estimated at 300 million euros, and were largely met by the Dutch Government with some assistance from the EU and the poultry industry.

The outbreak of HPAI and its control appear to have hastened the decline in the Dutch poultry sector, in the face of low priced competition from developing country producers. The number of poultry producers fell by 26 percent in 2003 although there was some recovery in 2004. One major poultry processor went bankrupt. Broiler production fell by 19% resulting in reduced demand for hatching eggs. Some owners of breeding farms switched to table egg production, attracted by high egg prices in 2003. However, as production recovered, with reduced domestic and export demand, the price fell dramatically in 2004, though it has risen a little since.

Broiler prices fell after the end of the outbreak but had recovered to more than the 2002 price level by the end of 2004. They stayed at a relatively high level through much of 2005, but have fallen since. *Per capita* consumption fell significantly in 2003 but recovered in 2004. Hence it appears that the effect of producers leaving the industry with a consequent limitation of supplies has balanced any reduction in demand that may have occurred. Commercial and hobby-farmer egg producers are changing to free range production in response to shifts in consumer preferences, but these are not related to food safety concerns.

A recent new outbreak of avian influenza, of low pathogenesis, has led some Southeast Asian countries to re-impose bans on imports from the Netherlands. The impacts have yet to be seen.

Even where market failure occurs, and government intervention is justified, the expense does not necessarily have to be met from public funding. Regulations may be imposed to for which producers must meet the costs of compliance. For instance, the imposition of enforceable regulations, such as controls on the movement of poultry aimed at limiting the spread of disease or mandatory housing of poultry, transfers the costs of these disease control measures to the individual producer.

It is possible that public sector provision of information on livestock disease control, will persuade producers to adopt such measures voluntarily. Poultry producers may be persuaded to improve levels of bio-security and disease surveillance by the provision of information on the risks of

outbreaks occurring, the potential damage and approaches to limiting these impacts. Alternative approaches to delivery and funding of control measures are set out in Table 2.

Table 2: Sharing the costs of disease control

Alternative source	Public finance	Private finance
Public delivery	<i>Direct action:</i> Border controls	<i>Regulation:</i> Movement controls Mandatory housing of poultry.
Private delivery	<i>Contracting:</i> Private vets contracted to carry out a vaccination programme	<i>Self regulation:</i> Bio-security measures

While the costs of some control measures such as tighter bio-security and careful surveillance naturally fall on private sector stakeholders, the costs of others can be shifted onto the poultry industry by imposing **regulations**, such as movement controls, or compulsory housing of birds. The costs of some regulations have unequal impacts on the two market sub-sectors, requiring major adjustment by the smallholder producers. These impacts are illustrated by comparing alternative control measures, in terms of the demands made on veterinary services and the incidence of the main costs, together with possible impacts on the structure of the poultry industry.

Impacts of preventive and precautionary measures

There are five main groups of preventative and precautionary measures:

- i) border controls and global surveillance,
- ii) domestic surveillance and bio-security
- iii) contingency planning and preparedness
- iv) industry restructuring and mandatory housing and
- iv) prophylactic vaccination.

It is recommended by FAO (2004) that a combination of these measures should be in place, in every country, regardless of whether or not a domestic outbreak of avian influenza has occurred. Some measures are likely to be implemented in every country, but probably with greater vigour in those where a domestic outbreak has already occurred.

Most of the costs of i) border controls, iii) contingency planning and v) vaccination are usually met by government. However, ii) domestic surveillance and bio-security depend upon active participation by producers and other stakeholders, while iv) restructuring and mandatory housing impose costs on the industry. The latter group of measures, also including zoning or compartmentalisation of production and the closure of 'wet markets', generally favours the commercial sub-sector, in some cases at the expense of the smallholder sub-sector.

Border controls only involve veterinarians in their design and monitoring, but otherwise are legally enforced. They are supported by international surveillance and monitoring by international agencies, such as the OIE. Domestic costs are mainly incurred by the government, but consequential costs to the poultry industry may arise if supplies of imported chicks are affected, while domestic prices may be increased by the exclusion of imports. Border controls may prove ineffective in the face of smuggling and transmission of disease by wild birds.

The costs of surveillance and bio-security are largely met by producers, traders and other stakeholders. However, costs are incurred by the public sector in monitoring and possible enforcement. The poorer standards achieved by System 3 and 4 producers provide incentives for private investment and government policy to be focussed on replacing these systems by the

industrial and commercial systems that maintain higher standards of surveillance and bio-security.

Some countries have adopted policies of industry restructuring, to promote and accelerate the change to more intensive production systems. Mandatory indoor housing of poultry and enclosure of ducks also promote more intensive production systems. Such policies discriminate against small-scale backyard producers, and may damage the livelihoods of many of the rural poor.

Vaccination necessitates a substantial input by the veterinary services and substantial costs are incurred by the government. Some industrial and commercial producers may be willing to finance their own vaccination programmes, for HPAI as for Newcastle Disease. However, to ensure full coverage of smallholder, system 3 and 4, flocks, public provision is necessary. The introduction of a policy of vaccination may lead to loss of export markets.

Impacts of measures adopted when an outbreak of the disease occurs.

Apart from activating and enforcing some of the precautionary measures, more strongly, the use of culling infected and at-risk flocks together with strict movement controls are the main methods of control. Compulsory slaughter requires inputs from veterinarians to diagnose infected birds and to identify dangerous contacts. Ideally skilled staff should be employed for slaughter and the sanitary disposal of carcasses.

Costs are incurred, by the Government, in enforcing and executing the culling policy and enforcing movement controls. Producers suffer the direct losses of birds and their products while they and other stakeholders incur the consequential loss of markets and future income. These consequential losses extend far beyond poultry producers and processors, and could impact on seemingly unrelated sectors, such as tourism.

There is widespread agreement that an effective culling programme to 'stamp-out' the disease must be accompanied by the payment of compensation at a level that is high enough for reporting to be worthwhile but not so high as to remove the motive for disease prevention.. Payment represents a transfer of income from the Government to producers, who therefore recover the costs. However, producers and other stakeholders are rarely compensated for consequential costs, that may extend far beyond poultry producers and processors, and could impact on seemingly unrelated sectors, such as tourism. In some countries, public financial support has been provided for restocking.

There is general agreement that an effective culling programme to 'stamp-out' the disease must be accompanied by the payment of compensation at a level that is high enough for reporting to be worthwhile but not so high as to make producers complacent in the belief that the government will meet all the costs (Ott 2005). In practice, low income countries with outbreaks have had difficulty in meeting these requirements. In Vietnam a rate of only 30% of market value was paid, weeks or months after the outbreak ended. In Cambodia no compensation was paid (McLeod *et al* 2006).

Public financial support is particularly needed where, as in many developing countries, agricultural credit provision is severely limited. The lower bio-security production systems 3 and 4 are more likely to become infected and therefore to face culling of their stock. These producers are also the least able to claim the compensation and support to which they are entitled, whilst facing more serious constraints on funding for recovery. Poverty-focussed programmes may be needed for their support.

Movement controls on birds and humans impact on many stakeholders in addition to the producers and traders. Few veterinary inputs are needed, but monitoring and enforcement by government are needed. Movement controls may lead to the shortening of market chains, for instance with direct delivery to slaughter. This in turn may lead to the expansion of integrated systems.

The conclusion of this section is that very difficult choices must be made in planning HPAI control policies. Alternative options must be assessed in the light of the epidemiology and risks of potential future outbreaks, their costs and benefits and their demands on scarce resources, such as limited veterinary capacity. In seeking cost-efficient disease control policies, potential impacts on the livelihoods of small-scale producers and traders must be considered. The costs of some proposed control measures fall disproportionately on the traditional smallholder sector.

7 Conclusions

Market impacts of HPAI, on national and global markets, result from production losses that reduce supplies, together with human food safety fears that reduce demand. The overall impacts depend upon the time profiles of shifts and recovery of supply and demand.

Export trade in poultry meat is concentrated in the industrial and commercial sub-sector of a few high- or middle-income countries. Although four different poultry production systems have been identified by FAO, a key distinction exists between industrial and commercial systems, with low disease risk and intensive production, and smallholder and 'backyard' systems with high disease risk and low productivity levels.

These two systems are associated with separate semi-independent market chains. The industrial/commercial system, responsible for most of the product output in high and middle income countries, generally includes large-scale processing and retailing companies. They have the resource capacity to survive the impact of HPAI outbreaks, although exporters faced with export bans may have problems.

Given the existing financial and veterinary resource constraints, collaboration is needed between governments and the commercial poultry sub-sector, in controlling the spread and limiting the adverse market impacts, of HPAI.

Suppliers of chicks and poultry feeds may face damaging reductions in demand, when poultry production and consumption are reduced by disease outbreaks.

Smallholder and backyard systems generally involve many more producers than do commercial systems. In low income developing countries, they may account for most of the total domestic poultry production. The risks to this sub-sector are high because the probability of infection is greater than in commercial systems, while the costs of an outbreak are much higher in relation to household incomes.

Private markets fail to deliver adequate levels of disease control in livestock, so public sector intervention is needed, though subject to financial and human resource constraints. Interventions include direct action, dissemination of information and regulation. Alternative control measures differ in their requirements of veterinary and other resources and in their impacts on the structure of the industry. Some measures impose greater costs on the smallholder sub-sector.

In the absence of special support measures for smallholder producers and traders, the incidence of HPAI outbreaks and measures for their prevention and control may hasten the growth of commercial systems and the decline of smallholder poultry production.

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ANNEX 1

Use of supply/demand diagrams to illustrate market impacts of HPAI

Figure A1: Impact of disease in a closed economy

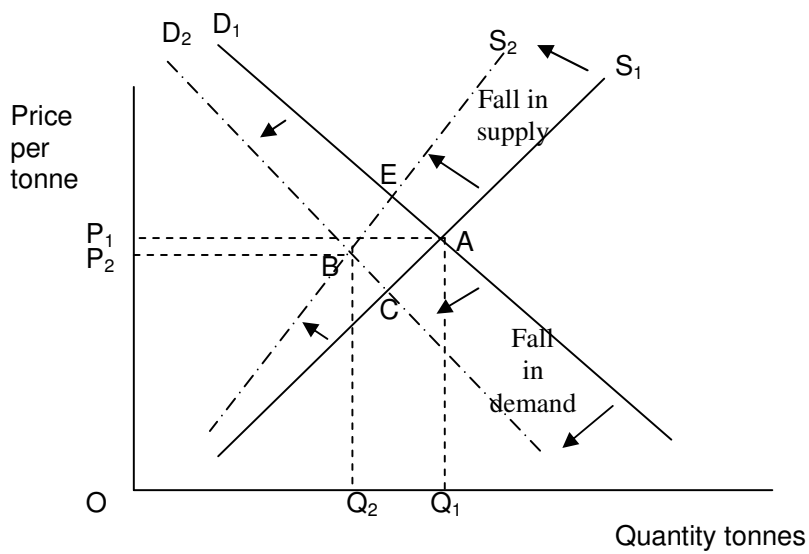
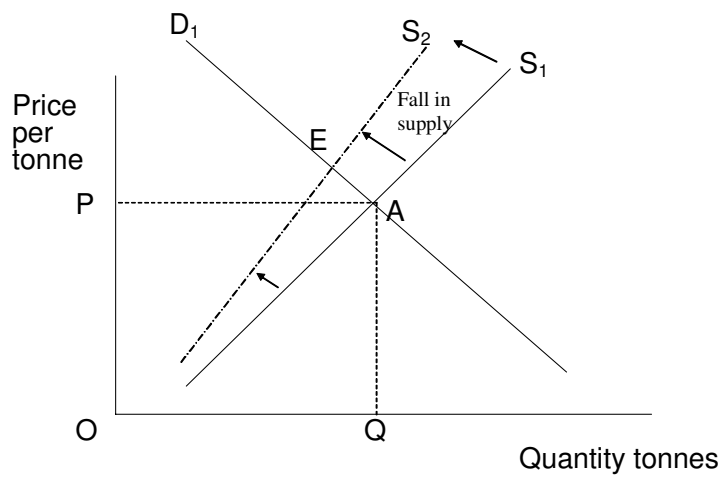


Figure A3: Imports meet excess demand

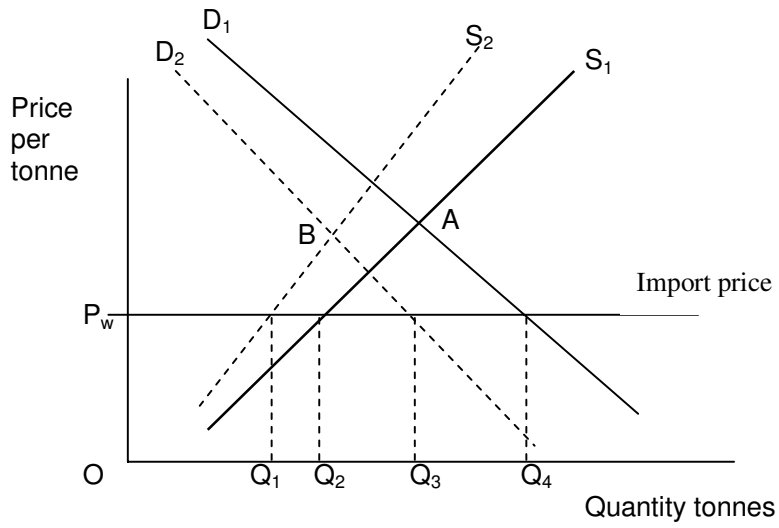


Figure A4: Losses due to export ban

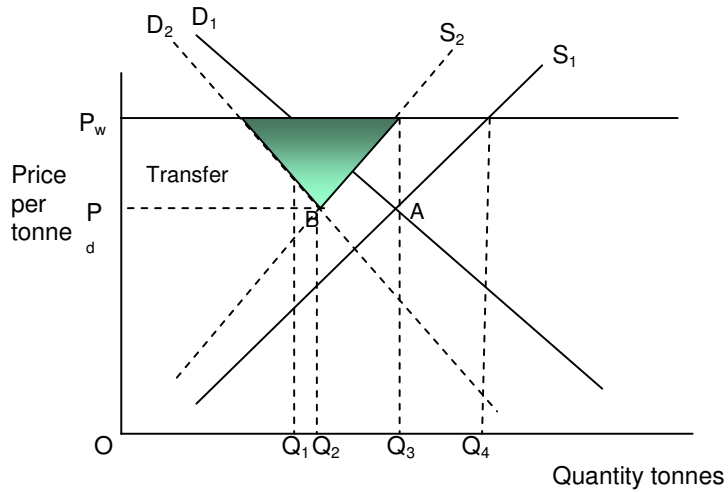


Table 2: Sharing the costs of disease control

Alternative source	Public finance	Private finance
Public delivery	<i>Direct action:</i> Border controls	<i>Regulation:</i> Movement controls Mandatory housing of poultry.
Private delivery	<i>Contracting:</i> Private vets contracted to carry out a vaccination programme	<i>Self regulation:</i> Bio-security measures