

The Impact of HPAI of the H5N1 Strain on Economies of Affected Countries

Ceyhun Elci

London South Bank University

The epidemic of the Highly Pathogenic Avian Influenza (HPAI) of the H5N1 strain is causing major economic problems to affected countries, mostly in South-East Asia. The poultry industry is the most devastated, with major losses. This paper assesses the impact and cost of an epidemic of this nature on affected economies. The paper evaluates the economic impact from the poultry industry to the governments and even further to the international level, as the epidemic has no consideration of borders. With the world at the crossroads of a global pandemic, the economic impact will also be considerable at the international level. With the use of forecasting models the affects of the epidemic will be evaluated. The impact to affected countries economies are not just national based, for those with the endemic H5N1 strain are socially burdened with sustaining or even intensifying resource-intensive activities and as a consequence are left with shouldering economic losses in order to safeguard international public health. This at a major level will require the cooperation of the international field, with increased global integration the financial responsibility will be left to the international countries, to make sure all is coherent. The paper in particular assesses the economic impact of the poultry industry for the affected countries. Within these countries the poultry industry is seen as a major sector and the consequence of this pandemic has been the death of poultry from the disease itself and the culling of poultry to stem its spread. Both these factor are leading to significant costs to the poultry industry and to the Governments of the affected countries in containing the epidemic. The increase in costs can be seen in terms of equipment, materials, transport and personnel, that are required to keep a control on the spread. The impact will be qualified by the assessment of GDP and modelling the losses of trade and Government expenditure in controlling the spread of the disease and subsidiaries that the government would have provided to farmers of diseased Livestock for compensation. The results of the impact will have a major impact on the development of the affected regions. The loss of a major source of income from the trade of poultry will have serious consequences on the balance of payments and Government Debt. The cooperation of the affected countries through information will help and lower the overall impact to each country. However the total impact will depend on the transfer of information between affected economies, and the period of time the epidemic will last and if H5N1 begins to transfer to humans.

Introduction

The epidemic of the Highly Pathogenic Avian Influenza (HPAI) of the H5N1 strain is causing major economic problems to affected countries, mostly in South-East Asia. The worst countries affected in this region are Cambodia, Indonesia, Thailand and Vietnam. The outbreak that began back in 1997, Hong Kong and became an all-Asian pandemic in 2003. Has had a number of important characteristics upon trade and therefore the industrial effect of livestock and poultry has been of great importance, in the past decades. Trade in these commodities have been significant sources of economic growth for a number of these affected countries. However trade and economic growth has been distorted, through non-traditional protectionist measures or barriers imposed by governments, and also through the problems of health and safety. Trade has been affected by the spread of animal disease, which has lead to major uncertainty for the future of these commodities and its impact on the GDP of affected countries. The international environment has seen in the past decade two major outbreaks, Avian Influenza (AI) and Bovine Spongiform Encephalopathy (BSE), causing havoc to a number of economies. However the impacts of these outbreaks vary, not just in regards to the type of the disease, but in reference to the costs of maintaining the spread and furthermore eradicating the problem (the disease). Therefore, reference needs to be made to the economic structure of the affected countries, for example, Thailand's poultry industry is heavily dependent on exports, which means the structure of affected commodities in relation to GDP will be an important factor to assess.

Furthermore the consequence of a disease outbreak deteriorates the confidence within the product in question, in this case the poultry industry. As confidence is questioned, trade is affected and exports become negligible, and therefore the excess supply of non-diseased poultry will be sold domestically at lower prices, as foreign markets restrict imports from these countries. This paper examines the impact AI has on affected countries. The paper hereafter aims to better understand the following:

- i. The HPAI of the H5N1 strain in South-East Asia,
- ii. The poultry industry,
- iii. The impact on affected economies – cost of an epidemic, and
- iv. The international impact - an epidemic with no borders.

Literature

The highly pandemic stance of H5N1 strain in previous outbreaks, e.g. Italy, cf. Mannelli, *et al* (2006), Capua, *et al* (2004), and Schäffr, *et al* (1993) can be seen through many studies cf. European Commission (2004), with more recent studies since the outbreak of the East Asian AI, cf. FAO (2004), Shortridge, *et al* (1998) and Webster, Cox and Stohr (2002). The FAO study concludes the position of continuing outbreaks that began back in late 2003, and elaborates on its disastrous affect on the economies of affected countries. The pathogenic nature of the H5N1 strain makes recommendations on the prevention, control and eradication, a difficult scenario. For despite control measures, the nature of the disease continues to spread internationally, causing considerable concern not just in East-Asia, however internationally, as can be said, the HPAI of H5N1 strain does not recognise borders. With the migration nature of birds this further disseminates the need for concern, as the disease is free to cross these borders. The major world animal and human health authorities that are the FAO¹, OIE² and WHO³, play an important role in providing global strategies and regional plans to minimise the HPAI threat, cf. FAO (2004), Delquigny, *et al* (2004), and Bolteron and Aquilino (2004). Studies show that AI of HPAI is an animal problem, however studies

¹ FAO - Food and Agricultural Organization of the United Nations.

² OIE - L'Office International des Epizooties - World Organisation of Animal Health.

³ WHO - World Health Organization.

also identify the foreseeable future of a human influenza pandemic stating that in most instances this is "*both overdue and inevitable*" (World Bank, 2005).

However reflecting back to historical epidemics the affects may not be as considerable, for instance the pandemics of 1957-1958 and 1968-1969 were comparatively placid. But there is the belief that the H5N1 strain, could gradually mutate and become of more concern in human-to-human transference, that shall be discussed later, which could be in the terms of the global pandemic, like the "Spanish" influenza of 1918-1919. However with further devastating affects as the international environment has grown faster and as international trade in commodities, is a major economic growth instrument. For example, poultry is traded from Brazil to Europe and Japan, trade is intense. The connection between H5N1 and the terms of international trade in relation to the economic impact will be assessed here within.

HPAI is an area of major importance with global influence. The United Nations FAO and WHO are the most important researchers. The link between these institutions and the H5N1 outbreaks is of primary health and safety. That provides information and sources of recommendation in handling the outbreaks. However the WTO and the World Bank's stance on the subject are of trade recovery. An assessment made by Brahmhatt (2005), identified the economic costs of the SARS outbreak in East-Asia, similar impacts are possible to be seen from an AI-H5N1 strain. Pervious surveys by UNESCAP⁴ assessed the full-scale of the AI outbreak in Asia, stating losses of approximately US\$ 10 billion in GDP terms during December 2003 to February 2006.

The composition of HPAI restricts international trade in live birds and poultry meat and therefore has an impact upon the economic system. Leslie and Upton (1999), state that in countries that the poultry export industry has been developed and considered as an important proportion upon a country's GDP, the impact will threaten investment, employment and international trade. Furthermore cf. Leslie and Upton (1999), believe in the positive benefits. The reappearance of diseased commodities can be handled with more care as information transfer is freely allowed.

H5N1

The epidemic of the Highly Pathogenic Avian Influenza (HPAI) of the H5N1 strain is an extremely contagious viral disease that at present spreads between animals caused by the influenza A virus (family Orthomyxoviridae) that is sub-divided as the basis of the hemagglutinin antigens (H1-H16) and neuraminidase antigens (N1-N9). The trade aspect of the disease outbreak is of importance under the SPS⁵ agreement, to safeguard health and safety of animals, regulated by standards of Animal health code through the L'Office International des Epizooties (OIE).

The HPAI virus of concern within this recent outbreak is an infection on poultry caused by one of H5 or H7 influenza A virus', in this case the H5 sub-strain. Determined by the result of the viral's mortality rate. The outbreak of H5N1 has gained ground since 1997 in Hong Kong, among wild birds and poultry spreading from South-East Asia to Central Asia and Eastern Europe see Table 1.

Table 1. Outbreaks by season 2003-2005

Season	Outbreaks
Winter 2003	367
Spring 2004	114
Summer 2004	414
Autumn 2004	596
Winter 2004	1160
Spring 2005	52
Summer 2005	44
Autumn 2005	441
Total	3189

Source: FAO (2006)

⁴ UNESCAP - United Nations Economic and Social Commission for Asia and the Pacific.

⁵ SPS - Sanitary and Phytosanitary.

Table 2. Outbreaks by Country and Season 2003-2005

	Season								Total
	Winter 2003	Spring 2004	Summer 2004	Autumn 2004	Winter 2004	Spring 2005	Summer 2005	Autumn 2005	
Cambodia	9	2	:	1	:	:	:	:	12
China	50	:	1	:	1	3	1	37	93
Croatia	:	:	:	:	:	:	:	3	3
Indonesia	6	:	:	2	76	45	:	:	129
Japan	9	1	:	:	:	:	:	:	10
Kazakhstan	:	:	:	:	:	:	1	:	1
Korea	7	:	:	:	2	:	:	:	9
Kuwait	:	:	:	:	:	:	:	1	1
Laos	19	:	:	:	:	:	:	:	19
Malaysia	:	:	:	5	:	:	:	:	5
Mongolia	:	:	:	:	:	:	2	1	3
Romania	:	:	:	:	:	:	:	29	29
Russia	:	:	:	:	:	:	:	10	32
Thailand	183	7	93	582	122	3	18	41	1049
Turkey	:	:	:	:	:	:	:	5	5
Ukraine	:	:	:	:	:	:	:	17	17
Vietnam	84	104	320	6	959	1	:	297	1771
Total	367	114	414	596	1160	52	22	441	3189

Source: FAO (2006)

Poultry Industry

Taking the Thai and Vietnamese poultry industries, similarities can be seen; the poultry industry has been in commercialisation; however it still has similarities with the Cambodian and Laos poultry industries that are dominated by backyard systems. These are more prone to outbreaks than clean advanced poultry systems. Thailand has the most advanced system with a majority of the poultry production system involved in clean plant production, with minimal human interaction (Rushton, *et al* 2004). This has led to the decline of traditional poultry farming techniques and adoption of advanced integrated poultry farming within modern facilities. This is seen as the best way to reduce potential outbreaks. However the same small number of backyard producers, still are potential threats to both these facilities and outbreaks.

Thailand is the fourth largest exporter of poultry in the world with 7 and 12 percent in volume and trade respectively, the Thai poultry market is estimated at approximately, US\$ 1.17 billion annually (Costale, 2004). Similarities in the importance of the poultry industry can be seen through many South-East Asian countries however with less turnover of revenue.

Impact on Affected Economies

To assess the impact of an AI, H5N1 outbreak within affected countries a macro and micro economic approach can be taken, cf. Verbiest and Castillo (2004). The impact is different depending upon the country and its commitment to the poultry industry. For example, Thailand an economy with a considerable poultry industry, the impact of H5N1 has been 1.5 per cent of GDP and Vietnam with a loss of 0.3-1.8 per cent of GDP, (FAO, 2004). The factors that have been the impact of these losses are culling and affected poultry flocks, resulting in the largest decline of 15 and 20 percent in Vietnam and Thailand respectively.

The main economic impacts are seen by the rural poultry industry in several South-East Asian economies. However the macroeconomic cost is relatively unimportant. Verbiest and Castillo (2004) state this to be the case as well, because the poultry industry is not of great importance as indicated by its limits to the region of 0.1-0.2 percent of GDP in Vietnam. However the impact of

H5N1 does have a relatively micro impact, in particular in the South-East Asian region that has a high level of small farmers dependent upon poultry production. The small farmers are in most cases poor or low income families, who are more reliant on poultry as sources of income. Therefore the cost of compliance in the eradication of AI has overwhelming costs, in culling and restocking of poultry in order to continue the required production levels, to maintain their livelihood. The costs are hard to maintain as financing becomes a major problem. This leads on to the two categories of costs, direct and indirect costs. Compensation is usually a direct cost to both encourage compliance and inform national and international organisations, the other reason is to compensate and support small rural farmers. However direct support in most South-East Asian Economies is difficult due to the fiscal expenditure constraints. However direct and indirect have their costs and benefits that can be accurately quantified in some aspects and estimated in others.

The major costs occurred as a consequence of HPAI of H5N1 outbreaks have been the cost of loss on poultry production through the spread, and the other costs have been to the government in containing the epidemic through government expenditure on equipment, material, transport personnel and a taskforce to tackle the outbreak. The major South-East Asian economies have seen direct costs, in the region of 140 million birds culled and the stated costs of containing the epidemic is in the region, of approximately US\$ 10 billion (World Bank, 2005).

For affected economies the impact has been the distortion of trade with the imposition of SPS measures by importing countries. For instance the FAO (2006) explained that with the detection of new AI, many countries took the protectionist route. This has been through the use of WTO regulatory agreements, established by SPS measures under the OIE to immediately impose standards that resulted in immediate declines in poultry consumption, affecting Thai exports from 5.1 million tonnes to below 70,000 tonnes from 2000 to 2004 relatively, see table 3. The cost of these regulatory practices have resulted in a decline in poultry revenue of US\$ 3.6 million to US\$ 123,000 relatively, see table 4.

Table 3. Chickens Exports - Qty (1,000)

	Year				
	2000	2001	2002	2003	2004
Far East	107,381	98,567	103,011	96,877	59,787
East & South East Asia	57,475	54,248	57,666	53,161	36,330
Brunei Darussalam	0	0	108	0	0
Cambodia	0	0	0	0	0
China	47,579	41,283	42,255	38,588	19,187
China, Hong Kong SAR	22	8	1	14	2
China, Macao SAR	0	1	2	2	0
Indonesia	1,325	1,017	628	508	6
Korea, Republic of	110	174	256	231	0
Malaysia	49,569	47,878	50,650	47,650	36,012
Myanmar	0	0	0	0	0
Nepal	0	0	0	0	0
Philippines	130	93	641	185	240
Singapore	1,246	818	951	163	3
Thailand	5,095	4,268	4,432	4,424	69
Total	272,238	251,382	263,688	246,915	155,904

Source: FAOSTAT (2005)

As table 4 shows, the impact has been felt by most of the South-East Asian affected economies, with general declines in the region. This in total in 2004 resulted in an 8 percent decline in South-East Asian international trade with a 36.8 percent decline in South-East Asian poultry trade. As a result of major production sources, with reference to South-East Asia, the result has been a loss of major competitive sources and in result a 30 percent increase in international poultry prices, as importation became restricted and competition declined with less supply.

Table 4. Chickens Exports – Value (US\$ 1,000)

	Year				
	2000	2001	2002	2003	2004
Far East	174,949	159,727	166,516	154,533	100,655
East & South East Asia	73,748	83,224	84,903	85,009	64,062
Brunei Darussalam	0	0	15	0	0
Cambodia	0	0	0	0	0
China	99,791	75,399	80,304	65,713	33,103
China, Hong Kong SAR	595	164	11	23	4
China, Macao SAR	0	2	3	5	0
Indonesia	2,748	1,371	1,593	1,249	5
Korea, Republic of	177	268	489	452	0
Malaysia	65,810	76,221	76,058	76,513	63,333
Nepal	0	0	0	1	1
Philippines	267	145	914	410	585
Singapore	1,150	578	406	175	16
Thailand	3,595	4,641	5,428	6,210	123
Total	423,645	402,678	417,935	394,075	265,372

Source: FAOSTAT (2005)

In comparing all recent outbreaks of AI for example, the 2003, Netherlands and 2004, North American. The Asian crisis has been the most significant and devastating. With Thailand and Vietnam being the worst affected with a reported 1,049 and 1,771 outbreaks respectively, see table 2, totalling 50 million poultry being slaughtered, (FAOSTAT, 2005).

The direct economic costs seen in South-East Asia is the loss of poultry and the cost of compliance through compliance of SPS-OIE codes, that have major costs in the certification and laboratory testing of products. Which have affected trade with direct costs to the production system, costing approximately 0.1-0.2 percent of GDP in economies like Thailand. However most of the influence is felt by the individual rural households that have been compensated partially. Furthermore the direct costs of having to deal with the outbreak and control its spread has direct economic costs to a country that can range from 0.2-0.3 percent of GDP, in an economy like Vietnam where most of the poultry production is still backyard production. However in economies like Thailand and Indonesia, where most of the production is commercialised, the impact is felt through industrial bankruptcies, high unemployment, lose of profits, and cost of restructuring. Plus government expenditure through compensation used to gain accurate data on outbreak figures that may otherwise be concealed.

Therefore economically reducing a government's balance of payment and therefore the burden therefore is an imposition of fiscal resources. The external factors affecting cost resulting in indirect costs to international countries are for example, a fall in tourism and the loss of labour hours as the workforce change their routines, because of disease fear. In most of East-Asia this has not been a major factor so far, see table 5, travel numbers are persistent and have not been affected in most circumstances.

Table 5. Tourism in South-East Asia (Million's)

	Year				
	2000	2001	2002	2003	2004
Cambodia	0.46	0.61	0.79	0.70	1.06
China	162.24	177.92	203.85	174.06	257.38
Indonesia	5.06	5.15	5.03	4.47	5.32
Malaysia	10.22	12.78	13.29	10.58	15.70
Philippines	1.99	1.80	1.93	1.91	2.29
Singapore	7.69	7.52	7.57	6.13	8.33
Thailand	9.51	10.06	10.80	10.00	11.65
Vietnam	2.14	2.33	2.63	2.43	2.93
Total	199.31	218.17	245.89	210.28	303.6

Source: Various (2006)

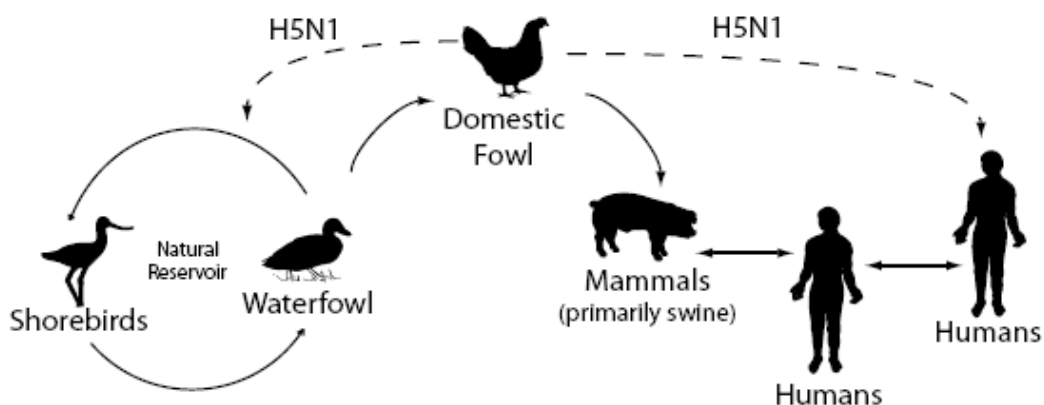
However apart from all the costs, there are some benefits from an outbreak of highly infectious pathogens; the benefits seen can create changes in systems, providing efficiency to a system that lacks control. Providing harmonisation and transparency between systems, as standards can reduce costs and compliance can advance technical facilities regarding animal, human and plant life, satisfying minimum residuals that will lower the risk of outbreaks. Therefore benefits do exist; controlling HPAI can provide considerable reductions in disease outbreaks that may otherwise have not been achieved. The affected South-East Asian countries have faced considerable problems with the HPAI, H5N1 strain outbreak. However, "*no single country can protect itself against an influenza pandemic, and the importance of actions undertaken in one country may well have implications of the well-being of the rest of the world's population that are incalculable*", as stated by the World Bank (2005: 123). This takes the impact to another level that explains the impact of such outbreaks are never just kept within the affected countries' borders, but has indirect affects to the international environment as international integration is on the increase.

International Impact

The highly infectious nature of HPAI will require an international control to handle and control a number of approaches that will reduce outbreaks. The international environment has major concerns and interests with the South-East Asian outbreaks that have gradually advanced internationally. The reasons for the international developed environment showing such interest is because of the possibility of an epidemic within developed countries. The economic cost is of great concern to many of these developed countries.

Furthermore the international environment is concerned with the possibility of the strain mutating and infecting humans that could have devastating economic effects, for if the epidemic evolved to human transmission the economic cost would be vast, more than the impact evaluated of the trade in just poultry. The WHO (2004) estimated the human casualties would be between 2-7.4 million deaths. This is considerable and the human loss would be felt with a loss of workforce labour, being detrimental to the economy. This is not a hypothetical scenario; the world has seen a number of cases within the last 9 years. The possible scenario of transmission has been evaluated by USGS. This can be seen in figure 1, showing the link of transmission between poultry to birds and humans. The scenario is made easy here; however even so, the possible transmission pathways for AI are not seen to be much more complex, considering the historical data on infection. The point of the pathway that is of importance is the mutation to human-to-human transfer, which has not been seen yet.

Fig. 1. Possible transmission pathways for Avian Influenza.



Source: USGS (2005)

The international factor that is important is the transfer of information, the element of concern is the responsibility to control the outbreak and transfer of information of outbreaks and an

affected countries ability to maintain and provide information. It may be that the countries in many of these cases are developing and generally poor or middle income per capita economies that will find it relatively expensive on resources. Therefore distorting trade through two categories, this being the compliance of SPS measures that shall transfer efficient resources that are scarce and the second factor is the backlash from the reputation of diseased products that can affect the exportation of other important products, produced by these economy's. This is a problem as the country will loss economically. However, the international integration and the free transfer of information have major opportunities through a coordinated intervention system, and therefore it is in the interests of all countries to integrate and work together in tackling a pandemic virus and its spread, in order to improve trade and reduce any potential economic impact of such outbreaks.

Affected countries fully acknowledge that containing and eradicating the H5N1 outbreak would be a desirable objective for all nations, even if the short-run cost is vast. This is justified, for any long-run cost would cause more problems. Furthermore the global public health implication of the potential emergence of the virus as the next human influenza pandemic is a possibility. Therefore these countries with the HPAI of the H5N1 strain endemic must sustain (and perhaps intensify), resource-intensive activities and therefore "*shoulder the burden of economic losses in part to safeguard international public health*" (World Bank, 2005). Assisting them with the financial costs of doing so is clearly an international responsibility, as the possibility of infection is equally likely to affect any country as those that have been affected.

On the international front the WHO has taken the position to draw-up recommendations and guidelines for pandemic preparedness and is "*developing a model country plan that will allow countries to assess their state of preparedness and identify priority needs*" (World Bank, 2005). However these are long procedural reports that take a long-time and are usually extremely costly for developing nations to implement. Therefore the international environment must play hand-in-hand, with the affected countries to develop plans for the control and future eradication of micro impacts of a disease. The outbreak must establish policies that shall bring together all stakeholders, the entire international environment. The harmonisation of standards and industrial production facilities and systems is gaining ground. However it is important to identify key international points that affect all economies. The integration of economic systems, has to be shown in integrating important health and safety concerns, that can also reduce the cost of tackling the outbreak, and also have a potential in stabilising international funds that can help sustain the financial clean up.

The future impact is uncertain, considering the mutation of the virus and its affect on humans and the transfer from human-to-human, if this occurs it will definitely have a global devastating impact. However the impact could be seen earlier with the fear factor. As for example, with the SARS outbreak the impact was seen through human perseverance factors upon the economy. Individuals changing routines to avoid becoming infected that leads to the loss of labour hours and furthermore the impact of public policies that try to control the spread through quarantines, restrictions, which affect economies through the loss of revenue in tourism, transport, retail, and services. Therefore a global pandemic would be huge considering output and input, reducing productivity and the redistribution of resources.

The international collaboration of the WHO, FAO and OIE provides a good starting strategy to help control HPAI, there strategy is a "*master coordination plan be prepared with a global vision defining the road map and time frames for the short, medium and long-term priority activities, to be endorsed and supported by individual countries and regional organisations*" (FAO-OIE, 2005: 2) that helps the international and national organisations bring together ideas to support cost-benefit scenarios that will provide better incentives to nations to adopt SPS measures. However as stated the cost factor is of most importance and more work needs to be done, with close collaboration with low income developing nations.

However further action needs to be taken, as the world is inadequate in its capacity of investment, fiscal and resources to eradicate HPAI. Actions that can be taken are developments in sustainable human and physical resources. That will develop socio-economic policies to evaluate the affected economies. Other routes that need to be taken are the development of improved

Natural Resources

vaccines and rapid diagnostic tests that shall provide more efficient and productive economies. In addition understanding the production and marketing systems and the risks associated with outbreaks, an effective disease control system can help restructure the poultry sector. A final action would be country-specific policies that would be to comply with international WTO SPS measures. That provides the basis for a restructuring facility for example, the poultry industry.

The indirect cost of human output would depend on the extent and length of the epidemic and furthermore the demographic structure and its resources to comply. Costs are in the form of Government prevention, increased standards, surveillance, diagnosis, culling and vaccination, all significant costs to any economy. However if nations are to eradicate H5N1 and its impacts they must understand the impact and possibly abide to WHO (2005) policies that covers monitoring cf. WHO (2005).

However when considering the developed countries, even if they seem to have the technology and resources to handle an outbreak they are not immune to the social and economic costs associated with such outbreaks. In most cases it is estimated that affects would be similar to South-East Asian Economies or even more devastating, with major losses in labour working hours and change in consumption behaviour. This has been seen among Europe, with the consumer fear towards poultry with consumption shocks, ranging from a dramatic 70 to 20 percent in Italy and France respectively. This has not only been limited to imported poultry the impact has been seen in demand decline for EU poultry as the AI outbreak moves westwards. This indicates that the cost impact has not only been upon the affected countries. But has already advanced to the international markets affecting the poultry industry in developed countries, further costs have occurred in Europe with the establishing of security zones with the increased surveillance to regulate the influx of diseased produce, which are all-in-order to maintain control of AI inflections. However this policy is not cheap and maintaining these policies, increase costs to the European states.

Even, so the most dramatic impact has been on the poultry industries of the East-Asian farmers. The prices have declined in juxtaposition of the decline in consumption. See table 4, indicating the decline in poultry revenue as a consequence of a decline in international poultry polices and the affect of H5N1 outbreaks. The results have been declines of 24.6, 49.6, 17.2 and 98 percent in South-East Asia, China, Malaysia and Thailand respectively.

The largest impact of HPAI to the South-East Asian affected economies has been through trade. The South-East Asian economies account for one forth of global poultry trade⁶. As a result of the H5N1 outbreak the result has been a decline of imports from these affected countries, as import oriented countries change to other non-affected suppliers such as the United States and Brazil. However as a consequence this has increased prices by 45 percent in some cases from pre-ban price levels (EMPRES-FAO, 2004). This has been as a consequence of poultry resources being transferred to less efficient sources as the South-East Asian economies that have a comparative advantage, can no longer sustain trade as an impact of the H5N1 outbreak.

The problem however faced by the international environment is the non-availability of perfect information on the global platform, the first point is, that it is expensive and secondly many countries fear backlashes from the exposure of infections that as a result will affect other sectors of the economy. Therefore many infected governments take their own stance in defining national strategies according to sovereignty and national biological, epidemiological, economical, political and social factors relevant to the country. However this strategy is not without its problems for example, the individual strategy provides a "Petri dish" (because of lagging information) for outbreaks outside the affected country which could result in faster infections and higher economic costs to other economies.

⁶ This includes re-exports form China, Hong Kong SAR and China, Macao SAR.

Conclusion

Therefore to adopt harmonised strategies as set out by the WHO pre-pandemic mandate, countries may be able to prevent the spread of HPAI in those countries that are currently infected, but each country may have different requirements, in the short-run. Therefore, in the long-run they should be the same, to eradicate the HPAI and prevent its spread to HPAI free economies.

This means policy makers need, to understand the threat and give top priority without delay, investing the necessary resources to reduce any long-term impacts, in result maintaining the costs to the short-run. The systems must work with full transparency and harmonisation of information, so that the epidemic may be handled with care and as quickly as possible. As stated by Ferguson *et al* (2005) through the use of a simulation model, by targeting a mass prophylactic use of antiviral, the pandemic can be halted in the short-run.

Further possibilities to reduce the industrial and economic impact could be through insurance schemes that can compensate and have a cost effective approach in controlling trans-boundary animal disease directly. This may strengthen international and regional cooperation. The benefits that have come out of the AI outbreaks in Asia are the heightened awareness, therefore increasing the transparency of information that affects public perception and would result in preventive measures that can reduce mistakes and halt any further expansion of outbreaks. The benefits of the AI are the building of cost-effective monitoring and control systems forming a good basis of other diseases. For example, in Thailand it has helped identify the factors that may help in future outbreaks.

Under SPS measures it would be the best route for all poultry producers to satisfy ISO 9001:2000 standards, in supply chain facilities in terms of trading, the sanitary of equipment and facilities, the receiving and transportation of produce, which should be controlled under ISO standards to maintain a tracing and recall system that can continually improve the system and prevent the occurrence of infectious disease. By conforming to relevant international and national regulations, established by the WTO's SPS measures, which should be adopted by all, even if not a member of the WTO as it can help lower the impact on H5N1 affected countries. However this requires close collaboration between all stakeholders from farmers, suppliers, intermediaries, official agencies, and governments, international organisation like the OIE and Codex and finally the consumer. Even though this may increase cost in the short-run, cost of compliance benefits will be seen in the long-run through the reduction of large economic impacts from outbreaks. Therefore compliance seems to be a necessity, countries that do not comply with international or national regulations to eliminate H5N1, either find it difficult or are less induced to comply, believing the compliance will outweigh costs of non-compliance or that the compensation is not well balanced.

In conclusion it would be beneficial for South-East Asian poultry producing countries to adopt a closed house system that provides more structure, lowering the risk of infection. Therefore lowering potential costs from losses and restructuring of standards and trade distortion. This has been seen through large exporters putting pressure on governments to limit small farmers that are more prone to outbreaks. This may eradicate the disease; however it must be deliberated with regards to production levels of small producers. Therefore in conclusion to control H5N1, all reasonable measures must be considered in connection with the cost implications. The welfare impact maybe highly problematic however the economic impact is of equal interest and therefore policies need to be based upon risk assessment, understanding the impact to all sectors. The cost of doing nothing is the worst case scenario; however the policy of culling all infected produce, without a compensation package can also be devastating for many farmers that rely on poultry as an income source.

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