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AI and its Impact on the Indonesian Economy: a CGE Approach[1]

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Abstract

Virus H5N1 is confirmed as the cause of AI in Indonesia as well as in other Asia countries. A possible human pandemic from AI has economic implications and may affect consumer behavior as well as other sectors such as tourist, trade and transportation. A Computable General Equilibrium (CGE) model is used to analyze the impact of the recent AI outbreak on the Indonesian macro and sectoral economy as well as on income distribution. The model is a combination of INDOF (Oktaviani, 2000), and WAYANG (Wittwer, 2002). Even though the contribution of the poultry sector is relatively small in the Indonesian economy, the AI outbreak had significant impacts at sectoral and macro levels. Government action to control AI is important if welfare is to be maintained amongst the most vulnerable groups in society.

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I. Introduction

The human casualties from the recent outbreak of AI (AI) have been reported by the Indonesian Ministry of Health. In its last report the Ministry reported that Mr. Iwan Siswara and his two daughters were infected by virus H5N1 in July 2005 in Tangerang City, Banten Province, Indonesia and subsequently died (Indonesian Ministry of Health, 2005). This raised wide concern across the nation.

Indonesia, like many other Asia countries has a high population and relatively unhealthy animal and human living environments which are potentially susceptible to diseases such as AI. The second AI outbreak in Thailand and Vietnam in 2004 resulted in eradication of 120 million poultry by authorities to prevent further spread of the disease. At that time the number of human deaths from AI was reported 12 in Thailand and 33 in Vietnam (Table 1). Other Asian countries also infected by the H5N1 virus are China, Laos, Cambodia, Japan, South Korea, Pakistan and Taiwan. The virus even infected poultry in the USA where 74,000 poultry were destroyed in Delaware State (Andrea, 2004). The AI outbreak has become a serious problem for many countries.

Table 1. Human Cases of AI (H5N1) Confirmed in 2004 and 2005

Time of confirmation	Viet Nam		Thailand		Cambodia		Indonesia		Subtype
	Confirmed	Death	Confirmed	Death	Confirmed	Death	Confirmed	Death	
2004	29	22	17	12	0	0	0	0	H5N1
2005*	15	11	0	0	1	1	0	3	H5N1/H5
Total	44	33	17	12	1	1	0	3	

* January-February, except Indonesia on July, Source: OIE, 2005 and Indonesian Ministry of Health, 2005

Virus H5N1 is confirmed as the cause of AI in Indonesia as well as in other Asia countries. It can also infect ducks, other types of birds, pigs and zoo animals such as tigers. In Indonesia, the disease was first identified in the poultry production areas of West Java, Central Java and East Java. More recently it was reported in the provinces of South Sulawesi, Jambi, East Kalimantan, North Sumatra and West Nusa Tenggara. OIE (2005) reported 5000 poultry deaths from AI since May 4th, 2005 in North Sumatra. The latest outbreaks Avian in Indonesia are shown in Table 2.

A possible human pandemic from AI has implications for individual welfare as well as for social, economic and political security. Such a pandemic could be more serious than conventional threats to social welfare because many societies, particularly in the developing world, are not prepared for it. In terms of economic and social implications, AI should not influence food security needs as consumers can choose proteins from other animal sources (Andrea, 2004). So far, the poultry production sector has experienced declining demand for poultry meat because of consumer fears about contamination (Arifin, 2005). This sector relies on large numbers of small scale producers and declines in poultry meat demands have affected income in these households. This has resulted in pressures on the Government of Indonesia (GOI) to take action to reduce potential losses and compensate losses at farm level. However, compensation taken by the GOI has not covered loss of farmers' profits with the value of the compensation far below production costs. Since shortcomings in compensation

payments probably reflect insurmountable GOI budget constraints, strategies that anticipate the outbreak of the AI are likely to be more effective than possible eradication policies that depend on compensation.

Table 2. New Outbreaks Avian in Indonesia

Province	District	Type of epidemiological unit	sub district	Date of start of the outbreak	Number of animals in the outbreaks		
					susceptible	cases	death
Jambi	Batang Hari	f/v*	Bajubang	07-03-2005	39,840	895	895
Jambi	Batang Hari	f/v*	Muara Bulian	07-03-2005	902,700	2,650	2,650
Jambi	Batang Hari	f/v*	Pamayung	07-03-2005	425,930	637	637
Jambi	Jambi	f/v*	South Jambi	21-03-2005	1,928,200	580	580
Jambi	Jambi	f/v*	East Jambi	21-03-2005	774,500	161	161
Jambi	Jambi	f/v*	Kota Baru	21-03-2005	1,265,500	355	355
Jambi	Jambi	f/v*	Telanaipura	21-03-2005	547,680	675	675
East Kalimantan	Tenggarong	village	Tenggarong	4-2005	3,000	2,000	2,000
North Sumatra	Simalungun	village	Ujung Padang	04-05-2005	10,000	5,000	5,000

* f/v: farm/village
Source: OIE, 2005

From a sectoral perspective, spread of AI has negatively impacted on the agricultural sector, poultry industries and regional trade. There are increasing concerns over the whole ASIAN region and worldwide that AI has the potential to disrupt international trade. Countries are starting to ban poultry product imports from infected countries. Decreases in poultry trade affect the poultry, restaurant, tourist, feed and other related industries. The agricultural sector supplying intermediate goods for the feed industry has also been affected. As well, money is needed to finance the health infrastructure to prepare for a potential human pandemic.

Animal husbandry plays an important role in the Indonesian agribusiness system. It employs millions of workers in both rural and urban areas. The sector has developed in response to increasing demand for high quality of meat, eggs and other animal products (Arifin, 2005).

The Agricultural Ministry predicts that the producer loss from AI was Rp 65[3] billion up to March 2005 (Agromedia, 2005). There were 16.32 million bird deaths from AI up until March 2005 with a peak of 2.57 million deaths in January 2004. AI spread to 17 provinces and 105 districts in Indonesia and reduced domestic demand for poultry. FAO-PAIRU reported in Agromedia in 2005 that demand for Day Old Chicks (DOC) in the disease area decreased 58% for the broiler industry and 40.5% for the layer industry. Feed demand decreased by 45%, feed supply decreased by 40.7 % and employment in the poultry industry fell 40% at the peak of the disease.

Indonesia has committed to liberalizing international markets under both AFTA and APEC agreements and this has led the GOI to ratify its trade regulations to comply with WTO

guidelines. The Agreement on Agriculture (AoA) required members to reduce trade barriers in the form of tariff or non-tariff barriers (NTBs). The agreement will provide wider market access and may also reduce activities in domestic industries. This has implications for the way AI is managed in Indonesia which imports fresh and processed chicken meat and exports (admittedly small amounts) to other countries such as USA, Japan and Malaysia. This trade could be severely disrupted until guidelines are agreed to implement sanitary and phytosanitary policies to protect consumers.

Negative public perceptions of AI had negative effects on the poultry industry and prices of live broilers tumbled following the outbreak. Additionally, although there is no evidence that AI can be contracted from eating cooked poultry meat or eggs, AI still caused declines in demand for these products. So indirectly, AI is also influencing even those parts of the poultry industry not affected by the virus. Therefore, it is important to understand the impact of AI in the broader context rather than just in terms of direct productivity losses. These psychological affects on consumer behavior are also likely to influence tourist, trade and transportation sectors. Further, reduced poultry demands because AI is likely to have macro and sectoral impacts as well as affecting income distribution.

II. Economic Performance of the Poultry Industry in Indonesia

2.1. Poultry Industry in Indonesian Economy: GDP Share, Export and Import

The contribution of livestock to GDP in Indonesia is relatively small compared to other sectors being 1.8 % on average during the period 1999-2002 (Table 3). This contribution is relatively stable from year to year and is believed to have the potential to improve given latent demands by Indonesia's high population and the potential of certain natural resources as input factors in increased livestock production.

The livestock sector is important in providing employment. Labor absorption from the livestock sector was 2.7 million in 2002, equivalent to 6.66% of agricultural employment or almost 3% of total employment (BPS, 2003 in Soegiharto, 2004). Therefore, an increase of livestock production can increase employment.

The livestock revolution in developing countries such as Indonesia is occurring in the twenty first century and reflects changes in livestock consumption and production patterns throughout the world (Hadiyanto, 2004). These changes also influence livestock processing and are impacting on international trade in livestock.

Table 3. GDP at 1993 Constant Market Prices by Industry of Origin (Billion Rupiahs)

	Sectors	1999		2000		2001		2002	
		Value	Share (%)	Value	Share (%)	Value	Share (%)	Value	Share (%)
1	Agriculture, Livestock, Forestry and Fishery	64985.3	17.13	66208.9	16.63	66858.2	16.24	68018.4	15.94
a	Farm Food Crops	34012.4	8.97	34533.8	8.68	34260.2	8.32	34442.1	8.07
b	Non-Food Crops	10702.0	2.82	10722.0	2.69	10979.5	2.67	11327.9	2.65
c	Livestock and Products	6836.9	1.80	7061.3	1.77	7312.7	1.78	7537.0	1.77
d	Forestry	6288.1	1.66	6388.9	1.61	6522.5	1.58	6651.3	1.56
e	Fishery	7145.8	1.88	7502.9	1.89	7783.3	1.89	8060.0	1.89
2	Mining and Quarrying	36865.8	9.72	38896.4	9.77	38894.8	9.45	39768.1	9.32
3	Manufacturing Industry	99058.5	26.11	104986.9	26.38	109290.2	26.55	113671.7	26.64
4	Electricity, Gas and Water Supply	6112.9	1.61	6574.8	1.65	7078.0	1.72	7514.6	1.76
5	Construction	22035.6	5.81	23278.7	5.85	24259.1	5.89	25255.3	5.92
6	Trade, Hotel and Restaurant	60093.7	15.84	63498.3	15.95	66888.1	16.25	69303.2	16.24
7	Transport and Communication	26772.1	7.06	29072.1	7.30	31207.1	7.58	33649.5	7.89
8	Financial, Ownership and Business Service	26244.6	6.92	27449.4	6.90	28388.6	6.90	29963.2	7.02
9	Services	37184.0	9.80	38051.5	9.56	38826.9	9.43	39596.6	9.28
	Gross Domestic Products	379352.5		398016.9		411691.0		426740.5	
	Gross Domestic Products without Gas	345418.5		363758.7		378957.2		393732.1	

Source: Central Bureau Statistic, 2003a

Indonesian exports and imports of fresh and processed chicken meat in 2003 are reported in Tables 4 and 5. Poultry products are exported to USA, Japan and Malaysia (Table 4) with total export volume to those countries at 2,761 tons in 2003 and worth US$ 4.96 million. Chicken exports are the fourth largest product by value exported from Indonesia. However, it is small compare to the value of, say, leather exports, of US$ 65.91 million.

Table 4. Main Poultry Exports and its Destination from Indonesia in 2003

No	Commodity	Volume (kg)	Value (US$)	Destination
1	Leather	8 128 481	65 915 662	Brazil, Hongkong, Italy, Vietnam, Spain
2	Milk	49 593 646	54 830 373	Malaysia,Philipina,Singapura,Iraq,Iran
3	Pig	22 234 566	21 724 971	Singapore, Brunei, USA
4	Chicken Meat	2 760 691	4 964 473	USA, Japan, Malaysia
5	Feed	15 816 538	4 654 097	Singapore, Australia, Bangladesh, the Philippine
6	Pork	5 906 036	3 218 093	Singapore, Malaysia, Honking, USA

Source: Central Bureau Statistic, 2003b

Table 5. Main Poultry Import to Indonesia and its Origin Countries in 2003

No	Commodity	Volume (kg)	Value (US$)	%	Origin Countries
1	Livestock feed	420 030 668	153 715 610	26.76	USA, New Zealand
2	Milk	117 318 145	207 475 321	36.11	New Zealand, Australia
3	Cows (parents and parental)	75 117 721	69 407 296	12.08	Australia
4	Edible offal cow	35 778 540	23 142 255	4.03	Australia, New Zealand
5	Leather	21 363 557	100 554 451	17.50	China and South Korea
6	Beef	10 671 389	18 566 045	3.23	Australia, New Zealand
7	Chicken				
	- Chicken Meat	281 830	27 5281	0.05	USA, Franch, Kanada, Japan, South Korea
	- Egg (Consumption)	1 406 597	1 285 447	0.22	China, Thailand, India, Vietnam, France
	- Egg (parental)	113 142	638 330	0.01	Malaysia, Dutch, German, USA, France
	Total		**574 485 539**		

Source: Central Bureau Statistic, 2003b

Compared to other livestock products, poultry products contributed in only a small way to Indonesian imports in 2003. Table 5 shows the import share of poultry products in total livestock imports was just 0.28%. Most domestic consumption is supplied from domestic production. If GOI banned poultry imports from an AI affected countries the direct effects on domestic markets would be minor. However, importantly, the Indonesian poultry industry makes significant use of feed imports.

Countries in Asia are concerned about the spread of the disease so scientific and policy cooperation is urgently required to minimize potential losses. At international level, FAO and OIE (Office International des Epizooties) rate the need for such co-operation highly and are expressing concerns about cross border transmission of the disease.

2.2 Consumption and Production

The livestock revolution in the 21st century is reflected in rapid growth in livestock sectors, especially poultry sectors, in both developed and developing countries. By 2020, people living in developing countries are expected to produce 38 per cent more meat and 62 per cent

more milk per capita than they did in the early 1990s (Delgado et al., 1999). Further, developing countries are expected to produce 60 percent of the world's meat and 52 percent of its milk by 2020.

On the consumption side of the livestock revolution (i) aggregate consumption growth rates of meat and milk are projected to be 2.8% and 3.3% per year respectively in developing countries compared to 0.6% and 0.2% in developed countries, (ii) aggregate meat consumption in developing countries will grow by about 100 MMT between the early 1990s and 2020 whereas the corresponding figure for developed countries is 18 MMT and (iii) additional milk consumption in developed countries of 18 MMT of Liquid Milk Equivalents (LME) will be dwarfed by additional consumption in developing countries of 224 MMT (Delgado et al., 1999).

The livestock revolution influences livestock development in Indonesia. Demand for meat, eggs and milk is expected to rise significantly in parallel with population growth and with the economic recovery after 1997. In 1999, consumption of meat, eggs and milk were 1.7 million tonnes, 0.6 million tonnes and 1.1 million tonnes, respectively corresponding to 4.1 kg/capita/year, 2.7 kg/capita/year and 5.09 kg/capita/year. Protein consumption from animal products accounted for 3.24 gram/capita/year (Table 6). With a growth rate of 10.77%, meat consumption in 2003 increased to 6.08 kg/capita/year and, likewise, egg consumption and milk consumption grew to 4.47 kg/capita/year and 7.28 kg/capita/year respectively.

Per capita meat consumption in Indonesia is shown in Table 7. Chicken was the most important meat consumed in 1990, 1993, 1999 and 2002 with demand for chicken meat in Indonesia in the last three years going up 8.83% (Ministry of Agriculture, 2004). Indonesian demand for chicken meat is highly elastic with regard to both income and prices in Indonesia. High income elasticities were demonstrated when demand for chicken meat dropped by 5.25% during the economic crisis and then rose by 9.75% during the recovery period. (Around 820,000 kg were consumed during this period.) High substitution elasticities occur for chicken since beef and fish are readily available to consumers enabling them to get meat protein from other sources when poultry prices rise.

Table 6. Meat, Egg and Milk Consumption and Growth, 1999-2003

Year	National Consumption (000 ton)						Consumption/capita/year (kg)						Protein Consumption (Gr/kap/day)	Growth
	Meat	Growth	Egg	Growth	Milk	Growth	Meat	Growth	Egg	Growth	Milk	Growth		
1999	1,215.90		640.40		1,116.00		4.09		2.74		5.09		3.24	
2000	1,516.00	24.68	783.30	22.31	1,400.00	25.45	5.15	25.92	3.48	27.01	6.50	27.70	4.10	26.54
2001	1,601.60	5.65	793.80	1.34	1,262.90	-9.79	5.28	2.52	3.42	-1.72	5.79	-10.92	4.08	-0.49
2002	1,808.40	12.91	945.70	19.14	1,266.40	0.28	5.75	8.90	4.04	18.13	7.05	21.76	4.61	12.99
2003	1,947.20	7.68	1,060.30	12.12	1,350.50	6.64	6.08	5.74	4.47	10.64	7.28	3.26	4.93	6.94
Average		12.73		13.73		5.64		10.77		13.51		10.45		11.50

Source: Ministry of Agriculture Republic of Indonesia, 2003

Table 7. Meat Consumption per Capita by Type of Meat and Processed Meat (Kg)

Commodity	Year			
	1990	1993	1999	2002
Fresh Meat				
1. Beef cattle	0.620	0.680	0.470	0.520
2. Buffalo	0.100	0.100	0.050	0.052
3. Horse	0.000	0.000	0.050	0.000
4. Goat	0.100	0.100	0.160	0.104
5. Pork	0.310	0.260	1.140	0.208
6. Chicken	1.920	2.290	0.570	3.276
7. Other Poultry	0.050	0.050	0.000	0.052
8. Other Meat	0.050	0.050	0.050	0.052
Preserved Meat				
1. Spicy Dried Meat	0.000	0.000	0.000	0.000
2. Smoked Beef	0.000	0.000	0.100	0.005
3. Spicy Shredded Meat	0.000	0.000	0.000	0.000
4. Others	0.000	0.000	0.000	0.000

Source: Ministry of Agriculture Republic of Indonesia, 2003

Egg consumption is likely to increase in future. Unlike in Australia, egg demand is elastic with respect to income so Indonesian egg consumption is predicted to increase as income increases. Bank Indonesia predicted Indonesian per capita income would be US$2,500 in 2005 and egg consumption would increase to 4.07 kg per capita. Based on this and other information, egg consumption was predicted to be 980 kilotons in 2005 (Livestock Directorate General, 2005).

The green revolution was different to the livestock revolution in that it was supply driven and reflected improved technology for seeds, fertilizer, and mechanization. The livestock revolution is mainly demand driven. Increased (mainly) meat demand and increased high population densities combined with increased per capita income has caused the livestock sector to become far more important in recent years in countries like Indonesia. This high dependence on demand means poultry production is most likely to be affected from the demand side in situations involving zoonotics such as H5N1. That is, consumer responses can far outweigh direct production losses from the disease.

The development of meat and egg production between 1999 and 2002 is shown in Table 8. Meat and egg production from intensive producers increased dramatically over the period compared to native chicken production. One of the implications of this was imports of parent stock increased steadily in the period preceding the first AI outbreak. Since such imports are a possible disease vector, this may partly explain why AI spread so rapidly in Indonesia.

Table 8. Meat and Egg Production in Indonesia, 1999-2003 (thousand tons)

Species	Year				
	1999	2000	2001	2002	2003
Meat					
Native Chicken	285.86	265.21	275.14	288.34	310.12
Layer	25.65	23.74	88.30	42.77	50.56
Boiler	294.50	515.00	536.95	751.93	819.62
Duck	15.67	13.79	23.12	21.78	22.93
Egg					
Native Chicken	167.36	139.02	154.95	161.69	180.12
Layer	357.20	502.98	537.79	614.41	701.20
Duck	115.87	141.31	157.58	169.65	179.05

Source: Ministry of Agriculture Republic of Indonesia, 2003

East Java, West Java and South Sulawesi are the main poultry production regions in Indonesia (Table 9). The high concentration of the poultry population in several regions increases the likelihood of a disease outbreak such as occurred with AI. It also influences types of forward and backward links from the poultry industry in the value chain and, by implication, further pathways for potential spread of the disease.

Table 9. Poultry Population by Province and Kind of Poultries, 2002 (thousand heads)

Province	Native Chicken		Layer		Broiler		Duck/ Manila Duck	
	2001	2002	2001	2002	2001	2002	2001	2002
North Sumatra	21,361.1	22,222.5	12,883.7	13,141.4	38,045.3	38,806.2	2,237.3	2,250.7
West Sumatra	7,604.6	7,784.1	3,691.6	4,208.2	10,653.7	76,213.0	1,744.7	1,781.0
South Sumatra	16,533.0	17,974.0	4,600.0	5,200.0	16,500.0	17,000.0	2,050.0	2,127.0
Lampung	15,163.9	15,315.4	1,780.3	1,798.1	22,522.0	22,747.2	426.2	430.5
West Java	27,703.0	30,029.5	7,403.5	9,278.2	238,050.4	243,781.3	4,055.5	4,414.8
Central Java	32,880.2	33,195.5	7,112.2	7,254.4	53,879.3	54,956.8	3,772.1	3,809.8
DI Yogyakarta	5,101.5	5,152.6	1,360.2	1,619.7	15,873.3	18,821.0	220.3	222.5
East Java	37,437.6	37,888.3	14,617.1	14,909.9	89,706.8	91,500.9	2,316.2	2,351.0
Banten	7,706.9	8,305.0	6,049.4	7,198.8	46,437.7	55,725.3	1,159.5	1,379.8
Bali	4,798.6	4,822.6	1,572.7	1,578.0	17,952.0	19,747.2	532.7	543.4
South Sulawesi	17,434.4	17,935.2	3,363.6	3,426.0	1,727.9	1,984.2	4,238.4	4,355.1
Total Indonesia	268,039.0	279,801.6	70,254.3	76,015.9	621,870.7	716,131.2	32,068.1	33,627.2

Source: Central Bureau of Statistic, 2003a

2.3 Industry Structure and Government Policies on Poultry

Government policy affecting the livestock industry is not integrated and historically has changed reflecting Ministry interest. In the beginning of the Suharto era around 1967 *Decree 6/1967* stated that livestock was to be produced within small scale industries. The Decree was consistent with other policies affecting production and marketing channels which favored small scale industry. Most farms had less than 1000 chickens. Broilers were not popular with

consumers at that stage and so the industry was subsistence in nature although integration occurred with upstream links to feed and parent stock suppliers. Since 1970 the GOI allowed foreign investment in the livestock industries.

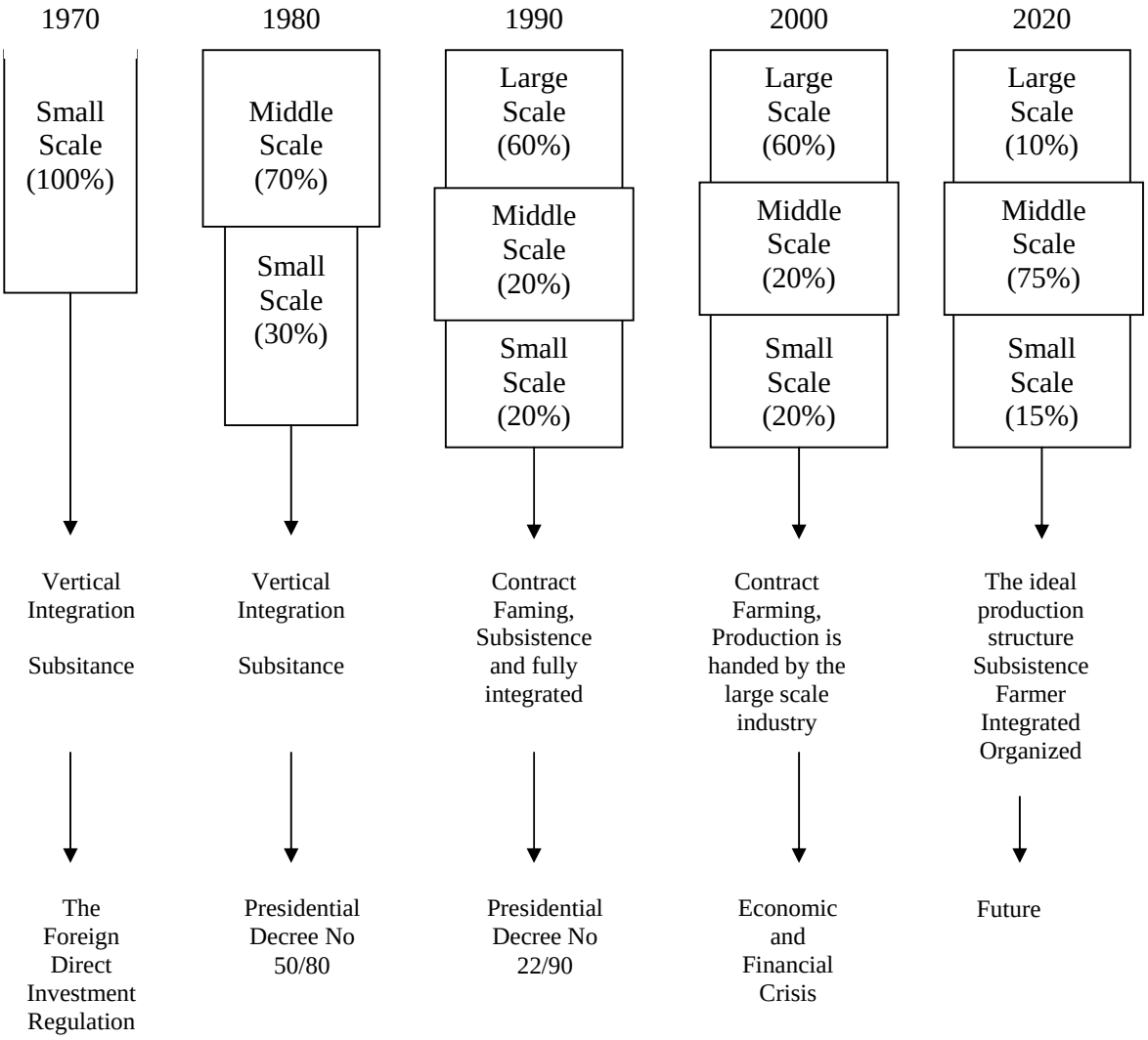


Figure 1 . The Scheme of the National Poultry Industry Structure
Source: Yusdja *et.al.*, 2000

Representatives from small-scale poultry farms protested in 1980 that competition from large producers was unfair. The *Presidential Decree 50/80* stated that poultry production was to be undertaken on a small-scale and large-scale production should change to meet this requirement. However, by 1990 small-scale poultry production had actually decreased. The GOI then changed the regulations through *Presidential Decree 22/90* which allowed economies of scale in poultry production with the condition that large-scale producers export 60% of production and have contract farming arrangements with small-scale producers.

The economic turmoil in 1997 also affected the Indonesian poultry industry which was supplying most of the animal protein requirements for Indonesia's population. Prior to the economic crisis, Indonesian poultry output had undergone growth of nearly 15% per year. However, per capita poultry meat consumption had remained amongst the lowest in Asia at five kg/year (Fas Online, 2005).

Since the AI crisis a breeding industry that previously produced 14-15 million DOCs per week (potentially 900,000 tons of broiler meat per year) has operated at only 30% capacity. Fas Online (2005) reported that nearly all small producers have liquidated their stock and only a few of the four major integrators: Charoen Pokphand, Japfa Comfeed, Subur, and Anwar Sierad have breeding stock.

In this difficult economic environment it is inevitable that consolidation of the industry will continue, presumably into the long term. This is particularly so among small- to mid-size breeding farms and processors. However, in the short term, integrators are experiencing tight capital conditions and, even where working capital can be obtained, it is claimed it would take three months for the industry to 'jump start'. Cultural dietary preferences for poultry meat, combined with a large population base and future potential for income growth indicate that Indonesia will be one of the largest markets for poultry meat in the future with supply from both domestic & foreign sources (Fas Online, 2005). However, since the economic crisis in 2000 there have been no government regulations providing encouragement for expansion in the poultry industry, especially for small-scale firms. Figure 1 shows most production in the poultry industries (60%) is large-scale. The AI outbreak that began in 2003 has given a negative signal to investors in poultry production in Indonesia. The aforementioned 2020 goal may not happen.

III Methodology

A Computable General Equilibrium (CGE) model is used to analyze the impact of the recent AI outbreak on the Indonesian economy. The model is a combination of INDOF (Oktaviani, 2000), and WAYANG (Wittwer, 2002). These models were modified to evaluate several factors pertinent to poultry sector performance including related sectors, macro and microeconomic variables and income distribution.

3.1. Model Structure

The notation system in the model is the same as in INDOF (Oktaviani, 2000) and WAYANG (Wittwer, 2002) which is similar to ORANI. In the past it was common for ORANI-based-CGE model to express equations in percentage terms however the equations here (more detail is provided in Appendix 1) are written in more conventional algebraic formats now commonly used by CGE modelers. As with other CGE models, our model assumes all industries operate under competitive conditions both in output and input markets. Thus, no firm or household

can assert market power and all are price-takers. At output level, prices paid by consumers are constrained to be equal to marginal production costs. Similarly, wages received by workers equal the value of the marginal product of labor. Finally, demand and supply for private agents are derived from optimization procedures reflecting constraints from both preferences and technology.

Following Horridge et al. (1993), Wittwer (1999), Oktaviani (2000) and Horridge et al. (2002), equations are organized into 17 blocks. The core block consists of similar equations to those in O'Toole and Matthews (2002) and, otherwise, the blocks are organized as follows:

1. Demands for labor
2. Demands for primary factors
3. Demands for intermediate inputs
4. Demands for composite primary factor and intermediate input
5. Commodity composite of industry output
6. Demands for investment goods
7. Household demands
8. Export and other final demands
9. Demands for margin goods
10. Purchaser's prices
11. Market clearing condition
12. Indirect taxes
13. GDP from both income and expenditure sides
14. Trade balance and other aggregates
15. Rates of return, indexation
16. Investment-capital accumulation
17. Debt accumulation

The structure of production in a given industry is shown in Figure 2.1. In the production process each industry can produce several commodities. Industries use both intermediate goods and factors as inputs. Each intermediate input can either be sourced domestically or imported. Factor inputs for each industry are labor, capital and land. Key simplifying assumptions made in this production model include input-output separability and the multi-stage, hierarchal structure. Thus given a level of industry activity, the decision as to what combination of products to produce is separate from, or independent of, the decision as to what combination of inputs to use. The hierarchal structure uses constant elasticity of substitution (transformation) production functions except for the combining of intermediate goods and of aggregate primary factors, a stage which uses Leontief (or fixed proportions) technology.

The production function is:

$$F(\text{input}, \text{output}) = 0$$

so that:

$$G(\text{input}) = X1TOT = H(\text{outputs})$$

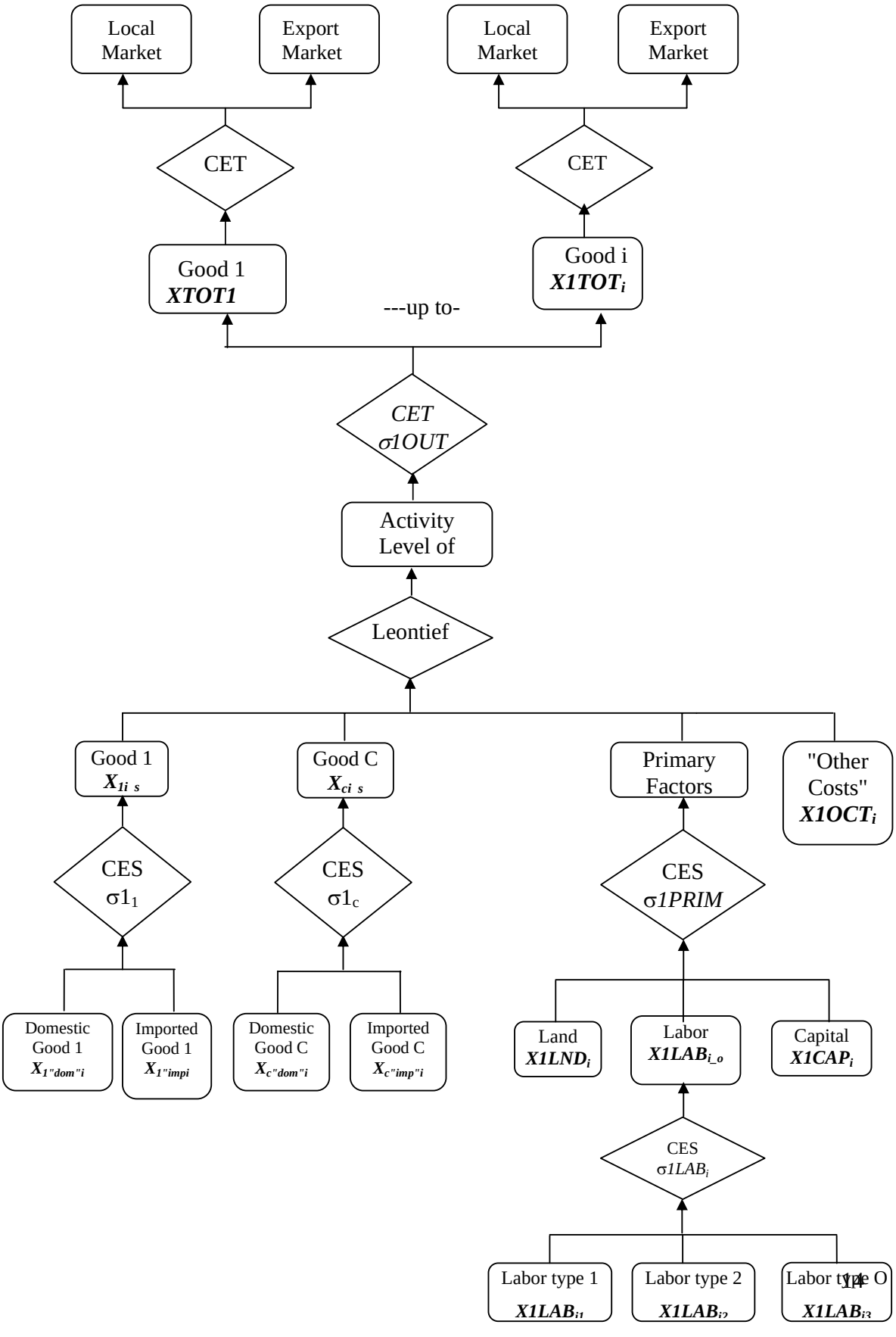
where X1TOT is an index of the level of industry activity. Input-output separability in the transformation function means production of a combination of products by an industry is not directly linked to the particular combination of inputs used, but only indirectly through the index of activity for that industry (Blackorby et al., 1978). Similarly, product prices do not effect input combinations except through the level of industry activity. This is an important empirical simplification.

While the H (outputs) transformation function is assumed to have only a single stage, the G (inputs) function is hierarchically nested with up to three stages. This implies further separability and further simplifies the demand side of the model. In particular, demand for inputs at any given level can be expressed as a function of prices of inputs at that level and need not be expressed as functions of prices of inputs at lower levels in the hierarchy.

As shown in Figure 2, the commodity composites, a primary factor composite and an "other cost" are combined using a Leontief or fixed proportions production function at the highest level of the input function where no substitution among inputs is allowed to occur. Equations for labor demand and the other blocks are reported in Oktaviani (2000).

The model is modified to include an exogenous risk variable in the index for level of activity in each industry. This is critical for understanding the impact of AI because it will increase risk in the poultry industry, tourism and trade.

Figure 2. Production Structure



3.2. Data Structure

The version of the model presented here does not use all 175 sectors in the 2000 Indonesian Input-Output Table but, rather, 22 sectors. This allows the impact of AI on the Indonesian economy to be captured after disaggregation of the poultry and related sectors.

The structure of the Input-Output database for the Indonesian AI outbreak model is the same as in ORANI-F described in Horridge, et al. (1993) and Oktaviani (2000). The database consists of an absorption matrix, a joint product matrix and an import duty matrix. The columns of the absorption matrix represent six groups of agents in the economy: (i) & (ii) domestic producers and investors in each of 22 industries, (iii) ten groups of household, (iv) aggregate foreign purchaser exports, (v) government sector corresponding to the "other" demand category and (vi) holders of inventories. All numbers in the matrix flow are in billions of Rupiah.

The rows show the sources of purchases made by the agents in each column. The rows include basic flows, margins, taxes, labor (farmer, operator, administrator, and manager/professional), capital, land and other costs. The basic flows in the first and second columns show flows of domestic and imported commodities which are used by industries as inputs or for capital formation. The basic flow in the third column shows commodities consumed by households. The basic flows in the fourth, fifth and sixth columns are the values of commodities exported, consumed by government and adding or taking away from inventory, respectively.

The margins flows in the second row are the margin costs of commodities used by producers, investors, households, government and the margin costs of exported commodities. The tax matrices in the third row show the taxes on commodities, as consumed by producers, investors, households and government and, finally, export taxes. The rows of labor, capital, land and other costs show primary factor usage by each industry in the first column indicating the return to these input factors by sector. It is assumed that one industry can produce but one commodity.

The Indonesian Social Accounting Matrix 2000 is published at two levels of sectoral aggregation, namely 37×37 and 110 × 110 classifications. While it might conceivably serve as the primary source of data for the study, unfortunately the production sector aggregations in the SAM are different from the aggregations in the published I-O Tables. Accordingly, the SAM is used only to supplement data from the I-O Table. In order to combine the data from the Social Accounting Matrix with the I-O Table a mapping between the sectors in the two is needed. The matrix is used to specify the occupational composition of labor, labor being divided into skilled and unskilled categories as well as into household dissagregations. This SAM is also used to specify the sharing of returns between capital and land. The dissagregation of institutions, factors of production, activities and household are shown in detail Table 10.

Table 10. Sets, Subsets and Dissagregation of the Model

Sets	Subsets	Dissagregation
Institutions		Producers, investors, households, aggregate of foreign purchaser export; government.
Household	Rural	Rural 1; landless rural household, Rural 2; rural household with less 0.5 ha of agricultural land ownership, Rural 3; Middle agricultural land owner (0.5-1 hectars), Rural 4; High agricultural land owner (greater than 1 hectars), Rural 5; Rural low income households-non-agriculture (Non agricultural rural household, entrepreneur low class, administration labor, sales, labor transportation, services and others), Rural 6; Rural middle income households (Non agricultural rural household non labor force & others), Rural 7; Rural high income households (Non agricultural rural household, entrepreneur high class, manager, army, professional, technician, teacher and others)
	Urban	Urban 1; Urban low income households (Non agricultural urban household, entrepreneur low class, administration labor, sales, labor transportation, services and others), Urban 2; Urban middle income households (Non agricultural urban household non labor force & others), Urban 3; Urban high income households (Non agricultural urban household, entrepreneur high class, manager, army, professional, technician, teacher and others)
Industries	Agriculture	Paddy, Maize, Other Agriculture, Soybeans, Oil Palm, Livestock, Poultry product, Fishery
	Non-agriculture	Mining, Livestock Processing, Industry, Fish product, Rice, Wheat Mills, Fertilizer and pesticide, Services, Trade, Restaurant, Hotel, Transportation, Bank, Tourism
Production Factors	Labor	Farmer, Operator, Administrator, Manager/Professional
	Land	
	Capital	

3.3 Data Source

Most matrices used in the database are calculated from the 2000 Indonesian Input-Output Table while some matrices, such as for tax, labor, land, capital, elasticities and other parameters, which are not available in the Input-Output Table, are modified from other sources, such as Social Accounting Matrix 2000. Oktaviani (2000) describes 'other sources' of information and the steps used to construct the matrix for the database.

3.4. Computing Procedure to Construct the Database

The computing procedure to create the database follows Oktaviani (2000). The only modifications are for industry and commodity aggregation, type of household and type of labor. The database construction began by converting the 2000 Input-Output (I-O) Table and 2000 Social Accounting Matrix (SAM) into the csv file and constructing a txt file for mapping from the IO to the SAM. All raw data files are converted to the .har file as a base to make the detailed matrix of the database using the MODHAR program. The result of these steps is the use001.har and use001S.har (after use00.har is divided by 1000). These files are consists of all basic header array file which is needed to build the header array matrix in detail for AI outbreak model. These files consist of total, domestic and import usage matrix, the labor and household aggregation matrix and the mapping from IO to SAM matrix. The next step is creating the Tablo file to manipulate these data that can be used in the model. The last step that will be carried out is to aggregate the database to the required aggregation.

3.5. Policy Simulation

There is no way to exactly calculate how much production risk is occurring in the poultry industry because of the AI outbreak. In the simulation below a hypothetical figure is used to show possible scenarios. Using this strong assumption, the policy simulations were carried out as follows:

1. Increase in risk of 10% in poultry production
2. Increase in risk of 10% on poultry production and tourism services
3. Increase in risk of 10% in poultry production and tourism services as well as a 5% risk in trade and transportation services
4. Increase in risk of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services and a decrease of 20% taste to the poultry production.

All risk variables are added into the equations to describe the percentage change or decrease in industry activity level because of AI. For example, increasing risk in poultry production by 10% means that using the same amount of primary factors, intermediate goods, other costs and technology, the activity level of the poultry industry will be reduced by 10 % because of AI. Moreover, the simulations are carried out over a five year horizon.

IV. The Impact of an AI Outbreak on the Indonesian Economy

The AI outbreak is assumed to increase industrial risk, especially in the poultry industry. Risks in the tourist sector are also assumed to increase because of AI. Tourists, especially from other countries, are assumed to delay their visits because of AI so that the activity level in the tourist industry decreases reflecting increased risk. Activity in the trade and transportation sectors is also assumed to decline because of the effects of AI on activity in the poultry and tourism sectors. The hypothetical level of risk in the research is 10% for the poultry industry and for tourism. Before explaining this in more detail, the discussion starts with the linkage of poultry industry with other sectors. The backward and forward linkages from the poultry industry are important to analyze because the impact on other sectors can then be explained.

The main focus of this research is the poultry industry and other industries with linkages to the poultry industry. Before analyzing the impact of AI on the economy the backward and forward linkages from each sector to the poultry sector need to be outlined. Linkage figures come from the Input Output Table.

Table 11. Forward and Backward Linkage of the Poultry Industry with other Industries in Indonesia

No	Industry	Forward Linkage	Backward Linkage
1	Paddy	0.00	0.00
2	Maize	0.00	0.30
3	Other Agriculture	2.30	0.40
4	Soybeans	0.00	0.00
5	Oil Palm	0.00	0.00
6	Livestock	0.10	0.00
7	Poultry Product	4.90	3.90
8	Fishery	0.10	0.00
9	Mining	0.00	0.00
10	Livestock Processing	36.00	0.00
11	Other Industry	6.60	79.30
12	Fish Processing	0.00	0.00
13	Rice	0.00	0.30
14	Wheat Mills	0.00	0.00
15	Fertilize & Pesticide	0.00	0.00
16	Services	4.40	0.10
17	Trade	0.00	12.20
18	Restaurant	38.40	0.00
19	Hotel	5.80	0.00
20	Transportation	1.40	3.40
21	Bank	0.00	0.00
22	Tourism	0.00	0.00
	Total	100	100

The poultry industry has its strongest linkage with the restaurant and livestock processing industries at around 38% and 36% respectively. That is, around 38% of poultry outputs are used as intermediate inputs in the restaurant industry and 36% goes into the livestock processing industry. On the input side, around 79% of poultry inputs came from other

industries and around 12% of other inputs used in the poultry industry are from trade (Table 11).

This means the poultry industry incurs trade and transportation costs. A more efficient trade and transportation sector can benefit the poultry industry. Moreover, Table 11 shows that the feed industry which use the soybean and maize do not have a high backward linkage to the poultry industry. This indicates the poultry sector has a high dependency on feed imports.

Table 12. Household Expenditure Share in Indonesia (%)

No	Industry	Share to the Total expenditure (%)
1	Paddy	0.00
2	Maize	0.60
3	Other Agriculture	6.70
4	Soybeans	0.10
5	Oil Palm	0.00
6	Livestock	0.20
7	Poultry Product	2.70
8	Fishery	3.20
9	Mining	0.00
10	Livestock Processing	3.70
11	Other Industry	31.50
12	Fish Processing	1.30
13	Rice	7.20
14	Wheat Mills	0.30
15	Fertilize & Pesticide	0.10
16	Services	17.70
17	Trade	5.40
18	Restaurant	7.60
19	Hotel	1.60
20	Transportation	6.60
21	Bank	2.70
22	Tourism	0.70
	Total	100.00

Table 12 shows that most total household expenditure is spent on products from other industries. Only around 3% of the total household expenditure is spent on poultry products compared to spending on livestock processing products of around 4%. Meanwhile, around 3% of the total household expenditure is spent on fishery products. Thus, households do not depend on poultry products as the only source of protein. In addition, the restaurant industry attracts a higher proportion of total household expenditure, at around 8%, than does the poultry industry (Table 12). Changes in demand for poultry products and livestock processing products following the AI outbreak did not affect household expenditure patterns so much and, moreover, households can easily change their sources of protein. The consumer response to AI can also change preferences for poultry products. In India, consumption of poultry product fell by 80% because of AI (Lokuge et al., 2005). Given that poultry and eggs are important sources of inexpensive protein in Indonesia and other developing countries the AI outbreak has the potential to affect nutrition levels and food security for the population.

4.1 Effect of AI on Microeconomic Performance and Income Distribution

The AI outbreak has reduced consumer preferences for livestock products and related products. (Based on the linkage analysis reported in Table 11, related products are mainly from the livestock processing industry and restaurant products.) In theory, reduced preferences should reduce demand for these products in the market. The analysis indicates that in all scenarios, especially scenario 4, household demand for poultry products and two related industries declines in all household groups in both rural and urban areas (Table 13).

Table 13. The Impact on Household Demand in Each Scenario

	Rural							Urban		
Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**
Scenario 1										
Poultry Product	-4.42	-4.11	-3.60	-2.62	-4.05	-3.82	-2.50	-4.04	-3.81	-2.81
Livestock Process	-4.32	-4.29	-4.16	-3.68	-4.13	-4.20	-3.59	-4.10	-4.11	-3.54
Restaurant	-4.46	-4.42	-4.29	-3.80	-4.27	-4.33	-3.71	-4.47	-4.50	-4.00
Scenario 2										
Poultry Product	-4.45	-4.17	-3.74	-2.94	-4.15	-3.95	-2.85	-4.12	-3.95	-3.12
Livestock Process	-4.27	-4.22	-4.10	-3.68	-4.12	-4.15	-3.62	-4.07	-4.08	-3.60
Restaurant	-4.37	-4.32	-4.19	-3.75	-4.22	-4.24	-3.69	-4.39	-4.42	-3.99
Scenario 3										
Poultry Product	-4.68	-4.25	-4.24	-4.16	-5.01	-4.57	-4.41	-4.7	-5.18	-5.1
Livestock Process	-3.13	-2.64	-2.53	-2.3	-3.42	-2.89	-2.53	-3.1	-3.51	-3.29
Restaurant	-3.03	-2.6	-2.53	-2.3	-3.33	-2.81	-2.56	-3.36	-3.81	-3.71
Scenario 4										
Poultry Product	-24.9	-24.2	-23.7	-22.7	-24.9	-24.1	-23	-24.82	-24.9	-24.11
Livestock Process	-3.22	-2.63	-2.11	-1.24	-3.34	-2.56	-1.54	-3.22	-3.34	-2.64
Restaurant	-3.85	-3.49	-3.25	-2.7	-4.1	-3.52	-3.03	-4.42	-4.76	-4.51

Note:
Scenario 1: an increase of 10 % risk on the poultry production
Scenario 2: an increase of 10% risk on poultry production and tourism services
Scenario 3: an increase of 10% risk on poultry production and tourism services as well as an increase of 5% risk on the trade and transportation services
Scenario 4: an increase of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services, and a decrease of 20% taste to the poultry production.

In addition, if risk in poultry production from AI increases by 10% (scenario 1) then the decrease in household demand for poultry products ranges from 2.50% (rural 7) to 4.42% (rural 1). Demands for processed poultry products (livestock processing) and from the restaurant industry also decrease as risk increases. If risk in the poultry industry is associated

with increased risk in the tourism industry (scenario 2) then household demand in the three industries directly related to the poultry industry decreases by about the same amount as in scenario 1. The same result also occurs with scenario 3 where household demand for poultry products and for products from the other two industries decreases by more than in scenarios 1 and 2. This is not surprising considering scenario 3 has higher risk (5% increase) in the trade and transportation industries and given the relatively strong backward linkage to the poultry industry (Table 11). Scenario 4 is where scenario 3 occurs simultaneously with reductions in demand for poultry products. This causes household demand for poultry to decline by a large amount. This shows that scenario 4 has stronger influence on poultry product demand than that in scenarios 1, 2 and 3.

An increase in risk in poultry production (scenario 1), or combining scenario 1 with risk in tourism (scenario 2), or combining scenario 2 risk in trade and transportation services decreases poultry production. Furthermore, if consumer preferences for poultry products decline (scenario 4), then both demand and supply for poultry products declines as the market contracts. Table 14 shows scenario 4 causes the largest reduction in poultry production (around 26 %). Reduced output from this industry is accompanied by reduced output in both upstream and downstream industries. In the downstream industries, the livestock processing industry suffered a decrease in output of around 3% in all scenarios. Supply of tourism services also declines with the largest decline occurring with scenario 3 (around 13%). The decline in the tourism industry is followed by contractions in the hotel industry which is closely related with the tourism industry.

Reduced servicing and production not only occurs in industries directly related to the poultry industry, but also in industries indirectly related to it. The analysis indicates that almost all industries suffer some sort of contraction in all scenarios. For example the output in the paddy industry declines by around 2 % for scenarios 1 and 2 and by around 3 % for scenarios 3 and 4. The AI outbreak, even ignoring human pandemics, has the potential to cause a contraction in the majority of industries in Indonesia.

Table 14. The Impact on Sectoral Output in Each Scenario

No	Industry	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1	Paddy	-2.18	-2.24	-2.74	-3.03
2	Maize	0.48	0.34	0.65	1.22
3	Other Agriculture	-0.33	-0.42	-0.32	0.00
4	Soybeans	3.53	3.30	3.86	5.58
5	Oil Palm	0.72	0.70	2.25	2.76
6	Livestock	-1.13	-1.33	-1.22	-0.96
7	Poultry Product	-13.22	-13.31	-13.67	-26.07
8	Fishery	-2.81	-3.03	-2.02	-2.57
9	Mining	0.62	0.62	1.63	1.87
10	Livestock Processing	-3.24	-3.26	-3.04	-3.52
11	Other Industry	-1.26	-1.26	-0.98	-1.37
12	Fish Processing	-3.08	-3.04	-2.27	-2.93
13	Rice	-2.22	-2.27	-2.79	-3.09
14	Wheat Mills	-1.37	-1.32	-0.02	-0.15
15	Fertilize & Pesticide	-4.34	-4.19	-4.26	-5.43
16	Services	0.40	0.47	0.62	0.08
17	Trade	-1.07	-1.04	-4.20	-4.50
18	Restaurant	-3.19	-3.15	-2.30	-2.90
19	Hotel	-3.52	-3.52	-3.64	-4.45
20	Transportation	-1.31	-1.29	-3.61	-3.96
21	Bank	-1.08	-1.05	-1.22	-1.47
22	Tourism	-4.56	-7.57	-13.16	-12.18

Note:
Scenario 1: an increase of 10 % risk on the poultry production
Scenario 2: an increase of 10% risk on poultry production and tourism services
Scenario 3: an increase of 10% risk on poultry production and tourism services as well as an increase of 5% risk on the trade and transportation services
Scenario 4: an increase of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services, and a decrease of 20% taste to the poultry production.

Increased risk in poultry production alone or combined with increased risk in tourism, trade and transportation causes reduced output prices for poultry products. The negative impact on poultry product prices is larger if consumer preferences change resulting in reduced demand. Furthermore, the analysis shows output prices decrease in all industries in all scenarios (Table 15). In the long-run, the AI outbreak reduces producers' total revenue, through both reductions in prices and quantities produced.

Prices in the poultry product industry itself decline by around 56% in scenarios 1 and 2 and by 11% in scenario 4. Industries with relatively strong forward linkages to poultry such as the livestock processing and restaurant industries also face price decreases reaching 11% in scenario 4.

Table 15. The Impact on Output Price in Each Scenario

No	Industry	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1	Paddy	-12.14	-10.93	-11.86	-16.35
2	Maize	-9.29	-8.48	-8.44	-12.01
3	Other Agriculture	-8.62	-7.82	-7.86	-11.30
4	Soybeans	-5.48	-5.00	-4.48	-6.62
5	Oil Palm	-6.01	-5.29	-4.46	-7.12
6	Livestock	-8.48	-7.68	-8.35	-11.78
7	Poultry Product	-6.58	-5.77	-7.11	-11.24
8	Fishery	-4.41	-3.35	-3.71	-5.19
9	Mining	-0.02	-0.01	0.06	0.04
10	Livestock Processing	-5.34	-4.89	-6.99	-9.29
11	Other Industry	-1.69	-1.53	-1.93	-2.77
12	Fish Processing	-1.31	-1.05	-2.57	-3.08
13	Rice	-10.78	-9.75	-11.05	-15.02
14	Wheat Mills	-2.18	-2.02	-4.35	-5.20
15	Fertilize & Pesticide	-1.51	-1.37	-1.21	-1.83
16	Services	-2.08	-1.91	-4.35	-6.00
17	Trade	-3.00	-2.83	-15.68	-17.26
18	Restaurant	-5.37	-4.97	-9.09	-11.39
19	Hotel	-1.04	-0.91	-1.54	-2.00
20	Transportation	-2.22	-2.06	-7.45	-8.23
21	Bank	-3.34	-3.16	-4.03	-5.30
22	Tourism	-0.88	-7.11	-8.52	-9.03

Note:
Scenario 1: an increase of 10 % risk on the poultry production
Scenario 2: an increase of 10% risk on poultry production and tourism services
Scenario 3: an increase of 10% risk on poultry production and tourism services as well as an increase of 5% risk on the trade and transportation services
Scenario 4: an increase of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services, and a decrease of 20% taste to the poultry production.

Reductions in output affect utilization of inputs such as labor and capital. Table 16 shows labor utilization in the poultry industry declines by 17 % in scenario 1 and, in the same scenario, labor absorption by the livestock industry decreases by 4 % and by 5% in scenario 4. Labor demand in the restaurant industry decreases by around 5 % in scenario 1. Labor demand also decreases except in the soybean, fishery, mining, fish processing, services, hotel and other industries where labor demand increases in scenario 1. Soybean and fish are alternative sources of protein so demand for them increases subsequently increasing demand for labor in those industries.

Utilization of capital also decreases in most industries in all scenarios. Capital utilization declines by 27% in the poultry industry under scenario 4 with capital utilization decreasing by around 3% in the livestock processing industry. In the restaurant industry, capital utilization also declines by about 1%, less than in the poultry and livestock processing industries. Similar reductions in labor demand that occurs in other industries, capital utilization declines in all other industries except in the maize, other agriculture, soybeans, oil palm, fishery,

mining, hotel, fish processing and other industries. The AI outbreak does not have any effect on capital demand in these industries.

Table 16. The Impact on Employment and Capital Demand in Each Scenario

No	Industry	Employment				Capital			
		scenario 1	scenario 2	scenario 3	scenario 4	scenario 1	scenario 2	scenario 3	scenario 4
1	Paddy	-6.41	-6.23	-7.64	-8.95	-2.03	-2.13	-2.87	-2.82
2	Maize	-2.25	-2.38	-2.28	-2.26	2.14	1.89	2.49	3.86
3	Other Agriculture	-2.72	-2.74	-2.66	-2.80	1.69	1.53	2.04	3.26
4	Soybeans	2.74	2.45	2.95	4.85	7.12	6.93	7.72	10.98
5	Oil Palm	-0.21	0.02	1.75	2.24	4.19	4.41	6.45	8.30
6	Livestock	-4.28	-4.33	-4.38	-4.91	0.17	-0.11	0.20	1.04
7	Poultry Product	-17.08	-15.20	-17.65	-32.58	-12.64	-11.45	-13.07	-26.64
8	Fishery	0.77	1.37	0.99	2.28	5.18	5.82	5.68	8.33
9	Mining	2.37	2.19	2.75	4.36	0.14	0.13	0.09	0.16
10	Livestock Processing	-4.16	-4.20	-3.58	-3.73	-2.67	-2.67	-2.60	-3.21
11	Other Industry	2.05	1.97	4.85	6.28	0.29	0.30	1.31	1.44
12	Fish Processing	9.01	8.08	21.27	25.82	4.33	3.72	11.05	12.99
13	Rice	-3.05	-3.17	-3.80	-3.71	-1.90	-1.92	-2.41	-2.86
14	Wheat Mills	-1.46	-1.46	1.18	1.69	-1.34	-1.28	-0.31	-0.59
15	Fertilize & Pesticide	-2.21	-2.12	-0.27	-0.11	-1.68	-1.59	-1.00	-1.45
16	Services	0.66	0.75	1.19	0.60	-0.08	-0.05	-0.43	-0.81
17	Trade	-0.68	-0.62	-10.57	-10.17	-0.08	-0.07	-0.71	-0.74
18	Restaurant	-5.16	-4.97	-2.54	-3.18	-1.03	-1.04	-1.06	-1.35
19	Hotel	3.05	3.02	9.02	11.50	0.38	0.36	0.93	1.17
20	Transportation	0.09	0.05	-5.04	-4.03	-0.29	-0.28	-1.99	-2.01
21	Bank	-0.91	-0.85	1.53	2.16	-0.28	-0.28	-0.34	-0.42
22	Tourism	2.61	-11.51	-7.59	-5.41	0.23	-1.77	-1.45	-1.31

Note:
Scenario 1: an increase of 10 % risk on the poultry production
Scenario 2: an increase of 10% risk on poultry production and tourism services
Scenario 3: an increase of 10% risk on poultry production and tourism services as well as an increase of 5% risk on the trade and transportation services
Scenario 4: an increase of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services, and a decrease of 20% taste to the poultry production.

AI has a negative effect on household welfare. Analysis at household level indicates AI will decrease household income at all income levels in all scenarios (Table 17). This results from reduced output demand causing reduced labor demand leading to reduced labor wages.

If the four scenarios are compared, then the largest decrease in income occurs in scenario 4 at around 7% to 8% with scenarios 3 and 4 reducing household income by around 3%. The impact on household income is larger when consumer preferences for poultry products decline. It shows that perfect information about human causalities in eating poultry product is desirable for good household decision making. Misperceptions about the impact of AI on people will reduce household welfare. In Thailand the AI outbreak occurring between

November 2003 and February 2004 had negative socio-economic affects. To help mitigate this problem geo-informatics technology was applied to obtain spatial information to be used for decision support for responsible agencies. It was also used to define restricted and clearing zones to facilitate biosecurity policies based on segmentation. Geographic Information System (GIS) and Global Positioning System (GPS) technologies were used to monitor trends and developments in the virus reservoir and its dispersion (Moukomla and Poomchatra, 2005). The authors are not aware of whether this technology has been applied in Indonesia yet.

Table 17. The Impact on Household Income in Each Scenario

Household	Scenario 1	Scenario 2	Scenario 3	Scenario 4
rural1	-3.42	-3.11	-5.16	-6.82
rural2	-3.55	-3.22	-5.02	-6.82
rural3	-3.63	-3.29	-5.35	-7.06
rural4	-3.40	-3.09	-5.66	-7.16
rural5	-3.33	-3.04	-5.65	-7.29
rural6	-3.55	-3.22	-5.46	-7.11
rural7	-3.33	-3.05	-5.95	-7.54
urban1	-3.44	-3.14	-5.46	-7.32
urban2	-3.57	-3.27	-6.12	-7.91
urban3	-3.27	-3.02	-6.41	-8.11

Note:
Scenario 1: an increase of 10 % risk on the poultry production
Scenario 2: an increase of 10% risk on poultry production and tourism services
Scenario 3: an increase of 10% risk on poultry production and tourism services as well as an increase of 5% risk on the trade and transportation services
Scenario 4: an increase of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services, and a decrease of 20% taste to the poultry production.

4.2 AI Impacts on Macroeconomic Variables

Despite the AI outbreak, the Indonesian economy is expected to grow at a small amount (around 0.2 percent). In the worst case scenario where consumer preferences for poultry products change (scenario 4) real growth in GDP will be 1.66%. Even though the contribution from the poultry industry to national GDP is insignificant, the agricultural sector as a whole contributes around 20 %. GDP growth is still likely to be positive with the AI outbreak but smaller than it would otherwise be. Growth in real GDP reflects anticipated increases to the capital stock and labor supply that will occur regardless of scenarios 1 to 4.

Scenario 2, where the tourism industry contracts following an outbreak of AI, has macro implications for the Indonesian economy. Contractions in tourism, which occurred with the SARS outbreak, may reflect tourists' concern about the safety of food or just a general sense of fearfulness that keeps people at home. Such a decline in tourism would have a significant impact on activity in the hotel industry or restaurant industry. At macro level, AI and concern over declines in tourism would only slightly affect economic development. It seems that household consumption and even foreign visitors would substitute from poultry to fish – or other livestock products. However, overall consumption would decrease in each household income group (Table 17). This is similar to results from Vietnam where Botteron and

Aquilino (2004) estimate that consumer demand plummeted because of the AI pandemic in 2003. Furthermore, the cost to the economy may be about 0.3% of GDP or the equivalent of US$116 million in Vietnam.

The level of capital stock is influenced by growth in savings and investment. The capital stock evolves over time and is state dependent with current growth reflecting previous period stock levels. From a welfare standpoint, investment in the current period and its annual growth rate is critical. For each sector in this study, the model includes a saving-investment balance. The positive impact on national income as shown by a steady increase in real GDP is closely associated with levels of sectoral investment. In other words, the larger the increase in the GDP, the larger changes in investment will be. This also occurs under here with an augmented capital stock depressing the cost of capital thereby increasing demand for investment. As seen in the Table 18, capital goods increase under the four scenarios around 7 % to 8 %. Capital-intensive sectors such as the mining industry would benefit from the declining cost of capital. The increased supply of such factors in the economy would shift the national production frontier outward, increasing output.

AI has no negative influence on aggregate exports. Aggregate exports are expected to rise over 5 years under all scenarios. Under scenarios 1 and 2 aggregate exports grow by approximately 4 and 3.9 percent respectively. This shows Indonesia remains competitive in the world market despite the AI outbreak. This result partly reflects reduced consumer demands from decreases in household income. Continuous rises in exports and declines in imports would result in improvement in the Indonesian balance of trade and this improvement in turn would augment Indonesian foreign savings. The model is specified to maintain a balance between saving and investment. Increases in total investment imply rises in either domestic savings (households, private and public saving) or foreign savings (capital inflow).

Table 18. The Impact on Selected Macroeconomic Variables is Each Scenario

Descriptions	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Balanced of Trade (delb)	2.34	2.25	3.33	4.47
Deflator GDP (p0gdpexp)	-3.29	-3.01	-5.53	-7.21
Real Exchange Rate (p0realdev)	3.29	3.11	5.53	7.21
Consumer Price Index (p3tot)	-3.35	-3.08	-5.06	-6.62
Export Price Index (p4tot)	-1.71	-1.63	-3.19	-4.01
Real GDP (x0gdpexp)	0.19	0.23	1.71	1.66
Household Consumption (x3tot)	-5.71	-5.51	-5.89	-7.83
Export Volume (x4tot)	4.01	3.93	7.06	8.96
Import Volume (x0imp_c)	-3.48	-3.16	-4.34	-6.03
Real Investment (x2tot_i)	7.09	7.07	7.65	7.50

Note:
Scenario 1: an increase of 10 % risk on the poultry production
Scenario 2: an increase of 10% risk on poultry production and tourism services
Scenario 3: an increase of 10% risk on poultry production and tourism services as well as an increase of 5% risk on the trade and transportation services
Scenario 4: an increase of 10% risk on poultry production and tourism services, an increase of 5% risk on the trade and transportation services, and a decrease of 20% taste to the poultry production.

The improvement in the balance of trade resulting from increased exports causes the Rupiah to appreciate against the US dollar by around 3 % in scenarios 1 and 2 and by around 7% in scenario 4. Because of increased supplies of capital and labor resulting from reduced production costs, it implies greater demand for exports than for imports resulting in an appreciation of real exchange rates. Related to improvements in the real exchange rate, Indonesian imports would decline by around 3.5% in scenarios 1 and 2 and 6% in scenario 4. Even in the case of the scenario 3, where trade and transport sectors decline, imports are expected to go up further than in scenarios 1 and 2. This is partly because consumer demand decreases due to reduced household income in each category and each scenario.

The consumer price index declines in all scenarios. This deflation increases purchasing power of households and causes real income to go up with subsequent increases in demand for goods and services. However, unfortunately, household income decreases by more than the deflation rate and so consumption decreases around 6% to 7% in all scenarios.

Deflation has a negative impact on production in most sectors. In the absence of market incentives some sectors reduce output. This in turn causes household expenditure to decline. In this situation GDP growth largely reflects growth in exports and investment. In reality, increased exports and investment needs a conducive business environment which does not always happen in Indonesia. Based on a survey of investors in eight provinces of Indonesia Oktaviani, et all (2004) found that there are internal factors (law, security and political stability) and external factors (exchange rate stability, purchasing power, economic growth, interest rate stability, trade and fiscal policy, infrastructure and decentralization) influencing realization of investment in Indonesia.

V Conclusions

Even though the contribution of the poultry sector is relatively small in the Indonesian economy the AI outbreak can still have significant impacts at sectoral and macro levels in the Indonesian economy reflecting that the poultry industry has strong forward linkages to the restaurant and livestock processing industries. On the upstream side, the poultry industry depends on other industries output and trade.

The AI outbreak reduces consumer preferences for poultry and for products of forward linkage industries. Household demand for poultry products and restaurant and livestock processing products decline under all of the scenarios, especially under scenario 4. Moreover, human causalities can be more affect decreasing demand of poultry and its related product. As a source of protein, the policy to increase the supply of other source of protein, for example soybean and fish is needed.

Increased risk in poultry production (scenario 1), or, together with increased risks in tourism (scenario 2), or scenario 2 together with increased risks in trade and transportation services, will reduce demand for poultry products. Furthermore, decreasing consumer preferences for poultry products (scenario 4) results in the largest decline in poultry production at around 26%. Perfect information about human causalities in eating poultry product is needed so household can be properly informed in their decision making. Misperceptions about the impact of AI on people reduces household welfare.

Reduced output in this industry leads to declines in output in both upstream and downstream industries. Under all scenarios prices of poultry products fall causing producer revenue to also fall. This has welfare implications because most producers are from medium and small-scale firms and are labor intensive. Government action to control AI is important if welfare is to be maintained amongst this vulnerable group.

Reductions in output reduce utilization of labor and capital in the poultry and related sectors. The household as the source of labor is affected and this is reflected in the simulations by decreases in household income. Therefore AI has a negative effect on household welfare and compensation losses at farm level is needed.

At macro level, the Indonesian economy is expected to grow around 0.2 percent and 1.66% in scenario 4. Household income declines by more than deflation resulting in falls in domestic consumption. On the other side, deflation has a negative impacts on most producing sectors. GDP growth stemming from AI is largely related to growth in exports and investment however it is offset by reduced household consumption.

VI. Preferences

Andrea, F. 2004. *Flu burung dan keamanan manusia* (AI and Human Security). *Koran Tempo*, February 19, 2004

Arifin, B. 2005. *Wabah Flu Burung dan Karakter Investor Sejati* (AI Pandemic and Investor Characteristic). Kompas, Monday, March 28th 2005, www.kompas.com.

Agromedia, 2005. *Kerugian Peternak Akibat Flu Burung Hampir Rp. 65 miliar* (Producer Loss because of AI is almost Rp 65 billion). March 17th 2005, www.Agroindonesia.com.

Central Bureau of Statistic. 2003. Indonesian Statistics. Central Bureau of Statistic, Jakarta.

Blackorby, C., Primont, D. and Russell, R.R. (1978), *Duality, Separability, and Functional Structure: Theory and Economic Application*, North-Holland, Amsterdam.

Botteron, C.A and J. Aquilino. 2004. AI (The Bird Flu) A Worldwide Cause for Concern. Report for the International Foundation for the Conservation of Natural Resources (IFCNR).

Delgado C., M. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. Livestock to 2020: The Next Food Revolution. Food, Agriculture, and the Environment Discussion Paper 28, International Food Policy Research Institution, Food and Agriculture Organization of the United Nation, International Livestock Research Institution.

Direktorat Jenderal Peternakan Departemen Pertanian. 2005. *Analisa Ekspor dan Impor Komoditi Peternakan Utama 2003* (Export Import Analysis of Livestock Commodity in 2003). www.bangnak.ditjennak.go.id

Fas Online. 2005. Livestock and Poultry; World Markets and Trade, March 1998. Economic Upheaval in Asian Poultry Markets, Fas Online www.permanent.access.gpo.gov.htm.

Hadiyanto. 2004. *Perunggasan dan Revolusi Peternakan* (Poultry and Poultry Livestock). *Majalah Poultry Indonesia* (Indonesian Poultry Magazine), September 2004.

Horridge, J., Parmenter, B.R. and Pearson, K.R.. 1993. "ORANI-F: a general equilibrium model of the Australian economy", *Economic and Financial Computing* 3: 71-140.

Lokuge, L, K. Lokuge and T. Faunce.2005. AI, Agricultural Trade and WTO Rules: The Economics of Transboundary Disease Control in Developing Countries. Working Paper. Centre for Governance of Knowledge and Development

Indonesian Ministry of Health, 2005. *Kematian Tiga Korban Flu Burung di Tangerang Akibat Kotoran Unggas* (Three human dead because of AI in Tanggerang). Indonesian Ministry of Health, www.depkes.go.id.

Ministry of Agriculture of Indonesia. 2004. Statistical Book on Livestock 2003. *Direktorat Jenderal Bina Produksi Peternakan*, Ministry of Agriculture of Indonesian, Jakarta.

----------. 2003. Agricultural Statistics. Ministry of Agriculture Republic of Indonesia, Jakarta.

Moukomla, S. and A. Poomchatra. 2005. Rapid Response Spatial Information System: AI in Thailand. Geo-Informatics and Space Technology Development Agency. Bangkok. Thailand.

OIE (the World organisation for animal health). 2005. Disease Information. The OIE Animal Health Information Department, World Health Organization (WHO), http://www.oie.int/eng/info/hebdo/AIS_64.HTM#Sec5.

O'Toole, R. and A. Mattews. 2002. The IMAGE CGE Model: Understanding the Model Structure, Code and Solution Methods. Working Paper. The Image Project Trinity College Dublin.

Oktaviani, R. 2000. The Impact of APEC Trade Liberalization on Indonesian Economy and Its Agricultural Sector. Ph.D thesis, The Sydney University.

Soegiharto, S. 2004. *Potret Tenaga Kerja di Sektor Pertanian* (The Performance of Agricultural Employment). Warta Ketenagakerjaan 12 Edition 12 (November) 2004

Wittwer, G. 1999. WAYANG: a General Equilibrium Model Adapted for the Indonesian Economy, Edition prepared for ACIAR Project no 9449. CIES, University of Adelaide (in association with RSPAS, ANU, CASER, Bogor, and CSIS, Jakarta).

Yusdja Y., R. Sajuti, M. Iqbal, and MSM. Tambunan. 2000. *Perumusan Kebijaksanaan dan Model Restrukturisasi Industri Ternak Unggas Nasional* (Policy and Model Construction for National Poultry Industry Restructuring). Research Report, Center for Economic and Social Research, Ministry of Agriculture of Indonesia, Bogor.