The outbreak of avian influenza and chicken consumption in Thailand

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Abstract

A few cases of avian flu infection were found in the fourth quarter of 2003 in Thailand. The outbreak was officially announced and confirmed in early 2004. The infection caused fears about chicken consumption throughout Thailand. The problem was widely spread throughout the country in 2004. As a result, chicken consumption has fallen significantly by about 29 percent in 2004. Another major economic loss was a substantial fall in the export of chicken by approximately half of its export value in the previous year.

The chicken consumption behaviour of the Thai people has changed notably by the recorded data and the estimated consumption model. The study was conducted to examine whether the consumption demand for chicken has significantly changed due to the outbreak of bird flu, using a pooled provincial data (76 provinces) over 4 years (2003-2006) when the avian influenza had widely infected people causing many deaths. The model allowed for a possible substitution of consumption of chicken with other three popular animal meats in Thailand; i.e., beef, pork, and fish. A large reduction in chicken consumption was found countrywide. The reduction of consumption was in evidence in all provinces with structural changes in elasticity in 2004, the first year of the outbreak. The impact was found to be temporary and showed to be significant only in the first year of the outbreak. The study also performed a statistical test of the geographical flu impact. The result indicated that there was a statistically negative impact on chicken consumption regardless of which areas were infected. This suggested that consumer confidence and information flow are important economic factors for consumers' consumption decisions especially at a time when experiencing a situation with a communicable decease like avian flu.

Key Words: Avian Influenza, Chicken Consumption, Own Price Elasticity, Cross Price Elasticity, temporary structural changes

1. Introduction

According to the Food and Agriculture Organization of the United Nations (FAO), avian influenza was first identified in Italy over 100 years ago. The recent outbreaks in Asia occurred in Hong Kong between 1997 and 1998 and again in 2003 and in the Republic of Korea in 2003. In Thailand, a few cases of Avian Flu Infection were found in the fourth quarter of 2003. The outbreak was officially announced and confirmed in early 2004. In early 2005, the avian influenza epidemic was widely distributed throughout Asia including Cambodia, People Republic of China, Indonesia, Japan, the Lao People's Democratic Republic, the Republic of Korea, Malaysia, Pakistan, Viet Nam and Thailand. The FAO estimated that more than 140 million birds died or were destroyed and many people died that accounted for the overall GDP loss as much as US$10 billion to US$15 billion (FAO New Room, 2005).

The potential impact of the avian influenza pandemic in general was expected to vary in different countries. In the USA, the Congressional Budget Office assessed the possible macroeconomic effect in order to increase the nation's preparedness in December 2005. A severe pandemic, similar to the one that began in 1918, might cause a decline in U.S. gross domestic product (GDP) of about 4-1/4 percent. A mild pandemic similar to those that occurred in 1957 and 1968 might reduce GDP by about 1 percent, subject to coverage and intensity (Arnold et al., 2006, p.12).

In Asia, the Asian Development Bank revealed that it was uncertain about predicting the economic cost of an influenza pandemic due to various uncertainties regarding the nature of such a pandemic and its economic consequences (Bloom, De Wit & San Jose, 2005, p. 2-3). It depends on epidemiological uncertainty (how many people are infected and the severity of the disease) and economic uncertainty (how the outbreak affects the economic activity and how the public responds to the outbreak). Though the study used a macroeconomic model (Oxford Economic Forecasting Global Model) to simulate the impact of the pandemic shock, various scenarios must be assumed to assess the impact such as a mild pandemic, the longevity of the flu and the psychological impact of it; etc. Demand shock and supply shock to the economy then can be evaluated. The impact will also depend on the response of the government to the pandemic shock.

The impact of a single outbreak in 2003 and 2004 in Asia was found to depend on the speed with which it was controlled (McLeod et al., 2005, 0. 1-2). Direct losses were found highest in Viet Nam (44 million birds, 17.5 percent of the poultry population) and Thailand (29 million birds, 14.5 percent of the poultry population). The contribution of the poultry sector to GDP ranged from the smallest in Thailand (0.5 percent) to Cambodia (1.5 percent). In Thailand the impact was estimated to be about 1.5 percent of the GDP lost over the year of the lost.

In Thailand, the Department of Livestock Development reported the number of deaths as 12 and 2 cases in 2004 and 2005 respectively. It was 17 and 5 for those infected with the flu. The Fiscal Policy Office estimated and reported in February 2004 that the impact of avian flu could cause a decline in GDP by 0.2 percent in 2004 if the chicken meat could not be exported for 2 consecutive quarters (and the government expense of 1,200 million baht (or $36.36 million at 33 baht per $1) for the compensation of farmers' birds killed (Satchapongse, 2004). The Fiscal Policy Office estimated the impact of the avian flu on the Thai economy using a macroeconomic model and it was found to cause the decline of the GDP by 0.22 per cent per year, export growth fell by 0.7 per cent per year and the government expense was 2,200 million baht (or $66.6 million at 33 baht per $1) for the compensation for farmers' birds killed and free chicken breeds (Fiscal Policy Office, 2004).

As it was realized that the avian influenza is rather more dangerous than other poultry diseases, the infection therefore caused fear of chicken consumption throughout Thailand. Consequently, chicken consumption fell significantly by about 29 percent in 2004. Apart from the fallen consumption, a substantial fall in the export of chicken was also found to be at approximately half of its export value in the previous year.

Thailand has many bird farmers throughout the country and chicken itself is a main dish for the daily food of Thai people, so the impacts of the avian influenza on chicken consumption is therefore valuable to investigate. Poultry (chicken, turkey, duck and specialty birds) is the second most consumed meat after pork and Thailand was ranked the 11th and the 10th of the top 15 broiler and poultry consuming countries respectively (Roenick, 1999, p.724). The trend of the world poultry consumption looks bright due to increased income, fast expanded modern poultry production facilities, and breakthroughs in agriculture biotechnology.

The main objective of this study was to examine the structure of chicken consumption demand in Thailand especially during the outbreak of avian influenza when the influenza had widely infected the people causing many deaths. One of the important issues regarding chicken consumption was whether consumption will return to the previous normal trend and whether the chicken consumption structure (consumption behavior) has changed, temporarily or permanently.

2. Chicken Consumption in Thailand

A few cases of Avian Flu Infection were found in the late 2003 in Thailand. Its outbreak was officially announced and confirmed in early 2004. The first announcement was on January 23, 2004 and found 190 infected human patient cases in 42 provinces (out of 76 provinces nationwide). The second, the hardest hit infection, was between July 3, 2004 and April 12, 2005 that infected 1,539 cases in 51 provinces. The third round of the outbreak was between July 1, 2005 and November 9, 2005 that found 75 infected cases in 11 provinces.

In Thailand, once there are cases or suspected cases of bird flu found and reported, the government gets rid of all birds in the areas nearby within a radius of 10 kilometres around the incident point. The infection caused fear of chicken consumption throughout Thailand. As a result, chicken consumption fell by 27 percent in 2005 and amounted to the loss of 10,955 million baht ($million 322 at 34 baht per $1) during 2004-5. Its export fell by half of its value in the previous year.

From the survey in 2 provinces (Lop Buri and Suphan Buri) which were hardly hit by avian flu, it was shown that people changed their chicken consumption behaviour (Supakankunti et al., 2007). Sixty three percent of the people in the sample reduced or even stopped their chicken consumption. Some of the sample turned their consumption from buying raw chicken to broiling chicken. Many of them switched to have more pork, fish, and beef. Those who were traditional chicken farmers (backyards) have turned to contract farmers.

From the statistics of the Department of Livestock Development, the quantity of bird production fell significantly in 2004. It went up to around the same number as in 2003 but it fell again in the next year in 2006 (Table 1A in Appendix). The significant drop in chicken consumption in 2004 made it still lower than the previous consumption level. The number of birds in 2006 was only 72.9 percent of that in 2003, a year before the outbreak of avian influenza. Exports fell significantly after 2003 and were still much lower than the past records (Table 2A in Appendix). This data showed clearly the impact of avian flu on chicken consumption demand in Thailand. In Thailand, although a few studies had been conducted on the impact of flu, most of them focused on the impact evaluation of flu on the economy and social aspects. Some of them were carried out on epidemiological issues for livestock planning by the government. No research has been done on the impact on chicken and other meat consumptions.

3. Chicken Consumption Model

Official data recorded a significant reduction in chicken consumption in Thailand after the outbreak of flu. It is, however, inadequate to examine whether the structure of the demand for chicken has changed. Many factors could affect the fallen consumption including merely a panic effect (or psychological effect) causing reduction in consumption on average per person without any change in elasticities or the demand structure. The impact could also change the structure of demand temporarily and the effect could return to the normal previous consumption pattern.

On the contrary, the flu might cause change in the structure of demand for chicken permanently. An implicit hypothesis here in the study was that the impact on the changing structure of demand was temporary. There is no rationale to explain a permanent change. However, as time passes by, many factors have changed such as income and the number of consumers changes causing consumption to change. The visible impact is, therefore, hard to explain. The chicken consumption model is, therefore, important to examine to see the real effect of the impact. It can be helpful for policy makers and businesses to learn and plan to adjust themselves for the change.

The standard consumption demand model was used in the study to examine the structure of chicken consumption in Thailand. Own price, cross price and income elasticities are therefore the key parameters of interest. To see the impact of avian flu on consumption, pooled data of chicken consumption across 76 provinces in Thailand over four years during 2003 – 2006 were considered to be used in the estimation. The pooled data of the provincial cross-section over the time period can help to examine from the model if the consumption structure has changed, temporarily or permanently, during (before and after) the outbreak of the avian Flu in 2004.

An advantage of using pooled data to estimate the model lies in the possible unobserved cross sectional effect or the provincial effect that can influence chicken consumption differently. Ignorance of the unobserved provincial effect in the model will cause the estimation result to be biased (heterogeneity bias) and inconsistent (Stock & Watson, 2007, Chapter 10; Johnston & DiNardo, 1997, Chapter 12).

The model used in this study took the form of Equation (1) below. It allowed for a possible substitution of consumption of chicken (CHK) with other three popular animal meats in Thailand; i.e., beef (BF), pork (PK), and fish (FS), as well as other food consumption in the estimated demand function. Since the outbreak of the avian flu did not spread throughout Thailand, the model was introduced DMF in the model, the dummy variable for only the areas where the chicken deaths were found and confirmed. This DMF was included to test whether or not the avian influenza can cause a fear of chicken consumption throughout Thailand.

$$\ln(\boldsymbol{QCHK}_{it}) = \boldsymbol{\alpha}_i + \sum_{j=1}^{5} \boldsymbol{\beta}_j \ln(\boldsymbol{P}_{jit}) + \boldsymbol{\gamma} \ln(\boldsymbol{GPP}_{it}) + \boldsymbol{\delta}_{04}\boldsymbol{T}_{04} + \boldsymbol{\delta}_{05}\boldsymbol{T}_{05}$$

$$+ \sum_{j=1}^{5} \boldsymbol{\phi}_{j04} \ln(\boldsymbol{P}_{jit})\boldsymbol{T}_{04} + \sum_{j=1}^{5} \boldsymbol{\phi}_{j05} \ln(\boldsymbol{P}_{jit})\boldsymbol{T}_{05}$$

$$+ \boldsymbol{\theta}_{04} \ln(\boldsymbol{GPP}_{it})\boldsymbol{T}_{04} + \boldsymbol{\theta}_{05} \ln(\boldsymbol{GPP}_{it})\boldsymbol{T}_{05} + \boldsymbol{\rho}\mathrm{DMF}_{it} + \boldsymbol{\varepsilon}_{it} \tag{1}$$

Where

$QCHK_{it}$	= Chicken consumption (number of birds; net of export)
P_{jit}	= Prices (baht per kilogram)
GPP_{it}	= Gross Provincial Product at 1988 constant prices (million baht)
T_t	= Dummy variable; = 1 for the tth Year in 2004 and 2005 when there were incidences found
DMF_{it}	= Dummy variables for the areas (Provinces) where there were found the infections during the years of outbreak (2004 and 2005).
i, j	= 1, 2, 3, 4, 5 (chicken, beef, pork, fish and other food) where consumer price index of food and beverage (CPIFB) was used to proxy the price of the other food
t	= years 2003, 2004, 2005, and 2006

The short name of all 76 provinces was listed in Table 1L in Appendix.

Data of birds were from the Annual Statistics Livestock in Thailand, Department of Livestock Development. Owing to unavailable data of chicken consumption by provinces, the number of birds in each province was used as the quantity of chicken consumed by assuming that supply is always equal to demand at any period of time. The rationale behind this assumption is that bird production takes a few months and many rounds can be produced in a year so farmers can adjust their supply to demand as frequently as they need. In addition, data of chicken export by provinces is also not available; proportion of chicken exported out of total production was used to calculate for the estimated chicken export by provinces. The number of domestic consumption (net of export) was then used in the model estimation.

Retail prices and the consumer price index (CPI) were drawn from the Department of Fisheries, the Ministry of Commerce, and the Bureau of Trade and Economic Index. Gross Provincial Product was from the National Economic and Social Development Board. Data on retail prices of some provinces was unavailable and so the study estimated them by basing them on Bangkok retailed prices and the provincial CPI of food relative to that of Bangkok.

The method of pooled cross section and time series data under fixed effect model was employed in the study. The fixed effect approach was estimated as being assumed that the possible unobserved provincial effect affecting the consumption does not change over time. In addition, to avoid the problem of heteroscedasticity from the use of provincial cross section, the Generalized Least Square estimation was used to estimate the model.

The study conducted an experiment to observe the result of ordinary least square estimation on the pooled data under common intercept (without the fixed effect). The result showed incredible and incorrect signs of coefficients (Table 3A in Appendix). These wrong signs and confusion of the estimated coefficients was a result of the heterogeneity bias and inconsistency of the estimation as mentioned above.

4. Findings and Discussions

The model was estimated firstly by incorporating the time dummy variables both T04 and T05 when there were occurrences of the infection. All prices concerned were also included in the model. Common intercept and slope model was firstly estimated by OLS and found rather unusual result of both positive own price effect and rather low adjusted R^2 (Table 3A in Appendix). Fixed effect with intercept changes for both years of the occurrence, mentioned earlier, was then used in the estimation. The results are shown in Table 4A (in Appendix). It suggested that only the first year of the occurrence (T04 for 2004) had a significant negative impact on chicken consumption. To improve efficiency of the model estimation, the study removed some variables in the model that were not statistically significant found in Table 4A. The study also estimated the model by allowing changing slopes (Table 5A in Appendix). The completed result of the model estimation is shown in Table 1 below.

Table 1 Model Estimation Result GLS (Cross Section Weights)
Dependent Variable is LOG(QCHK)
Sample: 2003 2006
Included observations: 4
Number of cross-sections used: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PCHK)	-0.956097	0.485819	-1.968012	0.0503
LOG(PBF)	-0.831120	0.265697	-3.128073	0.0020
LOG(PPK)	1.242724	0.535217	2.321906	0.0212
LOG(PFS)	-2.036830	0.444489	-4.582406	0.0000
LOG(CPIFB)	1.784460	1.239074	1.440156	0.1513
LOG(GPP)	0.236999	0.187326	1.265173	0.2072
T04	-18.17387	4.213114	-4.313643	0.0000
LOG(PCHK)*T04	1.869542	0.787978	2.372581	0.0185
LOG(PFS)*T04	2.570126	1.047270	2.454120	0.0149
DMF	-0.113796	0.076741	-1.482860	0.1396

Fixed Effects					
AMC	14.41126	NAN	13.97116	RET	14.91598
ATH	15.10178	NBL	13.75482	RNG	13.78069
AYD	14.03840	NGK	13.93988	RYG	15.21300
BKK	13.69083	NNY	14.32321	SBR	14.81377
BRR	14.80375	NPM	14.32269	SKH	13.71564
CCS	15.29887	NPT	15.08572	SKL	13.03161
CHM	14.32585	NRS	15.45418	SKM	13.89420
CHN	13.04344	NST	13.99402	SKN	14.11859
CHP	16.25750	NSW	14.03947	SKT	14.06317
CHR	15.00786	NTB	12.54564	SNG	13.95785
CLB	15.66438	NTW	12.74930	SPB	15.31939
CMP	13.47872	PBN	14.33635	SPK	13.14805
CNB	12.34634	PBR	15.55022	SRN	14.63602
KHK	14.67187	PCB	13.12226	SRT	13.34249
KLS	13.84650	PCK	14.87925	SSK	13.96593
KMP	13.95556	PCT	14.43235	SSS	12.73156
KNB	15.31022	PGN	13.62196	STN	12.78000
KRB	13.31768	PHK	13.38840	TAK	14.13737
LBR	16.21763	PRA	13.71757	TRD	13.54475
LOI	14.22936	PSL	13.15519	TRG	14.11471
LPG	14.80696	PTL	14.26422	UBR	13.55026
LPN	13.24964	PTM	14.26022	UDN	14.73715
MDH	13.58084	PTN	13.84070	UDT	14.47247
MHK	14.23610	PYO	14.20885	UTN	14.10187
MHS	13.95633	RBR	13.35133	YAL	13.37989
				YST	14.73191

Weighted Statistics			
R-squared	0.999077	Mean dependent var	27.07941
Adjusted R-squared	0.998717	S.D. dependent var	22.78425
S.E. of regression	0.816123	Sum squared resid	145.2003
F-statistic	2775.753	Durbin-Watson stat	3.414131
Prob(F-statistic)	0.000000		

Source: Author's estimation

Whether the estimation should be applied using fixed effects or random effects models, Hausman (1978) test was used in this paper to confirm the hypothesis. The random effects model can be appropriate if our N individuals are drawn randomly from a large population, which is not likely to be the case in this study. The Hausman of random effects model test is Chi Squared distribution under the assumption that the additional coefficient or unobserved effect (saying μ_i) is uncorrelated or independent with each explanatory variable. The Huasman test is calculated to be 27.2297 with 10 degree of freedom and the probability value of 0.0024. It is therefore justify estimating the equation using fixed effect model.

The finding indicates that in the regular situation, in 2003 prior to the outbreak of the avian flu, the cross price elasticities of demand for chicken with respect to the other meats were found significant except for the other food (CPIFB). Pork was found to be a substituting meat for chicken with elastic cross price. In other words, if the price of pork was cheaper, the Thai people would turn to eat less chicken (and more pork). Under the circumstances of fear of flu, people eat less chicken and more pork, if any other prices remain the same. The other two (beef and fish) were found complementary meat for chicken as the Thai people usually have chicken, beef and fish. The cross price was found elastic for fish prices and inelastic for beef prices. The other food (FB) was found to substitute for chicken but was statistically insignificant.

The own price elasticity of chicken consumption was found to be about unitary elastic. It perhaps suggests that chicken consumption is like usual consumption behaviour; a one percent reduction in its price will increase the consumption of chicken by one percent. On the other hand, the estimated income elasticity of chicken consumption was found rather small and statistically insignificant. In the other words, chicken consumption is not affected significantly by income change. People will continue to consume chicken as food as much as usual (income inelastic demand). In 2004, the first year after the outbreak of the avian flu, there was still no significant change in income inelastic chicken consumption (Table 5A in Appendix).

It is interesting to note that all types of *meat* were found to turn to be more substitutions for chicken during the outbreak in 2004 when the *slope changes* were all found to be positive in 2004 (Table 5A in Appendix). However, the positive changing slopes were significant only for the price elasticity of chicken and the cross price elasticity of fish for chicken. This implies that there was a significant structural change in the own price elasticity of chicken and the cross price elasticity of fish and chicken during the infection in 2004.

Note also that these two elasticities (the own price elasticity and the cross price elasticity of fish) *temporarily* became positive in 2004. The positive own price elasticity (being 0.9134 in 2004) indicated the fact that during the critical period when the infection spread over the country, people declined to have more chicken (actually even less) even though the price had fallen. This result is not unusual for the meaning of own price elasticity of demand under this temporary circumstance. It implied that after the outbreak, consumers were aware of the danger of infected chicken consumption. This could slowdown both the chicken price and demand (and supply) for chicken and resulted in positive price elasticity. In other words, lower price was accompanied with falling demand. The impact of bird flu could cause cautious consumption of chicken among the Thai people such that the price elasticity (structure of chicken consumption) significantly changed in the first year, before the consumption structure turned back to its previous structure.

It is also interesting to find that the becoming positive cross price elasticity of fish (0.5333) in 2004 which was previously negative in 2003 implied that fish became a substituting meat for chicken from being a complementary meat. It is obvious in Thailand that normally the majority of people especially those farmers whose number is about half of the Thai people have both chicken and fish as major meats on the table. During the outbreak, fish became substituting meat for chicken.

To interpret this result, chicken and fish are basic meat that can be found in all areas in Thailand, especially those in farms and the countryside. During the outbreak of the bird flu in 2004, fish became a substituting meat for chicken temporarily as there was less chicken but more fish consumption. For the other cross price elasticities, there was found no structural change during the outbreak in 2004.

The estimated model (Table 1) also pointed out another important structural change in that there was a significant reduction in overall chicken consumption in Thailand in 2004 (T04), the first year after the outbreak of the avian flu.

If the sizes of the fixed effect are sorted in sequence, there were 34 (out of 76) provinces where those fixed effects were larger than the average size (14.12). Those 34 provinces are listed in Table 2 below. It is interesting to note that there were 21 out of those 34 provinces (or 53.85 percent) of the highly fixed effect above the average being those officially reported as infected areas. This implies suggestion that more than half of the big chicken consumers were recorded the affected areas of avian flu.

Overall reduction in chicken consumption (fallen intercepts) was found to be relatively large in 2004. The fallen (negative) intercept of 18.17 of the logarithm of chicken consumption in 2004 was a relatively large fall compared to the regular provincial fixed effect that ranged between 12.35 and 16.26. Actually, the reduction in overall chicken consumption was very obviously noticeable by the Thai people as there was almost no shop or restaurant that could sell chicken country wide at that time. The people were cautious to have chicken except perhaps those which were cooked or well done.

It should also be noted that the inclusion of the geographical flu impact or DMF in the model that was the dummy variable for the provinces where infection were found *in*significant during the years of outbreak (2004 and 2005). This can confirm the large drop of chicken consumption countrywide, including both infected and uninfected provinces. There was no different impact, though negative, between the areas of infection and without infection of the avian influenza. This statistical test of the geographical flu impact indicated that there was an impact on chicken consumption regardless of whether the areas were infected. The consumer confidence and information flow is likely a key economic factor for consumption decisions especially when dealing with such a case of communicable decease like avian flu.

Table 2 Provinces with relative large sizes of the fixed effect

Variable	Provinces	Fixed Effect	Variable	Provinces	Fixed Effect
CHP	Chaiyaphum	16.2575	UDN	Udonthani	14.73715
LBR	Lopburi	16.21763	YST	Yasothon	14.73191
CLB	Cholburi	15.66438	KHK	Khonkaen	14.67187
PBR	Nakhonrachasima	15.55022	SRN	Surin	14.63602
NRS	Prachinburi	15.45418	UDT	Utraradit	14.47247
SPB	Suphanburi	15.31939	PCT	Pichit	14.43235
KNB	Kanchanaburi	15.31022	AMC	Amnatcharoen	14.41126
CCS	Chacherngsoa	15.29887	PBN	Petchaboon	14.33635
RYG	Rayong	15.213	CHM	Chiangmai	14.32585
ATH	Aungthong	15.10178	NNY	Nakhonnayok	14.32321
NPT	Nakhonprathom	15.08572	NPM	Nakhonpanom	14.32269
CHR	Chiangrai	15.00786	PTL	Pathalung	14.26422
RET	Roiet	14.91598	PTM	Pathumthani	14.26022
PCK	Prachubkirikhun	14.87925	MHK	Mahasarakham	14.2361
SBR	Saraburi	14.81377	LOI	Loei	14.22936
LPG	Lumpang	14.80696	PYO	Payoa	14.20885
BRR	Burirum	14.80375	TAK	Tak	14.13737

Source: ranked from the model estimation

The study further tested to see if the consumption model (1) behaved following the demand function property of the homogeneity of degree zero in prices and income. The Wald test of linear combination restriction was used to test under the null hypothesis (2) below.

$$H_0: \sum_{j=1}^{5} \beta_j + \gamma = 0 \qquad (2)$$

The restricted equation was caused by the omission of variables of the unrestricted model. The test is therefore whether the excluded variables in the restricted model have a significant joint effect on the dependent variable. The residual sum of square of the restricted model will not be different from those of the unrestricted model if those omitted variables have no effect on the dependent variable. As the residual sum of square is sensitive to the unit of measurement, the relative term of the difference of the residual sum of square between the restricted and the unrestricted models will be compared to that of the unrestricted model. The Wald test has an F distribution being the ratio of the two independent Chi Square since the sum of the independent squares has a Chi Square distribution. The F-test of linear restriction can be calculated as in Equation (3).

$$F = \frac{(e^{/}e_r - e^{/}e_u)/d}{e^{/}e_u/(N-k)} \quad (3)$$

Where

$e^{/}e_r$ = Residual sum of square of the restricted model

$e^{/}e_u$ = Residual sum of square of the unrestricted model

d = The number of restriction

N = Total observation

K = number of explanatory variables in the unrestricted model

The calculated F statistic was 0.2548 with the degree of freedom of (1, 294) and the probability value (p-vale) was 0.6140. The test can*not* reject the null hypothesis, thus it can be concluded that the estimated model conformed to the consumption demand behaviour in economic theory.

5. Conclusion

Chicken is a basic food for the Thai people and its consumption demand is growing rapidly. The avian influenza caused panic and created a shock to chicken consumption in Thailand during the first year of the outbreak of the flu in 2004. Consequently, there was a sharp reduction in chicken consumption in that year.

The study aimed to examine the structure of chicken consumption demand in Thailand especially during the outbreak of avian influenza. Since the infection of the flu caused a significant fall in chicken consumption in 2004, an important question is whether the recent amount of chicken consumption has gone up to the previous normal trend and whether the chicken consumption structure (consumption behavior) has changed, temporarily or permanently, since the outbreak of avian flu.

The study employed the standard consumption demand model to examine the structure of chicken consumption. Own price, cross price and income elasticities are the key parameters of interest. Pooled data of chicken consumption across 76 provinces in Thailand over four years during 2003 – 2006 was considered to be used in the estimation. The model allowed for a possible substitution of consumption of chicken (CHK) with other three popular animal meats in Thailand; i.e., beef (BF), pork (PK), and fish (FS), as well as the other food consumption in the estimated consumption function. DMF, the dummy variable for the areas where chicken deaths were found and confirmed, was introduced in the model. This inclusion of DMF was to examine whether or not the avian influenza can cause fear of chicken consumption throughout Thailand. The result indicates that there was an impact on chicken consumption regardless of whether the areas were infected. This was caused by unconfident consumption of chicken in Thailand for fear of the death during the outbreak of the flu.

The result obtained from the estimated model can help explain many interesting questions. Basically, the estimated consumption demand equation was found to follow the basic property of consumption demand theory, including the negative elasticity of own price and homogeneity of degree zero in prices and income property. Pork was found to be the major substituting meat for chicken while fish and beef were among the two complementary kinds of meat with chicken. Chicken was confirmed to be a necessary food in Thailand as the estimated income elasticity was statistically inelastic.

Avian influenza was found to cause a shock in chicken consumption in 2004. There were temporary structural changes in the demand function; i.e., both in fallen intercept (overall reduction) and changing own price elasticity of chicken demand and cross price elasticity of fish. The fallen intercept was found to be quite large. The structural change was noticeably found in the own price elasticity of chicken that was found to become positive. Under this temporary circumstance, consumers were aware of the danger of infected chicken consumption. This could slowdown both chicken price and demand for (and supply of) chicken and result in positive price elasticity. Another structural change was found in the cross price elasticity of chicken consumption with respect to the price of fish. During the outbreak of the bird flu in 2004, fish became an inelastic substituting meat for chicken temporarily from being elastic complementary earlier.

All the above findings suggest that the result of the avian influenza was significant in terms of both quantity reduction of chicken consumption and the structural change of the elasticities of consumption. Fortunately, the changes were found to be temporary. This impact could also cause other economic loss which was not covered in this study. The result suggested that consumer confidence and information flow is an important factor for consumers' consumption decisions especially during the time when having to deal with such a case of communicable decease like avian flu. Information on how to deal with dead birds, how to keep chickens safely, and how to stay healthy would be critical information for people at such a time.

Appendix

Table 1A Bird Production in Thailand, 1993 - 2006

Year	Birds	Growth (%)
1993	138,832,027	
1994	129,997,098	-6.36
1995	111,648,510	-14.11
1996	144,579,428	29.50
1997	164,685,842	13.91
1998	155,324,646	-5.68
1999	169,632,507	9.21
2000	189,341,110	11.62
2001	214,979,081	13.54
2002	228,760,326	6.41
2003	252,718,883	10.47
2004	179,738,810	-28.88
2005	254,204,068	41.43
2006	184,326,752	-27.49

Source: Information Technology Center, Department of Livestock Department**.**

Table 2A Export of Frozen and Cooked and Proceeded Meat

Export	Year	Frozen Chicken Meat	Proceeded and Cooked Meat	Total
Quantity (Tons)	1992	174,829	0	174,829
Value (million baht)	1992	10,399.29	0.00	10,399.29
Value (million $)	1992	409.42	0.00	409.42
Quantity (Tons)	1993	157,081	0	157,081
Value (million baht)	1993	8,885.70	0.00	8,885.70
Value (million $)	1993	350.94	0.00	350.94
Quantity (Tons)	1994	153,043	0	153,043
Value (million baht)	1994	9,854.38	0.00	9,854.38
Value (million $)	1994	391.83	0.00	391.83
Quantity (Tons)	1995	149,935	0	149,935
Value (million baht)	1995	9,661.77	0.00	9,661.77
Value (million $)	1995	387.79	0.00	387.79

Quantity (Tons)	1996	137,214	0	137,214
Value (million baht)	1996	9,085.02	0.00	9,085.02
Value (million $)	1996	358.47	0.00	358.47
Quantity (Tons)	1997	150,776	0	150,776
Value (million baht)	1997	10,949.28	0.00	10,949.28
Value (million $)	1997	349.01	0.00	349.01
Quantity (Tons)	1998	212,479	0	212,479
Value (million baht)	1998	16,638.51	0.00	16,638.51
Value (million $)	1998	402.18	0.00	402.18
Quantity (Tons)	1999	217,739	47,996	265,735
Value (million baht)	1999	15,260.05	5,935.76	21,195.81
Value (million $)	1999	403.27	156.86	560.14
Quantity (Tons)	2000	240,923	69,328	310,251
Value (million baht)	2000	15,689.91	8,749.67	24,439.58
Value (million $)	2000	390.66	217.86	608.52
Quantity (Tons)	2001	309,543	89,143	398,686
Value (million baht)	2001	23,934.88	11,546.61	35,481.49
Value (million $)	2001	538.14	259.61	797.75
Quantity (Tons)	2002	330,331	103,179	433,510
Value (million baht)	2002	22,958.94	13,152.63	36,111.57
Value (million $)	2002	533.88	305.85	839.72
Quantity (Tons)	2003	370,393	126,984	497,377
Value (million baht)	2003	24,767.24	15,703.65	40,470.89
Value (million $)	2003	596.37	378.13	974.49
Quantity (Tons)	2004	26,548	174,268	200,816
Value (million baht)	2004	1,749.05	20,852.99	22,602.04
Value (million $)	2004	43.43	517.83	561.27
Quantity (Tons)	2005	4,547	233,509	238,056
Value (million baht)	2005	537.87	27,338.53	27,876.40
Value (million $)	2005	13.36	678.89	692.24
Quantity (Tons)	2006	8,036	251,663	259,699
Value (million baht)	2006	595.65	28,842.65	29,438.30
Value (million $)	2006	15.70	760.45	776.15

Source: Ministry of Commerce and Department of Livestock Development and Bank of Thailand

Table 3A Estimation Results (Common Intercept of Pooled Least Square)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.254822	5.267956	1.377161	0.1695
LOG(PCHK)	0.360604	0.761722	0.473406	0.6363
LOG(PBF)	-0.399637	0.402561	-0.992736	0.3217
LOG(PPK)	-2.679906	1.149120	-2.332138	0.0204
LOG(PFS)	-0.130556	0.909864	-0.143489	0.8860
LOG(CPIFB)	3.587838	1.857747	1.931284	0.0544
LOG(GPP)	0.288769	0.065654	4.398371	0.0000
T04	-0.074926	0.229502	-0.326472	0.7443
T05	0.102438	0.246848	0.414983	0.6785
DMF	0.453196	0.183005	2.476412	0.0138

R-squared	0.139990	Mean dependent var	14.20126
Adjusted R-squared	0.113663	S.D. dependent var	1.149403
S.E. of regression	1.082111	Sum squared resid	344.2636
F-statistic	5.317373	Durbin-Watson stat	1.797583
Prob(F-statistic)	0.000001		

Table 4A Estimation Results (Fixed Effect with Intercept Changes for Both Years)
Dependent Variable is LOG(QCHK)
Sample: 2003 2006, Included observations: 4

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PCHK)	-0.159085	0.437909	-0.363285	0.7166
LOG(PBF)	-0.656393	0.279895	-2.345136	0.0195
LOG(PPK)	2.060442	0.680441	3.028097	0.0026
LOG(PFS)	-2.206633	0.596906	-3.696786	0.0003
LOG(GPP)	0.227497	0.279689	0.813393	0.4165
T04	-0.487828	0.112718	-4.327847	0.0000
T05	-0.146676	0.135992	-1.078562	0.2815
DMF	-0.086433	0.082577	-1.046698	0.2959

Fixed Effects					
AMC	15.88172	NAN	15.49121	RET	16.44287
ATH	16.53709	NBL	15.23814	RNG	5.25354
AYD	15.62596	NGK	15.50589	RYG	16.70804
BKK	15.17198	NNY	15.79435	SBR	16.34750
BRR	16.35626	NPM	15.84377	SKH	15.21496
CCS	16.74913	NPT	16.64264	SKL	14.31953
CHM	15.90265	NRS	17.06780	SKM	15.36375
CHN	14.51956	NST	15.39947	SKN	15.63145
CHP	17.80526	NSW	15.63160	SKT	15.59356

CHR	16.39757	NTB	13.96828	SNG	15.56748
CLB	17.11990	NTW	14.22645	SPB	16.92223
CMP	14.97468	PBN	15.88642	SPK	14.57652
CNB	13.80229	PBR	17.08406	SRN	16.40845
KHK	16.22440	PCB	14.42888	SRT	14.83864
KLS	15.38960	PCK	16.36182	SSK	15.48237
KMP	15.42701	PCT	15.94844	SSS	14.21675
KNB	16.79082	PGN	15.07091	STN	14.34065
KRB	14.84773	PHK	14.85525	TAK	15.78708
LBR	17.73234	PRA	15.37931	TRD	15.01712
LOI	15.67727	PSL	14.60261	TRG	15.69699
LPG	16.34629	PTL	15.73797	UBR	15.09703
LPN	14.66702	PTM	15.58844	UDN	16.25303
MDH	15.08059	PTN	15.33537	UDT	16.12961
MHK	15.75154	PYO	15.67905	UTN	15.57622
MHS	15.47688	RBR	14.96879	YAL	14.89045
				YST	16.25668

Weighted Statistics			
R-squared	0.998850	Mean dependent var	26.39540
Adjusted R-squared	0.998416	S.D. dependent var	20.50882
S.E. of regression	0.816323	Sum squared resid	146.6042
F-statistic	27289.93	Durbin-Watson stat	3.486708
Prob(F-statistic)	0.000000		

Source: Author’s estimation

Table 5A Estimation Result (Fixed Effect with Changing Intercepts and Changing Slopes)
Dependent Variable is LOG(QCHK)
Sample: 2003 2006
Included observations: 4 Number of cross-sections used: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PCHK)	-1.056524	0.408686	-2.585174	0.0104
LOG(PBF)	-1.016465	0.259045	-3.923887	0.0001
LOG(PPK)	0.879789	0.508073	1.731618	0.0848
LOG(PFS)	-1.899559	0.449982	-4.221408	0.0000
LOG(CPIFB)	2.444333	1.220418	2.002865	0.0465
LOG(GPP)	0.304023	0.176175	1.725687	0.0858
T04	-16.97436	9.756037	-1.739883	0.0833
DMF	-0.078490	0.079944	-0.981804	0.3273
LOG(PCHK)*T04	1.821746	0.759088	2.399914	0.0173
LOG(PBF)*T04	0.418169	0.356099	1.174305	0.2416
LOG(PPK)*T04	2.460610	1.464942	1.679664	0.0945
LOG(PFS)*T04	1.319876	1.108928	1.190227	0.2353
LOG(CPIFB)*T04	-1.972432	1.991576	-0.990387	0.3231
LOG(GPP)*T04	0.005582	0.081892	0.068162	0.9457

Fixed Effects

AMC	13.11336	NAN	12.6320	RET	13.49462
ATH	13.74045	NBL	12.4220	RNG	12.45070
AYD	12.46739	NGK	12.5628	RYG	13.60215
BKK	12.00601	NNY	12.9687	SBR	13.30468
BRR	13.39694	NPM	12.9743	SKH	12.35161
CCS	13.78743	NPT	13.5673	SKL	11.42834
CHM	12.86535	NRS	13.9568	SKM	12.57629
CHN	11.66436	NST	12.4550	SKN	12.73211
CHP	14.84795	NSW	12.5592	SKT	12.67580
CHR	13.52162	NTB	11.0403	SNG	12.57678
CLB	14.06716	NTW	11.3397	SPB	13.89197
CMP	12.08810	PBN	12.8534	SPK	11.57641
CNB	10.93081	PBR	14.0947	SRN	13.28799
KHK	13.20609	PCB	11.6587	SRT	11.83420
KLS	12.42840	PCK	13.4739	SSK	12.53773
KMP	12.51505	PCT	13.0444	SSS	11.20882
KNB	13.86719	PGN	12.2667	STN	11.40357
KRB	11.89105	PHK	11.9429	TAK	12.72327
LBR	14.79688	PRA	12.3889	TRD	12.20374

LOI	12.83871	PSL	11.6762	TRG	12.69999
LPG	13.40505	PTL	12.8918	UBR	12.12602
LPN	11.83692	PTM	12.6838	UDN	13.31423
MDH	12.32582	PTN	12.4476	UDT	13.08093
MHK	12.86038	PYO	12.8565	UTN	12.75058
MHS	12.66524	RBR	11.8866	YAL	11.94837
				YST	13.39416

Weighted Statistics			
R-squared	0.999151	Mean dependent var	27.37724
Adjusted R-squared	0.998797	S.D. dependent var	23.57134
S.E. of regression	0.817386	Sum squared resid	142.9778
F-statistic	2828.769	Durbin-Watson stat	3.446766
Prob(F-statistic)	0.000000		

Source: Author's estimation

Table 1L List of the name in short of 76 provinces

AMC	Amnatchareon	NAN	Nan	RET	Roiet
ATH	Aungthong	NBL	Nongboalumphu	RNG	Ranong
AYD	Ayudhya	NGK	Nongkhai	RYG	Rayong
BKK	Bangkok	NNY	Nakhonnayok	SBR	Saraburi
BRR	Burirum	NPM	Nakhonphanom	SKH	Srakao
CCS	Chacherngsoa	NPT	Nakhonprathom	SKL	Songkla
CHM	Chiangmai	NRS	Nakhonrachasima	SKM	Samutsongkarm
CHN	Chainat	NST	Nakhonsrithammarat	SKN	Sakolnakhon
CHP	Chaiyaphum	NSW	Nakhonsawan	SKT	Sukhothai
CHR	Chiangrai	NTB	Nonthaburi	SNG	Singbusi
CLB	Cholburi	NTW	Narathiwas	SPB	Suphanburi
CMP	Chumphon	PBN	Petchaboon	SPK	Samutprakarn
CNB	Chanthaburi	PBR	Petchburi	SRN	Surin
KHK	Khonkaen	PCB	Prachinburi	SRT	Suratthani
KLS	Kanlasin	PCK	Prachubkirikhun	SSK	Srisaket
KMP	Kumphaengphet	PCT	Pichit	SSS	Samutsakorn
KNB	Kanchanaburi	PGN	Pungna	STN	Satun
KRB	Krabi	PHK	Phuket	TAK	Tak
LBR	Lopburi	PRA	Phrae	TRD	Trad
LOI	Loei	PSL	Pitsanulok	TRG	Trang
LPG	Lumpang	PTL	Pathalung	UBR	Ubonrachathani
LPN	Lumphun	PTM	Pathumthani	UDN	Udonthani
MDH	Mukdahan	PTN	Pattani	UDT	Utraradit
MHK	Mahasarakham	PYO	Phayao	UTN	Uthaithani
MHS	Maehongsorn	RBR	Ratchaburi	YAL	Yala
				YST	Yasothorn

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