Consumer Responses to Animal Disease Epidemics: An Empirical Study of the FMD Outbreak

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Abstract

Key words: FMD, Probit model, Logit model

This paper examines consumer responses to the 1997 foot-and-mouth disease (FMD) outbreak that decimated Taiwan's pork industry, with special attention to consumer response differences according to demonstration and economic factors.

The probit and logit models were modified to analyze consumers' preferences and attitudes toward pork as demonstrated in data collected from a personal questionnaire distributed throughout Taiwan island which focused on consumers' knowledge and attitudes about food safety issues and factors. Results suggest that the FMD outbreak had a significantly negative impact on pork consumption, with higher income families, with greater education and

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living in city areas showing the greatest reluctance toward pork consumption after the third month and the sixth month. This study suggests a need for a greater gout effort to reveal that people who live in rural or city areas have significant and different responses to the FMD epidemic and the effect of these differences are sustained longer than any other variables.

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Introduction

Modern food production systems have increased productivity through employing capital-intensive facilities that utilize chemicals, antibiotics, hormones, and additives, etc. The side effects include hormone usage, chemical residuals, pesticide residuals, and radial pollution. Consumers are now paying more attention to these problems because more food safety information is being provided through various media (Qiang, 1995; Forrest, 1992; Henson, 1996). Taiwanese consumers are increasingly concerned about food quality nowadays rather than the quantity consumed. More food safety and health issues have become serious consumer concerns (Chien, 1988). Though consumer consumption behavior can be affected significantly by a single food poison event, consumer preference and purchasing behavior patterns are changed gradually through continuous exposure to reports about events involving food safety.

Taiwan had suffered from several food safety events during the past few years. In 1997, there were foot-and-mouth disease (FMD) epidemics in Taiwan, which led to huge reductions in pork consumption. Some consumers bought other substitute meats such as beef and chicken rather than pork. Some consumed pork only with Chinese Agricultural Standard (CAS) labels and/or branded pork products from big pork packing companies. All of these phenomena indicate that consumers are now more concerned with food safety than they have ever been. Therefore, the impact of FMD epidemic on pork consumption should be considered in addition to other economic variables (Brown and Schrader, 1990; Chang and Kinnucan, 1991). This paper employs data from a personal survey on changes in consumption of pork to describe the

impact of the FMD epidemic. Purposes of this research are to investigate the effects on pork consumption due to the FMD outbreak as well as the other factors.

FMD is a highly contagious disease that affects hogs, cattle, and other cloven-hoofed animals. The clinical diagnosis of FMD infected pig shows symptoms of vesicular eruptions following by erosions of the epithelium of the mouth, feet, and udder. According to food safety regulations, pork from FMD-infected pigs is prohibited from entering the market. However, some might enter the market because the pork from infected pigs could not been inspected during the incubation period of 14 days. Therefore, accidentally eating pork from FMD-infected pigs is possible.

The outbreak of FMD reveals the shortcomings of the modern animal production systems. In addition, it has stimulated consumers' concerns for the food safety issues particularly of pork and pork products. The impacts of a single food safety event may diminish. Another outbreak of FMD epidemics may occur again because Taiwan government implements an FMD control program rather than an FMD eradication program.

According to the Office International des Epizooties (OIE) regulations, Taiwan pork exports are prohibited after the FMD outbreak. In fact, the number of FMD-infected pigs slaughtered due to the FMD outbreak has been estimated as over 3.84 million head including infected boars, sows, hogs and even piglets. The actual consumption figures are not available since the changes in existing stock in the market are unknown. Therefore, there is no adequate time series data to evaluate the impact of FMD epidemics from demand side. Therefore, this research employs the cross sectional data from a personal survey to assess the impacts of an FMD on pork consumption behavior.

This article is organized as follows. First, a binary choice model is employed to investigate whether consumers reduce their pork consumption after the FMD epidemic. The next section presents the methodology used to collect data and the descriptive statistic results of the survey. Then, the binary choice models are estimated by employing the probit and logit methods. The final section presents the conclusions.

Model Specifications

After the outbreak of FMD, many consumers chose not consuming pork or reducing pork consumption. The demand of pork estimated by quantity is doubtable. In stead, the discrete choice between to reduce or not to reduce pork consumption is employed to evaluate the consumer responses to such animal disease epidemics. Assume an individual always tries to maximize his utility subject to the conventional budget constraint, the individual's utility maximization problem for discrete choice is defined as follows:

$$\max_{q,x} u = u(q(X_1, X_2), x(X_1, X_2), \ \varepsilon) \tag{1}$$

$$s.t. \ \ p'q + x = y$$

$$q(\cdot) \geq 0, \ \ x(\cdot) \geq 0$$

where q is a vector of goods may possibly consumed and x is the *numeraire* good. The demand of goods is affected by those function including exogenous economics variables, X_1, and a vector of preferences, attributes and demographic variables such as age, gender, and education, X_2. The residuals, ε, represent a vector of unobserved fluctuations in the respondent's choices. In the budget constraint equation, p is a vector of prices and y is the respondent's expenditures on all goods. In addition, nonegativity conditions on the goods consumed, $q(\cdot) \geq 0, x(\cdot) \geq 0$, are applied (Deaton and Muellbauer, 1991; Pollak and Wales, 1981; Greene, 1997; Thompson and Kidwell, 1998).

The solution of equation (1) is the system of Marshallian demand functions but a general analysis of the functions from equation (1) turns out to be difficult. Assume a rational consumer tries to maximize his utility subject to same expenditure level, when the utility of the bundle of consuming less q and more x is greater in terms of values, the respondent would

choose the bundle of consuming less q. In equation (2), assume $q_0 > q_1$ and $x_0 < x_1$, the price of x is equal to 1, then, the expected probability of the respondent's choice of the bundle of q_0 is equal to $E(Y)$ which is unobservable. Y is a binary choice variable, which is equal to 1 if the respondent chooses the bundle of consuming less q, otherwise 0.

$$E(Y) = \text{prob}[u^*(q_0(X_1, X_2), x_0(X_1, X_2), \varepsilon) > u^*(q_1(X_1, X_2), x_1(X_1, X_2), \varepsilon)] \quad (2)$$

Unlike the common assumption in which the dependent variable is continuous, a dichotomous dependent variable is qualitative in nature when consumers make decisions on such issues as whether to buy a car, whether to be in or out of the labor force, or whether to increase their consumption of a given food (Blaylock and Blisard, 1993). When economists deal with a discrete choice model, the binary nature of the dependent variable needs special estimation processes. There are several estimation tools for dealing with qualitative dependent variables such as the linear probability model, the probit model, the discriminate analysis, and the logit model.

This paper investigates the respondents' pork consumption behavior by the probit and logit models. The linear probability is not used in this research because the estimated probabilities could lie outside the (0,1) range which conflict with the conditional expectation as a probability. The discriminate analysis is very similar to the linear probability model and is less efficient in classification, therefore, it is not employed in this research (Amemiya, 1981).

The impact of FMD on pork consumption is treated as a binary choice of whether the respondent reduces the pork consumption. Many empirical studies dealing with a qualitative dependent variable are justified by positing a random utility assumption (Maddala, 1983 ; Hanemann, 1984 ; Shih, 1987). The study follows such an assumption. The model assumes that the respondent's choices are observable but some of the explanatory variables are unobservable.

Equation (2) indicates that the expected value of the discrete choice between no FMD outbreak and FMD outbreak depends upon the exogeneous attributes of pork and traits of the

respondent. The empirical specification of the dichotomous model is

$$\begin{aligned} \text{YT3} = \phi(\alpha_0 + \alpha_1\text{INCOME} + \alpha_2\text{EDU} + \alpha_3\text{CITY} + \alpha_4\text{FEAR} + \alpha_5\text{BLACK} \\ + \alpha_6\text{DAMAGE} + \alpha_7 TRUST) + \text{E} \end{aligned} \tag{3}$$

Where ϕ represent the cumulative distribution function. The dependent variable, YT3, is equal to 1 if the consumer still reduce the pork consumption after the third month of the FMD outbreak and otherwise YT3 = 0. The dependent variable can be replaced by either YT6 or YT9 which represent the reduction in pork consumption after the sixth or ninth month of the FMD epidemic, respectively.

The choice of exogeneous attribute variables such as consumer preferences of black pork, warm pork, and experiences of food safety problem, and concern about the effect of FMD on human being are includes in the questionnaire. A traditional variety of black pig with better taste in the market is special considered. Due to the preference of warm pork, the marketing system also provides warm pork in addition to cool and frozen pork. Another question is whether or not consumer who has experienced food safety problem within the past five years tends to reduce pork consumption due to FMD outbreak. Because people have no experience about FMD, whether or not the respondent fear accidentally eating pork from FMD-infected pigs and whether or not he trust the government's statement "There is no health problem even if consumers accidentally eat pork from FMD-infected pigs." Are both added to the questionnaire. A special concern is placed on whether the respondent trust the government's "CAS" certificate and whether he trust the quality of brand product. The respondent's opinion toward the potential harm if consumer accidentally eats pork from FMD-infected pigs is considered. The respondent's personal characteristics including age, gender, education, family size, income, and residence are also embodied in the questionnaire (Table 1).

In the empirical estimations, some of the above variables are not statistically significant in t values so as to be omitted in the estimation. The explanatory variables of equation (3) are specified to include a set of discrete variables representing the respondent's place of residence

Table 1 Variable Definition and Sample Statistics

Variable	Definition	Mean	Standard deviation
YT3	Pork consumption still decreases after the third month of the FMD epidemic = 1; otherwise = 0	0.7153	0.4518
YT6	Pork consumption still decreases after the sixth month of the FMD epidemic = 1; otherwise = 0	0.5762	0.4947
YT9	Pork consumption still decreases after the ninth month of the FMD epidemic = 1; otherwise = 0	0.3700	0.4833
BLACK	Prefer to buy native black pork = 1; otherwise = 0	0.4395	0.4969
WARM	Prefer to buy fresh warm pork = 1; frozen and cool pork = 0	0.3184	0.4664
POISON	Experiences of food safety problem within the past five years = 1; otherwise = 0	0.1140	0.3186
CONCERN	Are you concerned about the effect of FMD on human being? If the respondent is definitely concerned = 1; if moderately concerned = 2; if neutral = 3; if not very concerned = 4; if definitely not concerned = 5	3.8946	0.9338
FEAR	Do you fear accidentally eating pork from FMD-infected pigs? If the respondent is extremely fearful = 1; if moderately fearful = 2; if neutral = 3; if not fearful = 4; if not at all afraid = 5	2.1637	0.9229
TRUST	Do you trust the government's statement" There is no health problem even if consumers accidentally eat pork from FMD infected pigs" ? If the respondent does definitely not trust = 1; if does not trust = 2; if neutral = 3; if moderately trusts = 4; if trusts = 5	2.5269	1.0114
CTRUST	Do you trust the government's "CAS" certificate? If the respondent definitely does not trust = 1; if does not trust very much = 2; if neutral = 3; if moderately trusts = 4; if definitely trusts = 5	3.3161	0.9766

Table 1 Variable Definition and Sample Statistics (continued)

Variable	Definition	Mean	Standard deviation
BTRUST	Do you trust the quality of brand products from big pork packing companies? If the respondent definitely does not trust = 1; if does not trust very much = 2; if neutral = 3; if trusts moderately = 4; if definitely trusts = 5	3.1211	0.9403
DAMAGE	Do you think it will harm consumers if they accidentally eat pork from FMD-infected pigs? If the respondent thinks it will harm = 1; otherwise = 0	0.8117	0.3914
AGE	Age of the respondent (in years)	43.2170	10.3500
GENDER	If the respondent is male = 1; otherwise = 0	0.1076	0.3103
EDU	Years of formal education (in years)	10.7470	3.6536
SIZE	Number of persons in the household	4.6614	1.8359
INCOME	Monthly household income (in ten thousand NT dollars)	6.7578	3.5864
NONCITY	If the respondent lives in rural areas (noncity) = 1; otherwise = 0	0.3991	0.4903

Note: City denotes where the agricultural population is less than 10 percent of the total population in that area. In the questionnaire, however, the respondent's residence is divided into rural and not rural areas.

(NONCITY), fear of accidentally eating pork from FMD-infected pigs (FEAR), public opinion toward the government (TRUST), opinion toward the potential harm if consumers accidentally eat pork from FMD-infected pigs(DAMAGE), and preference for buying native black pork (BLACK).

In addition, the respondent's education (EDU) and his monthly household income (INCOME) are taken into account. The respondent's residence in the questionnaire is divided into rural and not rural areas. If the respondent lives in rural areas = 1, otherwise = 0. Here, the respondent who does not live in city (NONCITY) is analogy as those who lives in rural areas. The probit and logit models estimated the equations.

Data

The data were collected from a personal survey of Taiwan residents in 1997. A convenient sampling data of 500 households was drawn by 1 from every ten thousand households. However, the survey did not include Penghu County because it is geographic isolated from Taiwan Island. All questionnaires were returned. However, a total of 446 returned questionnaires with complete information were used for the analysis (Table 2).

The survey questionnaire was designed to assess consumers' pork consumption behavior after the FMD epidemic. Respondents were asked about their preference for pork, their knowledge of and attitudes forwards the outbreak of FMD, and general demographic information such as income, age, gender, education, and family size. In particular, respondent was asked if his pork consumption had still decreased after the third month of the FMD epidemic. Then the same question was repeated but emphasized different time periods such as the sixth or the ninth month after the outbreak of the FMD epidemic for comparison.

Overall, the survey indicates that about 72 percent of the respondents' pork consumption still reduced after the third month of the FMD outbreak. Fifty-eight percent or 37 percent of the respondents still reduced their pork consumption after the sixth and the ninth month, respectively, after the FMD outbreak. The result shows that the FMD epidemic has a significantly negative impact on pork consumption (Table 1).

Consumers in Taiwan like to eat a special species of native black pig normally called "Black Pig". Forty-four percent of the respondents indicate that they prefer black pork. In addition, they prefer to buy warm pork from traditional markets that handles pork without any cool or frozen storage and transportation facilities. Many people think that fresh warm pork provided by the traditional market has a better taste than cool or frozen pork. Statistics showed that Thirty-two percent of the respondents prefer to buy fresh warm pork from traditional markets. These special preferences are important to pork consumption and pork marketing system because the traditional markets might lack of adequate veterinary inspection of pork quality.

Table 2 The Number of Households and Selection of the Sample

Code	Area	NONCITY[a]	No. of households	Percentage	No. of survey	No. of usable questionnaires
1	Keelung City	0	100,810	1.79	10	9
2~4	Taipei City	0	910,571	16.16	80	75
5~7	Taipei County	0	832,424	14.77	75	68
8	Yilan County	1	111,928	1.99	10	6
9~10	Taoyuan County	0	380,327	6.75	35	33
11	Hsin chu County	0	92,613	1.64	10	6
12	Hsinchu City	0	88,822	1.58	10	9
13	Miaoli County	1	126,176	2.24	10	9
14~15	Taichung County	1	334,186	5.93	30	27
16	Taichung City	0	237,306	4.21	20	19
17	Nantou County	1	135,161	2.40	10	8
18	Changhwa County	1	284,535	5.05	25	22
19	Yunlin County	1	181,333	3.22	15	14
20	Chiayi County	1	137,988	2.45	10	10
21	Chiayi City	1	69,559	1.23	5	3
22	Tainan County	1	280,233	4.97	25	23
23	Tainan City	0	197,706	3.51	20	20
24	Kaohsiung County	1	313,518	5.56	30	30
25~26	Kaohsiung City	0	412,275	7.32	35	29
27	Pingtung County	1	223,916	3.97	20	15
28	Taitung County	1	65,926	1.17	5	5
29	Hwalian County	1	94,155	1.67	10	5
-	Penghu County [b]	1	24,468	0.43	–	–
	Taiwan Area	–	5,635,936	100.00	500	446

Note: a. If the respondent lives in city = 0; otherwise = 1.

b. The survey does not include Penghu County because there is no FMD epidemic in Penghu County and it is geographically isolated from Taiwan Island.

Consumers' knowledge and attitude about food safety are interesting. Eleven percent of the respondents experienced some food safety problem during the past five years. Generally speaking, the respondents are not concerned about the effect of FMD on the human health. However, they are still concerned about accidentally eating pork from FMD-infected pigs. Although the government reiterated that there was no health problem even if consumers accidentally eat pork from FMD-infected pigs, the respondents do not trust the government's statement. However, the surveys show that the respondents have some confidence in CAS products and take neutral attitude toward the quality of branded products from big pork packing companies. But 81 percent of the respondents still think that there may be some danger if consumers accidentally eat pork from FMD-infected pigs.

The results of the demographic variables show that the average age of the respondents is 43 years old. Eleven percent of the respondents are male because of the fact that many housewives buy food for their families. The average time of formal education is 11 years and the average number of persons in the household is 4.66 persons. The average monthly household income is 67,600 NT dollars. Sixty percent of the respondents live in cities where the agricultural population is less than 10 percent of total population in that area.

Empirical Results

Both probit and logit models are estimated based on the method of maximum likelihood. The maximum likelihood estimates of the probit and logit models are presented in Table 3. For testing the hypotheses about the coefficients, the t tests, using the standard errors from the information matrix is employed. In addition, to test that all the slope coefficients in the probit or logit model are zero, the likelihood ratio test is employed. The likelihood ratio statistic is LR $= -2[\ln Lr - \ln L]$, where Lr and L are the restricted and unrestricted likelihood functions, respectively. For this test, the constant terms remains restricted. The unrestricted log-likelihood is the same for both probit and logit models, $\ln Lo = n[P\ln P + (1-p)\ln(1-P)]$, where P

is the proportion of the observations that have dependent variable equal to 1. For the first equation of YT3, the log-likelihood ratio statistic of probit estimate is 153.146 with degrees of freedom 7. The log-likelihood ratio statistic shows that the estimation is statistical significant.

The goodness of fit for the model is shown by the McFadden's R^2 of 0.2874 (McFadden, 1974). The potential uses of probit and logit models are to predict whether or not an event will occur given the explanatory variables. In addition, applying the 50-50 criteria, the event could be predicted to occur if the probability is greater than 0.5. Based on the criteria, a measure frequently reported is the ratio of correct predictions. The correct predictions of the probit specification are approximately 82.74% (Greene, 1997).

Table 3 Pork Consumption Behaviors after the Third Month of the FMD Epidemic

Variable	Probit model			Logit model		
	Coefficient	t-ratio	Marginal probabilities	Coefficient	t-ratio	Marginal probabilities
INCOME	0.0424	1.9895**	0.0144	0.0749	1.9466**	0.0153
EDU	0.0593	2.8126***	0.0201	0.1067	2.8381***	0.0217
NONCITY	−0.2618	−1.7319**	−0.0888	−0.4217	−1.5915**	−0.0859
FEAR	−0.4848	−5.3295***	−0.1645	−0.8537	−5.2253***	−0.1739
BLACK	0.6415	4.0102***	0.2177	1.1135	3.8977***	0.2268
DAMAGE	0.5682	3.0120***	0.1928	1.0074	3.1548***	0.2052
TRUST	−0.1777	−2.2129**	−0.0603	−0.3110	−2.2641**	−0.0633
CONSTANT	0.6867	1.6283*		1.1311	1.5538*	
Iteration		4			4	
Log-likelihood ratio[a]		153.146			153.751	
McFadden R^2		0.2874			0.2885	
Correct predictions		0.8274			0.8274	
Ratio[b]		0.7152			0.7152	

Note: *, **, *** indicate that the estimated coefficient is significantly different from zero at the 0.10, 0.05, and 0.01 significant level, respectively.

a. The log-likelihood ratio statistic is distributed as chi-square with degrees of freedom 7.

b. Ratio of non-zero observations to the total number of observations.

The results show that all but the constant term among the explanatory variables in the equation of YT3 are statistically significant at a 5% level or better. Four of the statistically significant variables, INCOME, EDU, BLACK, and DAMAGE, have positive signs. That is to say, the higher the household income and/or the well-educated people, the greater possibility to reduce pork consumption after the FMD epidemic. The result is consistent with the fact that high income and well-educated people are more aware of food safety issues. Those who prefer native black pork are bothered by FMD-infection and tend to reduce pork consumption more than those who do not prefer native black pork. Because almost most native black pork is sold through traditional marketing channels which are unregulated and require no veterinary inspections. Therefore, consumers who prefer native black pork tend to reduce pork consumption more than those who do not prefer native black pork. When the respondent is asked if he/she think it will cause harm if he/she accidentally eat pork from FMD-infected pigs, the variable, DAMAGE, is equal to 1; otherwise 0. The variable, DAMAGE, has a positive sign. This shows that although the veterinarian reiterates that there will be no harm even if consumers accidentally eat pork from FMD-infected pigs, the survey results indicate that consumers are still afraid of possible harm. The rest of significant variables, NONCITY, FEAR and TRUST, have negative signs which show that people who live in city areas tend to reduce pork consumption after an FMD epidemic more than those who live in rural areas. People who do not fear accidentally eat pork from FMD-infected pigs do not reduce their pork consumption after an FMD epidemic. People who trust the government's statement " There is no health problem even if consumers accidentally eat pork from FMD-infected pigs. " do not reduce their pork consumption after the epidemic.

Table 3 also reports the estimated marginal change in the probability of reducing pork consumption after the third month of the FMD epidemic for each of the statistically significant explanatory variables. For the logistic distribution, the dependent variable will vary with the value of any selected explanatory variable. The marginal effects refer to the probability change of dependent variable subject to a unit percent change of any selected explanatory variable. It can be seen from Table 3 that consumers living in city areas are 9% more likely to reduce their pork consumption after the third month of the FMD epidemic than those living in rural areas.

This may be due to the fact that the city people have more information about the FMD epidemic, and more food substitutes for pork available in city areas. In addition, they are also more food safety or health conscious. On the other hand, households with higher incomes or advanced education have been more likely to reduce pork consumption after the third month of an FMD epidemic than those who have lower income or less educated. A unit percent change of income and education would cause changes of 1.44% and 2.01% in the probabilities, respectively.

The maximum likelihood estimates of the logit model are presented in Table 3 for comparison. The logit model is usually used to replace the probit model because it can obtain similar results through easier methods of estimation. For the first equation of YT3, the log-likelihood ratio statistic of logit estimation is 153.751 with degrees of freedom 7. The goodness of fit for the model is shown by the McFadden's R^2 of 0.2885. The correct predictions of the logit specification are approximately 82.74% where the ratio of non-zero observations to the total number of observations is 71.52%. All the estimated parameters of the logit model are similar to those of the probit model in signs, sizes, and the marginal probabilities.

The dependent variable, YT6, studies closely and systematically whether households still reduce their pork consumption after the sixth month of the FMD epidemic. The log-likelihood ratio statistic of the probit estimation is 252.126 with degrees of freedom 7. The goodness of fit for the model is shown by the McFadden's R^2 of 0.4148. The correct prediction of the probit specification is 83.86% where the ratio of non-zero observations to the total number of observations is 57.62% (Table 4).

The results show that all explanatory variables in the equation of YT6 have the same sign as those in the case of YT3 except the variable, TRUST, which is not statistically significant at a 5% level.

The marginal probabilities of the significant explanatory variables are similar to those in the case of YT3. However, the marginal probability of TRUST is not provided because it is insignificant at 5% level.

Table 4 Pork Consumption Behavior after the Sixth Month of the FMD Epidemic

Variable	Probit model			Logit model		
	Coefficient	t-ratio	Marginal probabilities	Coefficient	t-ratio	Marginal probabilities
INCOME	0.0536	2.4449***	0.0210	0.0973	2.4983***	0.0238
EDU	0.0491	2.2199**	0.0192	0.0887	2.2829**	0.0217
NONCITY	−1.5653	−10.033***	−0.6130	−2.7307	−9.4640***	−0.6668
FEAR	−0.4050	−4.2410***	−0.1586	−0.7275	−4.1646***	−0.1776
BLACK	0.7660	4.9147***	0.3000	1.3651	4.8858***	0.3333
DAMAGE	0.5522	2.6341***	0.2163	1.0088	2.7193***	0.2463
TRUST	−0.1365	−1.5967*		−0.2334	−1.5632*	
CONSTANT	0.4463	1.0216		0.6673	0.8764	
Iteration		4			5	
Log-likelihood ratio[a]		252.126			253.027	
McFadden R^2		0.4148			0.4163	
Correct predictions		0.8386			0.8363	
Ratio[b]		0.5762			0.5762	

Note : *, **, *** indicate that the estimated coefficient is significantly different form zero at the 0.10, 0.05, and 0.01 significant level, respectively.

a. The log-likelihood ratio statistic is distributed as chi-square with degrees of freedom 7 .

b. Ratio of non-zero observations the total number of observations.

A model concerns whether the respondent still reduce his pork consumption after the ninth month of the FMD epidemic is applied. The log-likelihood ratio statistic of probit estimation of equation, YT9, is 196.492 with degrees of freedom 7. The goodness of fit for the YT9 equation is shown by the McFadden's R^2 of 0.3237. The correct predictions of the probit specification are approximate 78.03% where the ratio of non-zero observations to the total number of observations is 37.00%.

Two variables, NONCITY and FEAR, are statistically significant at a 5% level though the correct prediction is still acceptable. Some explanatory variables may not be so important after the ninth month of the outbreak. Then only NONCITY and FEAR are used to estimate, both variables are statistically significant. However, the correct predictions reduce to 78%.

Table 5 Pork Consumption Behavior after the Ninth Month of the FMD Epidemic

Variable	Probit model			Logit model		
	Coefficient	t-ratio	Marginal probabilities	Coefficient	t-ratio	Marginal probabilities
INCOME	0.0089	0.4124		0.0119	0.3261	
EDU	0.0187	0.8647		0.0346	0.9478	
NONCITY	−2.0305	−9.7827***	−0.7666	−3.6449	−8.3094***	−0.8496
FEAR	−0.2966	−3.0224***	−0.1120	−0.5199	−3.0324***	−0.1212
BLACK	0.2409	1.6296*		0.4000	1.6085*	
DAMAGE	0.2428	1.1343		0.4217	1.1896	
TRUST	−0.0057	−0.0686		0.0026	0.0186	
CONSTANT	0.2620	0.6112		0.4186	0.5886	
Iteration		5			5	
Log-likelihood ratio[a]		196.492			196.415	
McFadden R^2		0.3237			0.3342	
Correct predictions		0.7803			0.7848	
Ratio[b]		0.3700			0.3700	

Note : *, **, *** indicate that the estimated coefficient is significantly different from zero at the 0.10, 0.05, and 0.01 significant level, respectively.

a. The log-likelihood ratio statistic is distributed as chi-square with degrees of freedom 7.

b. Ratio of non-zero observations to the total number of observations.

Generally speaking, all of the three equations show correct predictions and goodness of fit. The estimated parameters of YT3 and YT6 are statistically significant but some of those estimated parameters have become insignificant of YT9. For the third equation of YT9, the log-likelihood ratio statistics for the probit and logit estimations are 196.492 and 196.415 with 7 degrees of freedom. The goodness of fit for the probit and logit models are shown by the McFadden's R^2 of 0.3237 and 0.3342, respectively. The correct predictions of the two models are approximately 78.03% and 78.48% where the ratio of non-zero observations to the total number of observations is 37.00% (Table 5).

All the estimated parameters of the logit model are similar to those of the probit model in signs, sizes, and the marginal probabilities.

Summary and Conclusion

A personal survey of 500 randomly selected Taiwan households, yielding 446 completed survey respondents, was employed to assess consumer concerns about the FMD epidemic in the pork industry. The results of survey indicate that about 72 percent of the respondents consumed less pork after the third month of the FMD epidemic. However, the negative impact of the FMD epidemic on pork consumption has diminished significantly 58% after the sixth month and to 37% after the ninth month. The results show that high income and/or educated people tend to reduce pork consumption after the third month of the FMD epidemic that is consistent with the fact that high income and well-educated people are more aware of food safety issues. Moreover, consumers' fear and opinions about the potential ill effects from eating pork from FMD-infected pigs, and their confidence in the government's statement about the health problem of FMD are all important factors in the consumers' pork consumption decision. The results imply that the government needs to provide more food safety information and do more in public sanitation to build consumers' confidence. The geographic variable, NONCITY, indicates that people who live in rural or city areas have different responses to the FMD epidemic. In addition, it is interesting that those who prefer native black pork have reacted significantly more negatively to the FMD epidemic.

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消費者對動物傳染病爆發的反應毛豬口蹄疫爆發實證分析

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摘　要

關鍵字：口蹄疫、Probit 模型、Logit 模型

本文旨在從消費者人口統計變數、經濟變數等探討消費者對台灣在 1997 年爆發的毛豬口蹄疫傳染病的反應及其對豬肉消費的影響。

為了分析消費者對豬肉的偏好與態度受口蹄疫爆發的影響，特別針對全台灣的消費者進行抽樣人員訪問。問卷內容包括消費者對口蹄疫所引發的食品安全知識與態度等相關議題。文中依消費經濟理論，以 Probit 和 Logit 模型估計之。結果顯示口蹄疫爆發對豬肉的負面影響極為顯著。特別是所得愈高，教育年數愈高或都市地區居民受到的負面影響程度愈大。本研究結果發現都市與鄉村居民因口蹄疫爆發而減少消費豬肉，其減少豬肉消費的行為可能隨時間改變而漸減。

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