

Estimating the Income and Substitution Effects on the Demand for Poultry Meat

ZAINALABIDIN MOHAMED and ROSLAN A. GHAFFAR

*Department of Economics,
Faculty of Economics and Management
Universiti Pertanian Malaysia
43400 UPM Serdang, Selangor Darul Ehsan, Malaysia*

Key words: Poultry meat; demand; Slutsky equation; elasticity.

ABSTRAK

Kertas kerja ini cuba menganalisis dan menentukan faktor-faktor yang mempengaruhi permintaan daging ayam di Malaysia. Secara Spesifik, ianya cuba melihat perubahan terhadap permintaan daging ayam yang disebabkan oleh perubahan harga, pendapatan dan juga terhadap perubahan harga barang-barang yang berkaitan dalam pasaran daging. Dua model permintaan daging ayam telah diuji, ianya adalah persamaan tunggal dan persamaan pembolehubah 'instrumental'. Di samping itu juga persamaan Slutsky juga digunakan untuk menganggar kesan pendapatan dan gantian terhadap daging ayam dibandingkan dengan daging-daging yang lain. Analisis menunjukkan bahawa daging ayam adalah barang biasa dan daging lembu dan babi adalah barang pengganti bagi daging ayam. Walau bagaimanapun keputusan yang bercampuran didapati di antara hubungan daging ayam dengan ikan. Berdasarkan kepada kesan penggantian dan keanjalan silang harga, didapati permintaan ikan adalah tidak berkait dengan barang-barang lain.

ABSTRACT

This study attempts to analyse the factors underlying the demand and consumption trends of poultry meat in Malaysia. Specifically, it explores the poultry meat consumption due to changes in prices and income and the interaction in demand between poultry meat and the components of the rest of the meat market. To obtain the parameters of the demand model for poultry meat, two estimation techniques were used in estimating the demand model, namely single and instrumental variables approach, while Slutsky equations were utilized to estimate the income and substitution effects of poultry meat with the other components of the meat market. The results indicate that poultry meat is a normal good while both beef and pork are substitutes to poultry meat. However, mixed results were obtained for poultry meat and fish. Based on the magnitude of the substitution effect and cross price elasticity, it is concluded that the demand for fish is independent of the other components of the meat market.

INTRODUCTION

This study attempts to estimate and evaluate the consumption pattern of poultry meat. Specifically this paper explores the effect on poultry meat consumption due to changes in prices and income of the consuming population. Also included in the analysis is the nature of the interaction in the demand between poultry meat

and the components of the rest of the meat market.

This study is motivated by several reasons. First, despite the impressive growth of the Malaysian poultry sector¹, a review of the literature reveals that there is inadequate information with regard to the demand structure of poultry meat and its implications on the rest of

¹ A recent account of the developments in the poultry sector are given in Mohamed *et al.* (1988).

the red meat subsectors. A few empirical studies that have been conducted include those by Ng Yoke Yen (1976) and by Lee Peng Seng (1980). Considering that these studies are quite dated, more recent information on poultry meat demand is warranted.

Poultry meat is one of the several meats available in the Malaysian market. Questions pertaining to the substitutability or complementarity of poultry meat with respect to the other meats (eg. mutton, pork and beef) also need to be answered. It is reasonable to consider the demand for poultry meat to be less responsive to price changes as it is acceptable to all communities in Malaysia. This question, however, has not been rigorously investigated. An attempt along this line can be gleaned from the study done by Mohamed *et al.* (1988). The present study, however, differs in the sense that it also makes use of the Slutsky equation to measure the net substitutability/complementarity of poultry meat with other meats. In order to analyse the substitutability or complementarity effect of poultry meat on other meats, two models will be presented. The first model is a linear demand equation for poultry meat. Parameter estimates from this model are then used in model II which is basically the Slutsky equation to obtain the mean substitution effect between poultry meat and the rest of the meat products. Thus from such an analysis, the net substitution or complementarity between poultry meat and other commodities mentioned can be measured.

The rest of this paper is presented in three sections. The method and data used in this study will be presented in the following section. In section three the empirical results and some discussion on the results will be presented. The last section provides our summary and conclusion.

THE MODEL SPECIFICATION

Model I

The demand function for poultry meat can be written as follows

$$Q_a = f(P_a, P_b, P_p, Y_f, U) \quad (1)$$

where

Q_a = aggregate per capita consumption of poultry meat (kg)

P_a = retail price of poultry meat (\$/kg)

P_b = retail price of beef (\$/kg)

P_p = retail price of pork (\$/kg)

P_f = aggregate retail price of fish (\$/kg)

Y_f = aggregate per capita income (\$/year)

U = random disturbance terms

The signs of the variables appearing on the right hand side are expected to conform to demand theory. The sign upon own price is expected to be negative, which implies an inverse relationship between price and the commodity consumed. The substitute or competing and complementary items are expected to have a direct and inverse relationship, respectively, with the commodity consumed. In this regard the expected sign is positive and negative respectively. Lastly, a positive relationship is also expected between the commodity consumed and the aggregate per capita income.

A linear additive form of equation was utilized to analyse the demand function. In this case, two versions of the demand equation for poultry meat were formulated and estimated using two different techniques, namely Ordinary Least Squares (OLS) and the Instrumental Variables (IV) approach.

Model II

The second model is the comparative statics of the utility maximization model in the form of Slutsky equations which can be presented as

$$\left(\frac{\delta X_i^y}{\delta P_j}\right)_y = \left(\frac{\delta X_i^u}{\delta P_j}\right)_u - X_j^y \left(\frac{\delta X_i^y}{\delta Y}\right)_p \quad (2)$$

where

X_i = quantity of the *i*th commodity demanded

P_j = price of *j*th good

Y = per capita income

The alphabets *y*, *u*, and *p*, which appear as subscript and superscript in equation (2) indicate income, utility and price, respectively, and are held constant.

The Slutsky equation can be broken up conceptually into two parts. The first term on the right hand side of equation (2) is the pure substitution effect, or a response to a price change holding the consumer on the original

indifference surface. The second term on the right is the pure income effect where income is changed, holding price constant, to reach a tangency on the new indifference curve. Invoking the envelop theorem (Silberberg, 1978) for the cost minimization problem, the substitution effect can also be written as

$$\left(\frac{\delta X_i^u}{\delta P_j}\right)_y = \left(\frac{\delta X_i^y}{\delta P_j}\right)_u - X_j^y \left(\frac{\delta X_i^y}{\delta Y}\right)_p \quad (3)$$

In short, equation (3) can be further rewritten as

$$K_{ij} = \frac{\delta X_i^u}{\delta P_j} \quad (4)$$

where X_i , P_j and Y , and δ^* , y and p are defined as before.

According to Philips (1974) the total effect of price changes $\delta X_i^y/\delta P_i$ is negative if $\delta X_i^y/\delta Y > 0$, or if $\delta X_i^y/\delta Y < 0$ and $|\delta X_i^y(\delta X_i^y/\delta Y)| < |K_{ij}|$, which applies for normal good. The total effect of a change in price, $\delta X_i^y/\delta P_i$ can be positive if $\delta X_i^y/\delta Y > 0$ and $\delta X_i^y(\delta X_i^y/\delta Y) < |K_{ij}|$, which is the case for Giffen paradox. Hence the good is superior if $\delta X_i^y/\delta Y > 0$, and inferior if $\delta X_i^y/\delta Y < 0$.

On the other hand as indicated by Hick's (1946), based on total substitution effect, K_{ij} , goods i and j are classified as substitutes, complements or independent depending on whether K_{ij} is positive, negative or zero, respectively.

Thus given the means of the observed value of X_j ($X_j = 1, 2$ and 3), that is, the three main variables in equation (1) and the regression coefficients estimated from the equation, the substitution and income effect between poultry meat and other meat can be estimated through Model II.

Source of Data

Yearly time series data have been used for the period 1960-1984 and were obtained from various sources. Consumption data were obtained from the Division of Veterinary Services (DVS), while data on price were obtained from various FAMA (Federal Agricultural Marketing

Authority) bulletins. Population, income and consumer price index (CPI) were obtained from various Malaysia Plans and Economic Reports. All retail prices and income data were deflated by CPI (1967 = 100). The per capita consumption figures were derived by dividing the total consumption with the total consuming population.

RESULTS AND DISCUSSION

The estimation procedure used for estimating the demand equation was ordinary least square (OLS) with Cochrane-Orcutt Iterative Technique (COIT) to adjust for serial correlation for the single equation. Since we are also estimating the aggregate demand equation for poultry meat in a system of equations, the instrumental variables technique (IV) were utilized to alleviate the simultaneity bias. The instrumental variables chosen in this case are P_b , P_p and P_r .

The results for both OLS and IV estimator of model I are presented in Table 1. The results for the linear equation show that, except for Pf which has a negative sign, the signs on Pa, Pb, Pp and Y are met as expected. Although the expected signs on all variables, except fish, do conform to demand theory, statistically, these variables are not significant at the 10% probability level. The adjusted coefficient of determination (R^2) is 0.96 which indicates that approximately 96% of the variation in poultry meat consumption can be explained by the variation in the exogenous variables. For the IV estimator, the results in Table 1 show an improvement in the significance of the variables in the model especially for pork price and per capita income. However, the adjusted coefficient of determination was also 0.96²

Thus given the estimated coefficients from Model I, Model II can be estimated without difficulty. Table 2 presents the substitution, income and total effect for both OLS and IV approaches.

The results as presented in Table 2 show that the total effect of a change in own price is negative which indicates that poultry meat is a normal good. While according to Hick's de-

² Another demand model was estimated for both OLS and IV approaches by dropping the price of fish from the model. All variables do conform to demand theory. However the coefficient, R^2 and level of significance do not differ from Model I.

finition, both poultry meat and beef, poultry meat and pork are substitutes. However, the results obtained for poultry meats and fish generated by the OLS and IV approaches are mixed. In the single equation approach, the substitution effect indicates that poultry meat and fish are substitutes while in the simultaneous equation it is a complement. Nevertheless, the total effect indicates that both poultry meat and fish are complementary to each other.

TABLE 1
Estimated regression coefficients and summary statistics for poultry meat demand equation

Variable	OLSa	IVa
Intercept	12.029	1.9603
P_a	- 3.9824 (1.0944)*	- 2.5751 (0.7123)*
P_b	0.8976 (0.8962)	0.7907 (0.8192)
P_p	0.4019 (0.5674)	2.4948 (1.0701)
P_f	- 0.0060 (0.2532)	- 0.2091 (- 0.2488)
Y	0.0095 (0.0120)	0.0022 (0.0046)**
Adjusted R ²	0.96	0.96
F - Statistics	102.50	133.93

^a Figures in parentheses are standard errors
* Significant at 5% probability level
** Significant at 10% probability level

The question now arises as to what level or magnitude of the substitution effect can indicate the degree of independence of the two commodities. Nicolaou (1977) suggests that if the value obtained is around 0.2 and below, it could be considered as an independent good. Alternatively, according to Johnson, *et al.* (1984) using the elasticities one could also tell the substitutability and complementarity of two goods. Table 3 presents the elasticity coefficients calculated at the mean of the observed values for poultry meat with respect to its own price (P_a), P_b , P_p , P_f and Y for both OLS and IV approaches. For the OLS equation, the own price elasticity for poultry meat is elastic at -1.2

indicating that poultry meat is a normal good. Beef appears to be the stronger substitute for poultry when compared with pork, which is consistent with the finding in Model II. However the cross-elasticity between poultry meat and fish is very inelastic, almost approaching zero.

TABLE 2
Estimated substitution, income and total effects of poultry meat with respect to other meat: Model II

	OLS	IV
Substitution effect (SE)		
K_{aa}^*	- 3.9081	- 2.453
K_{ab}	0.9150	0.7944
K_{ap}	0.4091	2.5116
K_{af}	0.2078	- 0.1596
Income effects (IE)		
I_{aa}	0.0739	0.0171
I_{ab}	0.0174	0.0040
I_{ap}	0.0724	0.0168
I_{af}	0.2138	0.0495
Total Effect (TE)		
T_{aa}	- 3.9819	- 2.4701
T_{ab}	0.8976	2.4948
T_{ap}	0.3367	2.4948
T_{af}	- 0.006	- 0.2091

*The subscript ab, ap and af indicates that IE, SE and TE of poultry meat and beef, poultry meat and pork, and poultry meat and fish respectively.

TABLE 3
Estimates of elasticities of demand for poultry meat

	Poultry	Beef	Pork	Fish	Income
OLS	- 1.244	0.428	0.138	- 0.0014	0.168
IV	- 0.777	9.369	0.835	- 0.047	0.377

On the other hand the own price elasticity was inelastic in the case of the IV approach. However, pork seems to be a stronger substitute than beef, which is opposite to the OLS results. Again the cross-elasticity of poultry meat with respect to fish is very inelastic. Thus from the above discussion one can conclude that fish is an independent good with respect to poultry

meat consumption. It is to be noted that, the results pertaining to the substitution effect or income effect, total effect, and elasticities depend upon whether the mean of X_j ($j = 1, 2$ and 3) provide realistic value for X_j , whether or not K_{ij} is significant, and lastly, whether or not the model is correctly specified.

CONCLUSION

This study is an attempt to estimate the demand for poultry meat in Malaysia. The variables were selected based on economic theory and a priori expectation. The results indicate that poultry meat is a normal good while both beef and pork are substitutes to poultry meat. Mixed results were obtained between poultry meat and fish. It is concluded that fish is an independent good based on the magnitude of the substitution effect and cross price elasticity. Hence the results from Model II and the computed elasticity values are generally consistent.

The change in income was also found to generate little response in poultry meat consumption as indicated by the income elasticity. The results seem to be in conflict with the value of 1.9 and 1.02 obtained by Ng Yoke Yen (1976) and Lee Peng Seng (1980) respectively. While differing sampling periods and estimation procedures may contribute to the difference, one can also be comfortable with the idea that poultry meat may no longer be a luxury item as it was twenty years ago. Thus there is a great potential for the expansion of poultry meat consumption as it is appealing to every class of the population.

REFERENCES

- DIVISION OF VETERINARY SERVICES. Various reports.
- FAMA. Various issues of FAMA Bulletin.
- HICKS, J.R. 1946. *Value and Capital*, 2nd ed. Oxford: Oxford University Press.
- JOHNSON, R.S, ZUHAIR HASSAN and R.D. GREEN. 1984. *Demand System Estimation Method and Applications*. Ames: The Iowa States University Press.
- LEE PENG SENG. 1980. Demand Analysis of Live-stock Meat in Peninsular Malaysia. Unpublished Project paper, Universiti Pertanian Malaysia.
- MALAYSIA. Ministry of Finance. Economic Reports, various issues.
- MALAYSIA PLANS. Prime Minister Department. Various issues.
- NG YOKE YEN. 1976. Demand Analysis of the Live-stock Meats and Projection of the Demand for Livestock Meats and Feedstuffs in West Malaysia. Unpublished Project Paper, University of Malaya.
- NICOLAOU, G.B. 1977. The Place of Petroleum in the U.K. Fuel Market. *Applied Economics*, **9**: 167-172.
- PHILIPS, L. 1974. *Applied Consumption Analysis*. Amsterdam: North Holland.
- SILBERG. 1978. *The Structure of Economics: A Mathematical Analysis*. McGraw-Hill Book Company.
- ZAINALABIDIN MOHAMED, MAD NASIR SHAMSUDIN and ROSLAN A. GHAFAR. 1988. Staff Paper No. 2, *A Study of Demand for Poultry Meat in Malaysia*. Department of Agricultural Economics, Universiti Pertanian Malaysia.

(Received 27 July, 1988)