Determinants of Purchase Likelihoods and Amounts Spent on Meat in Malaysia: A Sample Selection System Approach

Andrew K. G. Tan, Steven T. Yen, Abdul Rahman Hasan, and Kamarudin Muhamed

A sample selection system is used to examine factors associated with likelihoods of purchase and amounts spent on fresh, frozen, and processed meats in Malaysia based on data from the 2009/10 Malaysian Household Expenditure Survey. Statistical tests support use of the sample selection system estimator over more conventional estimation procedures. Results indicate that household size, location of residence, ethnicity, age, education, and income are closely associated with patterns of household expenditures for fresh, frozen, and processed meats. Several observations are noted regarding determinants of purchase likelihoods and expenditure patterns for meat in Malaysia.

Key Words: censoring, fresh meat, frozen meat, Malaysia, processed meat, sample selection system

Malaysians have long enjoyed meat and meat products (hereafter referred to simply as meat) as staple foods in household diets. The popularity of meat there is reflected in data from the United Nations Food and Agriculture Organization (FAO) that suggest that annual per capita consumption of meat in Malaysia increased steadily between 1990 and 2009, rising more than 40 percent—from 37.2 kilograms to 52.3 kilograms. Thus, Malaysia ranked as one of the top meat-consuming countries in the Association of Southeast Asian Nations (ASEAN) region in 2009 (FAO Statistics Division 2013). This trend corroborated data from the Malaysian Household Expenditure Survey showing that average household expenditures on meat had been gradually increasing; the average annual expenditure was MYR 41.00 in 1993, MYR 50.00 in 1998, MYR 54.00 in 2004, and MYR 64.00 in 2009 (Department of Statistics Malaysia 2011).[1]

In addition to its characteristic aroma, texture, and flavor, meat is an important source of high-quality protein (amino acids) and vitamins. In adequate portions, meat is an excellent source of essential minerals for optimal health, contributes to the development and maintenance of muscles, provides energy, prevents anemia, and supports the immune system (Murphy and Allen 2003,

[1] On October 28, 2014, the exchange rate was approximately USD 1.00 = MYR 3.28.

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McAfee et al. 2010). Nevertheless, the nutritional benefits of consuming meat are tempered by concerns about potential harmful effects of meat-rich diets associated with a high intake of total fat, saturated fat, and cholesterol (Wang and Beydoun 2009). Diets loaded with fat and cholesterol have been linked to a host of chronic health disorders, including heart disease, type 2 diabetes, and certain types of cancer (Chao et al. 2005).

A review of the literature reveals a considerable body of research on the effects of meat consumption in western countries (e.g., Burton, Dorsett, and Young 2000, Newman, Henchion, and Matthews 2001, Yen and Lin 2008) but few investigations of the socio-demographic factors associated with the likelihood of purchasing meat and consumers' expenditure patterns in newly industrialized countries such as Malaysia. Ahmed and Mohamad (2007) studied consumption patterns for various types of meat in Malaysia but the scope was limited due to the sectoral nature of the data used. Tey (2008) used data on nationwide household expenditures and a single-equation Tobit (censored regression) model to investigate demand for various types of food items, including meat, with an emphasis on income and own-price elasticities. Abdullah (1997), Ishida, Law, and Aita (2003), and Tey et al. (2010) focused on price and income (expenditure) elasticities of meat with little attention to the roles of socio-demographic characteristics.

There is a need for more detailed disaggregated analyses of Malaysia's meat market. As postulated by Ahmed and Mohamed (2007), in addition to the effects of evolving relative prices and rising incomes, growth in meat consumption is associated with changes in dietary patterns, tastes, preferences, and the overall development of marketing and distribution channels. Newman and Matthews (2002) suggested that markets for various types of meat are distinctive, offering unique characteristics that meet consumer needs and complement their lifestyle choices. For instance, meat can be purchased from retailers fresh or as a frozen or processed product. Fresh meat requires preparation at home and purchases may thus be closely related to household preferences for convenience, which would likely be prevalent among younger, urban, all-working, and professional consumers (Newman, Henchion, and Matthews 2001, Newman and Matthews 2002). Consequently, household members who place a high value on convenience may prefer processed products to fresh meat. However, processed meat products often contain large amounts of salt, nitrates, and chemical preservatives that can be detrimental to human health (Wang and Beydoun 2009). As a result, household members concerned about such health-related issues may favor fresh meat over frozen or processed meat. Another factor is the capacity to store fresh and frozen products. In sum, socio-demographic characteristics associated with consumption of meat can be interpreted via a multitude of household preferences.

Our primary objective is to augment existing studies of meat consumption in Malaysia by examining socio-demographic determinants associated with purchase likelihoods and expenditure levels for fresh, frozen, and processed meat. A sample selection system approach is used to account for observed zero expenditures since the expenditure patterns for these three types of meat may be interdependent or correlated with one another. By accommodating interactions of unobserved socio-demographic characteristics across equations, system estimation produces more efficient empirical estimates than estimation of a single product. The maximum-likelihood estimation procedure used here further improves statistical efficiency relative to existing two-step estimators.

Knowledge of the socio-demographic determinants of household purchase likelihoods and expenditures for meat is relevant both to public health authorities and to marketers interested in the general dietary patterns and preferences of meat consumers.

Background Literature

Studies of meat consumption and its association with socio-demographic characteristics have gained prominence in recent years. For instance, Coffey, Schroeder, and Marsh (2011) suggested that a greater number of family members increases the quantity of ground beef demanded but decreases the quantity of beef steak demanded. Household size was found to positively influence demand for chicken broiler parts but negatively influence the quantity of pork (Davis, Yen, and Lin 2007) and poultry (Yen and Lin 2008) consumed. It therefore has been hypothesized that larger households are more likely to buy and also spend more on all three types of meat due to economies of size.

Coffey, Schroeder, and Marsh (2011) suggested that greater household incomes may account for increases in the quality of meat purchased while Tey et al. (2010) asserted that households with higher incomes are less likely to purchase white meat than low-income households. Affluent households may treat red meat as a source of daily protein despite the higher risk associated with it. We posit that households with higher incomes will exhibit a greater purchase likelihood and spend more for all three types of meat; that is, meat is a normal good.

Meat preferences may vary across regions, due in part to differences in accessibility and to an urban/rural divide with respect to time available for home cooking. Newman, Henchion, and Matthews (2001) and Newman and Matthews (2002) suggested that convenience and preparation time required prior to consumption may be important factors for urban households, leading them to prefer processed meat. Burton, Dorsett, and Young (2000) found greater likelihoods of purchasing meat and larger shares of budgets devoted to it among metropolitan consumers in Britain. Even for developing Asian countries, Ishida, Law, and Aita (2003) noted that consumption of both meat and food in general was expanding and diversifying due to rapid urbanization and lifestyle changes. Thus, largely due to time and convenience factors, we expect that metropolitan and urban households will favor frozen and/or processed meat over fresh meat.

Previous studies of meat consumption have generally used white, black, Hispanic, and Asian as ethnic/racial classifications (Yen, Lin, and Davis 2008). Malaysia has a diverse multi-ethnic population primarily composed of three ethnic groups: Malay (56 percent), Chinese (26 percent), and Indian (7 percent); other indigenous groups account for 11 percent (Department of Statistics Malaysia 2008). Thus, it is possible that differences in culture, religion, and/or taste may influence consumption of meat among these ethnic groups. For instance, consumption of pork is prohibited for the Malay Muslim majority while consumption of beef is forbidden for Hindus, who form a large part of the Indian population in Malaysia. These religious restrictions elevate poultry, making it the most sought-after meat commodity. However, we posit no *a priori* assumptions about the role of ethnicity in the likelihood of meat purchases or in expenditure patterns.

According to Burton, Dorsett, and Young (2000), female-managed households are traditionally more liable than male-managed households to buy meat,

although that tendency has been declining over time. The change has been attributed to women's increased participation in the labor force, which has resulted in greater interest in convenience-oriented meals. As in most Asian countries, men in Malaysia generally have a greater degree of decision-making power and responsibility in socioeconomic spheres while women tend to be more conscious of health and nutrition issues and thus continue to play an integral part in food purchasing decisions (Wardle et al. 2004). We expect that female household managers will be more inclined than male household managers to choose fresh meat over frozen or processed meat.

Newman, Henchion, and Matthews (2001) found that older consumers prefer meat more than younger ones and offered two potential reasons for this difference. First, households managed by older individuals may buy larger quantities of meat or spend more by buying cuts of better quality. Second, younger individuals may have a strong preference for convenience in meal preparation and thus procure less fresh meat and more processed or minced meat. In contrast, Yen, Lin, and Davis (2008) concluded that meat consumption generally declines with age in response to age-related changes in lifestyles, tastes, and preferences that are motivated by increasing concerns about health. Overall, older consumers may opt for fresh food items because of concerns about food safety and greater health consciousness.

Newman, Henchion, and Matthews (2001) noted that households headed by career professionals spend significantly less on lamb, pork, bacon, ham, chicken, and minced meat than people who have blue-collar occupations. These outcomes could result from consumers in lower socio-demographic groups refraining from consuming meat or from a negative perception of meat among those with professional social status. Career professionals may also face greater time constraints and consequently prefer time-saving meal preparations, which normally translate into less fresh meat purchased for home dining (Newman, Henchion, and Matthews 2001). Based on time and convenience considerations, we expect that white collar households will favor frozen and/or processed meat over fresh meat.

Better educated persons are less likely to consume meat and tend to spend less on red meat than less educated individuals (Yen and Lin 2008), likely because individuals with more education have better dietary knowledge and/or access to scientific information and thus may be more cognizant of the hazards of meat consumption in terms of cholesterol and risk of chronic disease. Moreover, there may be a "snob effect" in which certain types of meat consumed by better educated individuals are of superior quality to those consumed by less educated consumers (Newman, Henchion, and Matthews 2001). We thus hypothesize that greater health consciousness and concern about food safety lead better educated households to consume more fresh than frozen or processed meat.

Theoretical Framework

Our empirical specification is motivated by the discrete random utility theory. Assume that a household maximizes the random utility function subject to a fixed budget, m, for meat products:

$$\max_{\mathbf{q}}\{U(\mathbf{Dq}, c, \mathbf{s}; v) \mid \mathbf{p}'\mathbf{q} + c \leq m\} \tag{1}$$

where $\mathbf{q} = [q_1, \ldots, q_n]'$ is a vector of quantities of meat with positive prices, $\mathbf{p} = [p_1, \ldots, p_n]'$; c is a composite commodity for other meats with price normalized at unity; $\mathbf{s}$ is a vector of demographic characteristics; $\mathbf{D} = \text{diag}[d_1, \ldots, d_n]$ is a diagonal matrix with each binary indicator d_i representing a potential consumer of q_i; and v is a random disturbance term that reflects the unobservable. Assume that the deterministic component $U(\mathbf{Dq}, c, \mathbf{s})$ is strictly quasi-concave and increasing with respect to c and positive elements of $\mathbf{Dq}$. Then, solving equation 1 yields the notional demand, $\mathbf{q}^*$, for n products—a vector of optimal quantities demanded without non-negativity constraints as a function of prices and budget (Liu, Kasteridis, and Yen 2013). This constrained utility-maximization framework motivates two alternative specifications for the demand functions. First, assume that all individuals are potential consumers of q_i. In that case, $d_i = 1$ for all i and censoring of each q_i corresponds to a corner solution governed by a Tobit mechanism. Second, when an individual can otherwise be a potential nonconsumer, either $d_i = 1$ and maximum utility occurs in the interior of the choice set ($q_i > 0$) or $d_i = 0$ and $q_i = 0$ since the price, p_i, is greater than 0 by assumption. In the latter case, censoring in each q_i is governed by a sample selection mechanism. We express the notional demands as a system of equations for latent expenditures (y_i^*):

$$y_i^* = \mathbf{x}'\boldsymbol{\beta}_i + v_i, \quad i = 1, \ldots, n \tag{2}$$

where $\mathbf{x}$ is the vector of explanatory variables, $\boldsymbol{\beta}_i$ represents parameter vectors (Liu, Kasteridis, and Yen 2013), and v_i is a random error term.

Econometric Procedure

We need to address censoring in our expenditure variables to obtain consistent parameter estimates. One option is to employ models such as the Tobit system (Amemiya 1974):

$$y_i^* = \max\{0, y_i^*\}, \quad i = 1, \ldots, n \tag{3}$$

where y_i^* represents the latent variables defined in equation 2. There are several important shortcomings associated with the Tobit parameterization. First, any variable in the Tobit model that increases the probability of a nonzero value must also increase the mean of the positive values (Lin and Schmidt 1984). More importantly, the Tobit parameterization links the shape of the distribution of positive observations to the probability of positive observations. Furthermore, the relative effects of two continuous explanatory variables on the probability, conditional mean, and unconditional mean of the dependent variable are identical and equal the ratio of the corresponding coefficients. Such presumptions are questionable in the context of meat consumption and make the Tobit model unpalatable for empirical analysis (see Lin and Schmidt (1984) for additional restrictions associated with the Tobit model).

The sample selection model (Heckman 1979) features a more flexible parameterization and richer behavioral explanations for zero observations. We use the sample selection system of Yen (2005), which is an extension of Heckman's (1979) bivariate sample selection model. Consider a simplified, three-good system in which a discrete (zero or positive) outcome in each

expenditure (y_i) is represented by a binary sample selection rule (observation subscripts are suppressed for brevity),

$$\begin{aligned} \log y_i = y_i^* \quad & \text{if } \mathbf{z}'\boldsymbol{\alpha}_i + u_i > 0 \\ y_i = 0 \quad & \text{if } \mathbf{z}'\boldsymbol{\alpha}_i + u_i \leq 0 \end{aligned}, \tag{4}$$

for fresh meat ($i = 1$), frozen meat ($i = 2$), and processed meat ($i = 3$) where $\mathbf{z}$ and $\mathbf{x}$ are vectors of explanatory variables, $\boldsymbol{\alpha}_i$ and $\boldsymbol{\beta}_i$ are conformable parameter vectors, and u_i represents random errors. This sample selection system is more flexible than the Tobit system since the binary and level outcomes for each y_i are governed by separate stochastic processes. Furthermore, each dependent variable y_i in equation 4 is transformed by natural logarithm. Such transformation is common in estimation of endogenous selection and switching regression models and ameliorates potential nonnormality and heteroskedasticity of the error terms (Yen 2005, Yen and Rosinski 2008). Maximum-likelihood estimation proceeds by maximizing the sample likelihood function based on multivariate normal distribution of the error terms (Yen 2005, Liu, Kasteridis, and Yen 2013).

We calculate marginal effects of the probabilities, conditional levels, and unconditional levels to facilitate interpretation of the effects of the explanatory variables. For each good *i*, the probability of a positive observation is

$$\Pr(y_i > 0) = \Phi(\mathbf{z}'\boldsymbol{\alpha}_i) \tag{5}$$

and the conditional mean of y_i (Yen and Rosinski 2008) is

$$E(y_i \mid y_i > 0) = \exp(\mathbf{x}'\boldsymbol{\beta}_i + \sigma_i^2 / 2)\, \Phi(\mathbf{z}'\boldsymbol{\alpha}_i + \rho_{ii}^{uv}\, \sigma_i) \,/\, \Phi(\mathbf{z}'\boldsymbol{\alpha}_i) \tag{6}$$

where $\Phi(\cdot)$ is the cumulative distribution function of the unit normal and ρ_{ii}^{uv} is correlation between the error terms (u_i, v_i) of the *i*th selection equation and the corresponding level equation. Then, using equations 6 and 7, the unconditional mean of y_i is

$$E(y_i) = \exp(\mathbf{x}'\boldsymbol{\beta}_i + \sigma_i^2 / 2)\, \Phi(\mathbf{z}'\boldsymbol{\alpha}_i + \rho_{ii}^{uv}\, \sigma_i). \tag{7}$$

Differentiating (differencing) equations 5, 6, and 7 with respect to explanatory variables $\mathbf{x}$ and $\mathbf{z}$ gives the marginal effects of the continuous (discrete) explanatory variables (Yen and Rosinski 2008), which can be evaluated for all observations and averaged over the sample. Standard errors of average marginal effects are calculated by mathematical approximation.

Data and Variables

The data used in this study came from the 2009/10 Malaysian Household Expenditure Survey, which is collected by Department of Statistics Malaysia. Sampling followed a stratified multi-stage area-probability method to ensure that the sample was representative of the Malaysian population (Department of Statistics Malaysia 2011). Respondents were canvassed on household monthly expenditures on fresh, frozen, and processed meat (see the definitions provided in Table 1) as well as on socio-demographic characteristics. After removing 99

households for which there was incomplete information, we retained 21,542 observations for analysis. Of this sample, 17,790 households (82.6 percent) reported expenditures for fresh meat, 5,394 (25.0 percent) for frozen meat, and 9,552 (44.3 percent) for processed meat during the survey period (Table 1).

Drawing on preceding studies by Burton, Dorsett, and Young (2000), Newman, Henchion, and Matthews (2001), Yen and Lin (2008), and Yen, Lin, and Davis (2008), we hypothesized that the following characteristics of households and heads of households would be associated with purchase probabilities and expenditures for meat: (i) for households, size, regional location (metropolitan, nonmetropolitan, East Malaysia),[2] urbanicity (urban, rural), ethnicity/race (Malay, Chinese, Indian, other), and monthly household income bracket (poverty-low, lower-middle, upper-middle, high); (ii) for heads of households, gender (male, female), age bracket (18–29, 30–45, 46–59, 60 or older), occupation type (white collar, blue collar), and education level (none/primary, secondary, tertiary). See Table 1 for definitions of these characteristics.

Results

In the remaining discussion, all expenditures are in Malaysian ringgit (MYR) unless otherwise noted.

Parameter Estimates

The sample selection system is estimated by maximum likelihood. One parameter identification issue relates to choice of regressors for the selection and level equations. For maximum-likelihood estimation of the current model, parameter identification *does not* require exclusion restrictions since the identification criteria are met because of the functional form and distributional assumptions. From a theoretical perspective, there is no basis for excluding variables that explain the probabilities from the level equations since all of the variables potentially affect preferences, which in turn help to determine the level of expenditure. However, to avoid relying solely on nonlinear functional forms for parameter identification, we impose exclusion restrictions. In particular, we incorporate income-category dummy variables in the selection equations and the logarithm of household income and its squared term in the level equations. These exclusion restrictions guarantee identification of the model parameters. Maximum-likelihood estimates of the sample selection system for the three types of meat are available upon request.

At a significance level of 5 percent or less, the error correlations are significant among all of the selection equations, among all three level equations, and between the selection and level equations for frozen meat (–0.503) and processed meat (0.215). Corroborating the significance of these error correlations are results of joint significance tests. Against the full model, the

[2] In the absence of prices (due to lack of data), the regional location and urbanicity dummy variables reflect price variations in addition to (real) regional and rural/urban differences in consumption (due, for example, to differences in tastes and habits). Regional differences are the primary source of price variation in cross-sectional data. While meat prices may vary by location, the standard of living (and hence prices) would invariably be higher in metropolitan states and urban areas with relatively high population densities than in nonmetropolitan states and rural areas. We hypothesize that such regional price variations affect meat consumption patterns in terms of purchase likelihoods and amounts spent.

Table 1. Definitions and Sample Statistics of the Variables

Variable	Definition	Mean (Std. Dev.)
Dependent Variables		
Fresh meat	Monthly household expenditures on fresh meat (e.g., beef, pork, mutton, chicken, duck, buffalo, goose, turkey, other fresh meat (venison, rabbit, camel, ostrich))	51.72 (86.82)
	Among consuming households (82.58 percent of sample)	62.63 (91.89)
Frozen meat	Monthly household expenditures on frozen meat (e.g., beef, pork, mutton, chicken, buffalo, other frozen meat (venison, rabbit, camel, ostrich))	8.17 (22.50)
	Among consuming households (25.04 percent of sample)	32.63 (34.98)
Processed meat	Monthly household expenditures on processed meat (e.g., roasted pork/duck/chicken, bacon and ham, canned/packed beef/chicken/pork, sausage/meat used for burgers, chicken/meat balls, nuggets, essence of chicken)	8.49 (17.13)
	Among consuming households (44.34 percent of sample)	19.14 (21.41)
Continuous Explanatory Variables		
Household size	Number of household members	4.15 (2.16)
Income	Monthly household income (hundred MYR)	37.35 (38.92)
Household Characteristics: Binary Explanatory Variables (yes = 1, no = 0)		
Metropolitan	Residing in the metropolitan West Malaysian states of Penang or Selangor or in the federal territories of Kuala Lumpur and Putrajaya	0.25
Nonmetropolitan	Residing in the nonmetropolitan West Malaysian states of Perlis, Kedah, Perak, Melaka, Negeri Sembilan, Johor, Pahang, Kelantan, or Terengganu (reference)	0.51
East Malaysia	Residing in the East Malaysian states of Sabah or Sarawak or in the federal territory of Labuan	0.25
Urban	Residing in an urban area with population of 10,000 or more	0.69
Poverty-low [a]	Monthly household income bracket of MYR 0–999[b]	0.09
Lower-middle	Monthly household income bracket of MYR 1,000–3,999 (reference)	0.60
Upper-middle	Monthly household income bracket of MYR 4,000–7,999	0.22
High income	Monthly household income bracket of MYR 8,000 or more	0.09

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Table 1 (continued)

Variable	Definition	Mean (Std. Dev.)
Characteristics of Household Head		
Malay	Ethnicity is Malay (reference)	0.64
Chinese	Ethnicity is Chinese	0.24
Indian	Ethnicity is Indian	0.06
Other	Ethnicity is other	0.06
Male	Gender is male	0.83
Age 18–29	Age 18–29	0.12
Age 30–45	Age 30–45 (reference)	0.39
Age 46–59	Age 46–59	0.32
Age 60 or older	Age 60 or older	0.17
White collar	Has a white collar occupation (e.g., legislators, senior officials, managers, professionals)	0.13
None/primary	Not educated or has primary school as highest education level	0.31
Secondary	Highest level of education is secondary/high school (reference)	0.53
Tertiary	Highest level of education is some college	0.17
Sample size		21,542

[a] The four income categories in U.S. dollars correspond to \$0–304, \$305–1,219, \$1,220–2,439, and \$2,440 or more.

[b] As of October 28, 2014, the exchange rate was approximately USD 1.00 = MYR 3.28 or MYR 1.00 = USD 0.31.

Notes: The values for continuous variables are sample means and standard deviations are shown in parentheses. Compiled from data from the Department of Statistics Malaysia (2011).

independent system is rejected (Wald 1298.60, likelihood ratio (LR) 795.20, Lagrange multiplier (LM) 884.41, degrees of freedom (df) 15), as is the pairwise bivariate selection model (Wald 772.76, LR 732.65, LM 795.21, df 12). Joint significance is also found among the error terms of the three selection equations (Wald 554.85, df 3) and the three level equations (Wald 62.76, df 3). Finally, Vuong's (1989) nonnested test suggests that the sample selection system is preferable to the Tobit system with a standard normal statistic of 492.68. All of these tests have *p*-values of less than 0.0001.[3] In sum, the sample selection system outperforms the pairwise selection, independent, and Tobit systems in fitting the data and supports joint estimation of the three selection equations and the three level equations. The roles of the explanatory variables are more informatively conveyed by the marginal effects, to which we turn.

[3] The Tobit system estimates confirm one restriction of the Tobit parameterization previously discussed. For processed meat expenditures, the ratios of the average marginal effects of probability, conditional level, and unconditional level with respect to household size to the corresponding average marginal effects with respect to household income are 0.659 / 0.0004 ≈ 0.2446 / 0.0166 ≈ 0.2948 / 0.0203 ≈ 147.1907. All Tobit results are available upon request.

Marginal Effects

Average marginal effects of the explanatory variables on the probabilities, conditional levels, and unconditional levels of expenditures on fresh, frozen, and processed meat are presented in Table 2. For each explanatory variable, the marginal effect on probability reflects the contribution of that variable to the likelihood of consuming that type of meat (i.e., a positive expenditure outcome) for each unit increase in the variable. The marginal effect on the conditional level indicates a corresponding effect on the level of monthly expenditure conditional on expending (i.e., among those who consume) while the marginal effect on the unconditional level indicates the effect on the monthly level of expenditure unconditionally—for the whole population of interest.

The results show that, *ceteris paribus,* an additional family member contributes to a greater probability of purchasing fresh (2.84 percentage points, henceforth percent), frozen (0.73 percent), and processed (1.84 percent) meat and to greater monthly expenditures for all three types of meat. Among meat consumers, the conditional monthly level of expenditure increases 5.62 for fresh meat, 0.88 for frozen meat, and 0.33 for processed meat. Overall, the respective unconditional level increases are 6.36, 0.47, and 0.48 per month.

Residents of metropolitan states are 6.37 percent less likely to purchase fresh meat than residents of nonmetropolitan states and spend less per month on fresh fish: 10.79 for conditional consumption and 12.43 for unconditional consumption. Metropolitan Malaysians also are more likely than nonmetropolitan residents to purchase frozen (1.35 percent) and processed (8.63 percent) meat and spend 1.64 more per month unconditionally on processed meat. Since East Malaysian households are 17.70 percent less likely than West Malaysian households to spend on fresh meat, their conditional (4.29) and unconditional (13.07) expenditures fall behind those of nonmetropolitan households. East Malaysian households are 30.69 percent more likely to purchase frozen meat, are 32.69 percent more likely to purchase processed meat, and spend more for fresh and processed meat: 16.72 more conditionally and 15.50 more unconditionally for fresh meat and 4.88 conditionally and 8.63 unconditionally for processed meat. Compared to rural households, urban households are more likely to purchase fresh (1.83 percent) and processed (6.71 percent) meat. They spend only slightly more on processed meat, 0.83 conditionally and 1.53 unconditionally per month, than urban households.

Ethnicity plays a significant role. Chinese households are more likely than Malay households to purchase frozen (2.57 percent) and processed (8.16 percent) meat; they also spend more conditionally and unconditionally per month on fresh (13.90 and 12.48), frozen (4.13 and 2.01), and processed (2.69 and 2.83) meat. Indian households spend less conditionally (3.74) and unconditionally (4.04) on fresh meat but purchase more frozen meat conditionally (4.08) and unconditionally (1.36) than Malay households. We find that Indian households are 5.91 percent less likely to purchase and spend 1.14 less per month unconditionally for processed meat than their Malay counterparts. Households of other ethnic backgrounds are also less likely than Malaysians to purchase fresh (8.96 percent), frozen (4.62 percent), and processed (10.77 percent) meat, *ceteris paribus*. In terms of overall (unconditional) spending, the marginal effects suggest that households of other

Table 2. Marginal Effects of Explanatory Variables on Probabilities, Conditional Levels, and Unconditional Levels of Expenditures

	Fresh Meat			Frozen Meat			Processed Meat		
Variable	**Probability (× 100)**	**Conditional Level**	**Unconditional Level**	**Probability (× 100)**	**Conditional Level**	**Unconditional Level**	**Probability (× 100)**	**Conditional Level**	**Unconditional Level**
Continuous Explanatory Variables									
Household size	2.84***	5.62***	6.36***	0.73***	0.88***	0.47***	1.84***	0.33***	0.48***
	(0.11)	(0.21)	(0.20)	(0.15)	(0.15)	(0.06)	(0.16)	(0.07)	(0.05)
Income	—	0.79**	0.64***	—	0.24***	0.06***	—	0.28***	0.11
		(0.03)	(0.03)		(0.03)	(0.01)		(0.02)	(0.01)
Binary Explanatory Variables									
Metropolitan	−6.37***	−10.79***	−12.43***	1.35*	−0.19	0.33	8.63***	0.34	1.64***
	(0.72)	(0.96)	(0.88)	(0.75)	(0.89)	(0.34)	(0.78)	(0.40)	(0.26)
East Malaysia	−17.70***	−4.29***	−13.07***	30.69***	16.72***	15.50***	32.69***	4.88***	8.63***
	(0.77)	(0.97)	(0.86)	(0.85)	(0.92)	(0.53)	(0.75)	(0.41)	(0.32)
Urban	1.83***	−1.28	−0.09	0.30	−1.01	−0.21	6.71***	0.83**	1.53***
	(0.59)	(0.95)	(0.87)	(0.66)	(0.76)	(0.30)	(0.73)	(0.36)	(0.21)
Chinese	0.92	13.90***	12.48***	2.57***	4.13***	2.01***	8.16***	2.69***	2.83***
	(0.63)	(1.13)	(1.05)	(0.73)	(0.79)	(0.33)	(0.79)	(0.36)	(0.24)
Indian	−1.61	−3.74**	−4.04**	0.46	4.08**	1.36**	−5.91***	−0.28	−1.14***
	(1.14)	(1.74)	(1.59)	(1.27)	(1.66)	(0.65)	(1.31)	(0.79)	(0.42)
Other (ethnicity)	−8.96***	−11.12***	−13.69***	−4.62***	−0.64	−1.50***	−10.77***	−0.51	−2.07***
	(1.21)	(1.67)	(1.44)	(1.09)	(1.38)	(0.46)	(1.34)	(0.74)	(0.38)
Male	−2.09***	2.86***	1.36	0.70	0.52	0.35	−2.00**	−0.82*	−0.77***
	(0.62)	(1.06)	(0.97)	(0.80)	(0.84)	(0.33)	(0.88)	(0.43)	(0.27)

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Table 2 (continued)

Variable	Fresh Meat			Frozen Meat			Processed Meat		
	Probability (× 100)	Conditional Level	Unconditional Level	Probability (× 100)	Conditional Level	Unconditional Level	Probability (× 100)	Conditional Level	Unconditional Level
Binary Explanatory Variables									
Age 18–29	−8.60***	−7.48***	−10.75***	−2.44***	−0.28	−0.78**	−2.16**	−0.30	−0.51*
	(0.91)	(1.26)	(1.11)	(0.93)	(1.02)	(0.39)	(1.02)	(0.48)	(0.29)
Age 46–59	2.76***	9.87***	10.04***	−0.45	2.02***	0.47	−3.05***	0.54	−0.25
	(0.59)	(1.02)	(0.95)	(0.68)	(0.73)	(0.30)	(0.74)	(0.35)	(0.22)
Age 60 or older	4.36***	13.42***	14.20***	−1.93**	1.24	−0.21	−6.39***	0.46	−0.88***
	(0.72)	(1.49)	(1.39)	(0.92)	(1.06)	(0.41)	(1.03)	(0.50)	(0.29)
White collar	0.39	−1.88	−1.40	−0.45	−0.56	−0.29	2.62**	−0.32	0.28
	(0.88)	(1.33)	(1.24)	(0.98)	(0.98)	(0.40)	(1.06)	(0.43)	(0.28)
None/primary	−2.20***	−1.66	−2.61***	−0.51	−0.22	−0.21	−5.92***	−0.64	−1.31***
	(0.66)	(1.02)	(0.93)	(0.73)	(0.77)	(0.31)	(0.82)	(0.39)	(0.23)
Tertiary	−2.73***	−4.51***	−5.29***	−0.13	−2.25**	−0.70*	3.63***	0.61	0.94***
	(0.84)	(1.22)	(1.12)	(0.92)	(0.91)	(0.37)	(1.00)	(0.43)	(0.28)
Poverty-low	−14.31***	−1.50	−9.18***	−10.66***	−3.76***	−3.84***	−18.48***	1.17*	−2.82***
	(1.12)	(1.15)	(1.09)	(0.90)	(0.76)	(0.33)	(1.18)	(0.59)	(0.26)
Upper-middle	1.75***	0.19	1.11**	2.79***	0.89***	1.07***	12.24***	−0.62*	1.70***
	(0.65)	(0.16)	(0.43)	(0.75)	(0.30)	(0.30)	(0.82)	(0.30)	(0.19)
High income	0.66	0.07	0.42	6.59***	2.05***	2.57***	17.65***	−0.85*	2.40***
	(1.04)	(0.12)	(0.66)	(1.29)	(0.57)	(0.53)	(1.30)	(0.40)	(0.29)

Notes: Asymptotic standard errors are shown within parentheses. *** Significant at 1 percent; ** significant at 5 percent; * significant at 10 percent.

ethnic backgrounds spend less than Malaysian households on fresh (13.69), frozen (1.50), and processed (2.07) meat.

Households headed by males are less likely to purchase fresh (2.09 percent) and processed (2.00 percent) meat than female-headed households but spend 2.86 more conditionally on fresh meat per month. They also spend less on processed meat conditionally (0.82) and unconditionally (0.77) than female-headed households.

Compared to households headed by individuals age 30–45, younger households (household heads age 18–29) are less likely to purchase fresh (8.60 percent), frozen (2.44 percent), and processed (2.16 percent) meat, spend 7.48 less conditionally per month on fresh meat, and spend less unconditionally on fresh (10.75), frozen (0.78), and processed (0.51) meat. In contrast, households headed by individuals older than 45 are more likely to purchase fresh meat (2.76 percent for those 46–59 and 4.36 percent for those 60 or older) and spend more per month conditionally (9.87 and 13.42 respectively) and unconditionally (10.04 and 14.20 respectively). Households in the oldest age group are 1.93 percent less likely to consume frozen meat but households in the 46–59 age group spend 2.02 more per month on frozen meat than the 30–45 age group. In terms of processed meat, the 46–59 age group is 3.05 percent less likely and the 60 or older age group is 6.39 percent less likely to consume it. The 60 or older group also spends 0.88 less per month on processed meat than the 30–45 age group.

Households with limited education are less likely to purchase fresh (2.20 percent) and processed (5.92 percent) meat and spend 2.61 and 1.31 less, respectively, than secondary-educated households for it. Households that are headed by college-educated individuals are less likely (2.73 percent) to consume and spend less conditionally (4.51) and unconditionally (5.29) on fresh meat than secondary-educated households. They also spend less conditionally (2.25) and unconditionally (0.70) on frozen meat but are more likely (3.63 percent) to buy processed meat and spend 0.94 more overall on it than secondary-educated households.

In terms of income, we use low-middle income earners as the baseline and find that poverty-low income households are less likely to consume fresh (14.31 percent), frozen (10.66 percent), and processed (18.48 percent) meat and spend less overall—9.18, 3.84, and 2.82 respectively. Upper-middle-income households are more likely to purchase fresh (1.75 percent), frozen (2.79 percent), and processed (12.24 percent) meat and spend more overall—1.11, 1.07, and 1.70 respectively. Finally, high-income households are more likely to spend on frozen (6.59 percent) and processed (17.65 percent) meat and spend more overall on frozen (2.57) and processed (2.40) meat per month.

Discussion and Marketing Implications

The sample selection system allows an investigation of socio-demographic determinants of expenditures for three types of meat (fresh, frozen, and processed) by households in Malaysia. The procedure ameliorates statistical biases related to censoring in the expenditure levels and, compared to the single-equation and two-step procedures used in many previous studies of meat, improves statistical efficiency by estimating the equations jointly and by maximum likelihood.

Our results show that household size, geographic location, ethnicity, age, education, and income are closely associated with purchase likelihoods and expenditures for meat in Malaysia. These results have important implications for marketing strategies

In terms of household size, our results confirm those of Burton, Dorsett, and Young (2000) and of Coffey, Schroeder, and Marsh (2011) in studies of western countries in which household size was positively associated with purchase decisions and expenditures for all three types of meat. Thus, as family structures in Malaysian households become more complex, there is likely to be greater degrees of difference in the preferences and tastes of members of a household. We therefore suggest that strategies for promoting meat consumption should target relatively large households as part of the market segmentation plan by, for example, offering specially designed family packs and/or special cuts. Particular attention should be paid to reaching a diverse range of ages since tastes and preferences for each type of meat could vary by age.

We find that metropolitan and urban households are more likely to purchase and spend more on processed meat than nonmetropolitan and rural households, a result that echoes those of Newman, Henchion, and Matthews (2001) and Newman and Matthews (2002). These results suggest a greater desire for convenience among metropolitan and urban dwellers. Since metropolitan and urban households likely encounter increasingly hectic lifestyles, they exhibit greater interest in convenient food products and time-saving cooking methods and thus prefer processed meat to fresh meat. Along the same vein, we find similar preferences by college-educated heads of households.

In terms of policy implications, economic incentives such as subsidies to reduce the price of meat in a market may not be as effective in sustaining or motivating meat consumption as measures that focus on consumers' changing lifestyles. Such alternative measures could include promoting time-saving cooking methods by which fresh meat would be more convenient to prepare and highlighting the greater nutritional value of fresh meat relative to processed meat. These marketing and advertisement programs could be targeted at metropolitan, urban, and educated households since they exhibit a greater desire for convenience.

While no *a priori* assumptions were posited in this research, it is evident that ethnicity is closely associated with decisions about meat consumption and expenditures in Malaysia. For example, compared to Malaysian households, Chinese households exhibit a greater propensity and other ethnic groups exhibit a smaller propensity to purchase meat while Indian households spend more only on frozen meat. These results reflect cultural, religious, and taste differences among these ethnic groups. Consequently, marketers could consider market-penetration strategies such as increasing existing sales and/or consumption frequency among ethnic Chinese residents. Market expansion plans also could be directed at Indian households since they spend more on frozen meat. These measures could include advertisements in language-based media outlets such as newspapers, magazines, and television and radio stations.

Since mature and retired households have a greater preference for fresh meat and a weaker preference for processed meat, decision-makers in those age groups (46+) may be more cognizant of their health and thus include greater amounts of fresh meat and smaller amounts of processed meat in their diets. Therefore, approaches aimed at increasing the frequency of purchases of fresh meat could focus on older households that already consume meat while efforts

to expand into new markets could target the relatively untapped younger households.

In terms of health policies, it may be prudent for Malaysian health authorities to continue to promote and create awareness, particularly among younger households, of the health benefits of consumption of fresh meat.

Finally, we consider the influence of income. While Tey et al. (2008) predicted sustained growth for the Malaysian meat industry based on relatively large household expenditure elasticities in response to income, our results suggest that affluent Malaysians specifically prefer high-quality frozen and processed meat over fresh meat. Given the relevance of household income to capturing increases in the quality of meat purchased (Coffey, Schroeder, and Marsh 2011), our results imply that meat in general and frozen and processed meat in particular will continue to rise in importance in Malaysian diets in tandem with anticipated economic development.

We acknowledge several limitations in this study that can serve as a catalyst for future studies of Malaysian household expenditures on meat products. Given the secondary nature of our data, only values of total monthly household expenditures for meat are solicited. Therefore, the expenditure variables are assumed to take the implicit interaction between prices and quantities (demand) in the market for meat into account. Failing to estimate price elasticities is another shortcoming of this analysis, and future studies could estimate a utility-theoretic demand system when appropriate data on prices or multiple years of surveys become available. In addition, the household survey does not take the quality or type of meat (beef, pork, poultry, etc.) purchased into account. We acknowledge that an equal number of purchases of all high-quality cuts would raise expenditures and that purchases of different types of meat could change the amount expended. Hence, future studies could investigate the quality of cuts or disaggregated meat products. Additional household information, such as the marital status of the head of household, the number of working adults, the number of children and their ages, knowledge of preparation, hours spent at work, and reasons for consuming or not consuming meat would provide a better understanding of the role of socio-demographic determinants on meat expenditures. Such information was not available in the survey.

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