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DEMAND FOR QUALITY RICE: EVIDENCE FROM CROSS-SECTIONAL AND TIME-SERIES DATA

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ABSTRACT

This study investigated the emerging dimension of demand for rice in terms of quantity and quality from perspective of both the cross-sectional and time series data. Though there are arguments in expenditure and quantity elasticities that derived from the cross-sectional and time series data, quality elasticities suggest that there has been a change from quantity to quality rice. Malaysian consumers are willing to pay more for quality rice.

JEL: *Q11*

Keywords: *Rice, quantity elasticity, expenditure elasticity, quality elasticity*

1. INTRODUCTION

Agricultural economists have long focused on the changes of food consumption in general and rice consumption in particular alongside with overall growth and modernization. Rice is highlighted because of its abundance of calorie to fulfill human basic dietary need for energy. Hence, rice is the staple food in many countries. Though the primary role of rice in the dietary of populations during transformation of a developing economy is seen as staple, a proportion of it is substituted with more protein-based meat products.

With such diversification in food basket, Ito *et al.* (1989), Huang *et al.* (1991), and Bouis (1991) argued that rice is an inferior good by referring to rice expenditure or income elasticity. Bouis (1991) suggested that the negative expenditure or income elasticity is not a lone impact of increasing per capita income but it is also a result of mixed factors – growing urbanization and increasing commercialization of rice production. The combination probably has redefined and shaped a modern food consumption pattern, which Senauer (2001) argued that consumers have moved up Maslow's hierarchy of needs pyramid from satisfying basic physiological needs. To higher extend, Antle (1999) saw this change as the "new economics of agriculture" that consumers are increasingly demanding for quality-differentiated food products.

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The changes in food consumption may have driven most market players, consumers, and policy makers' attention away from staple food – rice. But we all were reminded of its importance by the unfolding Food Crisis in 2008. A revisit to the rice market has seen emerging dimension of demand and supply in the market itself. In general, fragrant rice is perceived as better quality than other types of rice. The world's largest rice exporter, Thailand largely exported White Rice 5%, 10%, 15%, 20-45%, glutinous rice, parboiled rice, and cargo rice prior to her export of fragrant rice in 1988. The export of fragrant rice was just 148,543 metric tons or 3.1 per cent of Thailand's rice export in 1988 but jumped to its unprecedented high at 1,706,260 metric tons or 23.7 per cent of Thailand's rice export in 2002 (The Thai Rice Exporters Association, 2009).

Arising from the above, the objective of this study is to investigate the demand for rice in terms of quantity and quality from perspective of both cross-sectional and time series data. In order to do this, Malaysia is selected to be the case study due to her unique reliance on both domestic production and imports for domestic consumption. Imported rice is not only meant for meeting the demand but also serves as a quality benchmark for local rice to compare and compete with and subsequently consumers' demand for rice. Hence, this study is expected to provide evidence that there has been an emerging dimension of demand for rice for the benefits of rice market players and policy makers.

2. METHODOLOGY

Quality of rice products generally vary in terms of variety, composition of broken rice, and country of origin. However, consumers may not observe or be fully informed about all these. Hence, rice products are graded mostly by referring to variety and composition of broken rice. For example, the grading system for Malaysian local rice ranges from 15 per cent broken rice to 5 per cent broken rice. The 15 per cent broken rice is price controlled at the range of RM1.65-RM1.80/kg in order to provide safety net to the poor in the country. The 5 per cent broken rice, on another hand, is imposed with ceiling price of RM2.60/kg. Very often, consumers pay more for their purchase of higher quality rice like the 5 per cent broken rice.

Quality in ordinary goods or foods can be identified via three types of product quality characteristics: search, experience and credence characteristics (Darby and Karni, 1973; Nelson, 1970 and 1974). However, diversification in dietary has seen diminishing role of rice which is complemented with other food products. Rice is no longer a need to 'taste like rice' in an increasingly affluence society. Encountering such structural and cultural change, it would be ideal to yield indication of demand for quality of rice from the theoretical framework developed by Hassan and Johnson (1977).

Hassan and Johnson (1977) presented that Engel curve is the relationship between household income, y and household expenditure on ith item, e_i, where e_i is the product of the price, p_i, and quantity purchased, q_i of ith item. Economic theory that lays on the observation that consumers are willing to pay premium prices for better quality products when per capita income increases illustrates quality effects in the Engel curve and can then be expressed in expenditure function:

$$e_i(y) = p_i(y)\, q_i(y) \tag{1}$$

where each of the variables is independent of y. A differentiation of logarithm functional form of Equation (2) by In y results in:

$$\frac{d \ln e_i}{d \ln y} = \frac{d \ln p_i}{d \ln y} + \frac{d \ln q_i}{d \ln y} \tag{2}$$

which can be seen that expenditure elasticity, ε_i, is the sum of quality elasticity, θ_i, and quantity elasticity, η_i.

$$\varepsilon_i + \theta_i + \eta_i \tag{3}$$

Derived from the discussion above, there is a need to estimate (i) expenditure Engel function and (ii) quantity Engel function to yield expenditure elasticity, ε_i, and quantity elasticity, η_i, respectively. By doing so, the difference between expenditure elasticity, ε_i, and quantity elasticity, η_i, can yield quality elasticity, θ_i :

$$\theta_i = \varepsilon_i - \eta_i \tag{4}$$

Similar approach was also empirically used by Sarma *et al.* (1979), Alderman and Garcia (1993), Douglas and Isherwood (1996), Gale and Huang (2007), and Tey *et al.* (2009). Banks *et al.* (1999) have suggested that Engel curves require quadratic terms in the logarithm of expenditure. Hence, this study applied estimation method for non-linear Engel curves like Gale and Huang (2007), and Tey *et al.* (2009).

A non-linear expenditure Engel Equation can be expressed as:

$$\text{In } e = \alpha_i + \gamma_1(1 / y) + \gamma_2 \text{ In } y + \gamma_i D + u \tag{5}$$

where e represents per capita expenditure on rice, y is the per capita income, D is a set of demographic variables, and u is a random disturbance term.

The expenditure elasticity, ε, can then be derived by:

$$\varepsilon = -\gamma_1 / y + \gamma_2 \tag{6}$$

Similarly, a non-linear quantity Engel Equation can be expressed as:

$$\text{In } q = \alpha_i + \beta_1(1/y) + \beta_2 \text{ In } y + \beta_1 D + u \tag{7}$$

where q is the per capita consumption (quantity) of rice and other variables are as defined earlier.

Like Equation (5), the quantity elasticity, η, can be estimated by:

$$\eta_i = \beta_1 / y_j + \beta_2 \tag{8}$$

Quantity elasticity, η_i, can be estimated from the difference between expenditure elasticity, ε_i, and quantity elasticity, η_i :

$$\theta_i = \varepsilon_i - \eta_i \tag{9}$$

3. DATA

With the identification of variables in Equations (5) and (6), cross-sectional and time series (1980-2007) datasets were collected from the Household Expenditure Survey (HES) 2004/05 and various issues of Paddy Agricultural Statistical Handbook and Paddy Statistics of Malaysia respectively. The cross-sectional and time series datasets are defined and described statistically in Table 1.

Table 1
Data Descriptions

	HES 2004/05 (N=14,084)		*Time Series Data (N=20)*	
	Mean	*Standard Deviation*	*Mean*	*Standard Deviation*
Per capita expenditure on rice	2.07	0.69	115.32	25.50
Per capita rice consumption	1.48	0.70	85.45	5.15
Per capita income	504.41	513.09	11,237.81	3,758.36
Household size	4.53	2.17		
Age of respondent	47.53	13.62		
Urban	0.66	0.47	0.5768	0.0746
Remark	Respondent resides in urban area (0, 1). Base = Rural		Per centage of population resides in urban area.	
Male	0.85	0.36		
Remark	Respondent is a male (0, 1). Base = female			
Employment	0.79	0.41		
Remark	Respondent is employed (0, 1). Base = unemployed			
Malay	0.57	0.49		
Remark	Respondent is Malay (0, 1). Base = other race/ethnic			
Chinese	0.22	0.41		
Remark	Respondent is Chinese (0, 1). Base = other race/ethnic			
Indian	0.06	0.23		
Remark	Respondent is Indian (0, 1). Base = other race/ethnic			

4. RESULTS

Analysis on Cross-Sectional Data

Equations (5) and (7) were initially estimated for HES 2004/05 via ordinary least squares (OLS) and the obtained parameters are presented in Appendix Table 1.1. However, the OLS residuals in Appendix Figures 1.1 and 1.2 indicate that most of the residuals are zero but the range for other residuals is quite big. They suggest that the error terms are probably heteroskedastic. Hence, Breusch-Pagan-Godfrey heteroskedasticity tests were carried out. From the results in Appendix Table 1.2, the null hypotheses of homoskedasticity for both models are rejected. Subsequently, Equations (5) and (7) were re-estimated using weighted least squares (WLS). The ultimate aim of weighting is to downweight high error variance observations. (Starz, 2007). Therefore, the estimation of demand elasticities for rice using cross-sectional data would occupy the estimates of WLS equations in Table 2.

Table 2
WLS Estimates of Expenditure and Quantity Engels Functions (Cross-sectional)

	Expenditure Engel Function		*Quantity Engel Function*	
Variable	*Coefficient*	*(Std. Error)*	*Coefficient*	*(Std. Error)*
Constant	1.2687	(0.1616)***	0.9048	(0.1636)***
1/ Per capita income	-4.2850	(5.3272)	-5.7023	(5.3973)
LN (Per capita income)	0.1070	(0.0191)***	0.0755	(0.0193)***
LN (Household size)	-0.4548	(0.0125)***	-0.4732	(0.0127)***
LN (Age of respondent)	0.3089	(0.0227)***	0.3003	(0.0230)***
Urban	-0.1013	(0.0131)***	-0.1041	(0.0133)***
Male	0.0406	(0.0174)**	0.0446	(0.0176)**
Employed	0.0373	(0.0169)**	0.0357	(0.0171)**
Malay	-0.4331	(0.0167)***	-0.4061	(0.0169)***
Chinese	-0.4076	(0.0207)***	-0.3995	(0.0210)***
Indian	-0.4331	(0.0282)***	-0.4007	(0.0286)***
R-squared	0.2214			0.2131

Note: Significance levels are denoted by *** for 1% and ** for 5%.

Analysis on Time-Series Data

Augmented Dickey-Fuller (ADF) test was conducted for stationary test of the time-series data. The results are as presented in Table 3. All of the computed ADF test-statistics are greater than the critical values (-2.9763 at 5 per cent significant level) at level, they suggest that the set of data has unit root problem. Then ADF test was further conducted and found that unit root problem is corrected at the first difference ($I(1)$). The number of lags reported in ADF tests is zero based on the Akaike Information Criterion, but the unit root finding is really invariant to the number of lags chosen.

Table 3
Augmented Dickey-Fuller Test Statistics of Unit Roots

Variable	*Level*	*First Difference*
LN(Per capita expenditure on rice)	-1.1635	-5.6543
LN(Per capita rice consumption)	-1.7110	-3.8786
LN(Per capita income)	0.0631	-4.4669
Urban	-2.4788	-5.0180
Critical value [a]	-3.01236	-3.02997

Note: [a]95 per cent confidence level.

Following that, Equations (5) and (7) were estimated in the form of first difference operator via ordinary least squares (OLS). The yielded residual series were tested to identify whether there is cointegration relationship between variables in the equations. This method as described by Karagiannis and Mergos (2002) is called Engle-Granger cointegrating test which is more appropriate in applied demand analysis than other cointegration tests. As suggested by the results of ADF for both residual series, variables are cointegrated in the equations. Therefore, the expenditure and quantity Engel functions were estimated in the form of an error correction model (ECM). The expenditure and quantity Engel function was further tested with (i) Breusch-Godfrey tests for serial correlation in the residuals; and (ii) Breusch-Pagan-Godfrey heteroskedasticity tests to check for heteroskedastic. As they turned out in Appendix Tables 2.1 and 2.2, there is no serial correlation in the residual and homoskedasticity in the models. Therefore, the estimation of demand elasticities for rice occupied the estimates of the initial ECM-OLS equations in Table 4.

Table 4
OLS Estimates of Expenditure and Quantity Engels Functions (Time-Series)

	Expenditure Engel Function		*Quantity Engel Function*	
Variable	*Coefficient*	*(Std. Error)*	*Coefficient*	*(Std. Error)*
Constant	28.6708	(18.5052)	30.7338	(14.0898)**
1/Per capita income	-7575.2890	(2235.6400)***	-2013.9580	(1682.8740)
LN (Per capita income)	-0.7650	(0.2623)**	-0.2469	(0.1736)
Urban	2.9804	(0.5491)***	-0.2272	(0.3503)
ECM(-1)	-0.2128	(0.2800)***	-0.1917	(0.1932)**
R-squared	0.9578		0.6790	

Note: Significance levels are denoted by *** for 1% , ** for 5%, and * for 10% respectively.

Demand Elasticities

Table 5 presents the estimated demand elasticities for rice in Malaysia. In general, all demand elasticities are less than one. However, there is contradiction in direction of the expenditure and quantity elasticities from the cross-sectional and time series data. Quality elasticities were yielded from the difference between expenditure and quantity elasticities.

From the analyses on cross-sectional data, the positivity of expenditure and quantity elasticities for rice is similar to the findings in Chern (2000) that suggest rice is still a normal good. A 1 per cent increase in per capita income is likely to result an increase of 0.1150 and 0.0649 per cent in per capita rice expenditure and consumption (quantity), respectively. It is apparent that per capita expenditure on rice is likely to increase faster than per capita rice consumption (quantity), which is a result of consumers' willingness to pay more for higher quality rice. Thus, the estimate of quality elasticity (0.0501) implies that quality is an important desired attribute as consumers become more affluence.

Table 5
Estimated Demand Elasticities for Rice, Malaysia

	Elasticities		
	Expenditure	*Quantity*	*Quality*
Cross-sectional	0.1150	0.0649	0.0501
Time series	-0.1449	-0.4118	0.2669

From the analyses on time series data, the negative expenditure and quantity elasticities for rice imply that rice is an inferior good like those argued in Ito *et al.* (1989), Huang *et al.* (1991), and Bouis (1991). The estimate of expenditure (-0.1449) and quantity (-0.4118) elasticities suggest that a 1 per cent increase in per capita income would expect a faster decrease of 0.4118 per cent in per capita rice consumption (quantity) than 0.1449 in expenditure and consumption (quantity), which means consumers are willing to pay more for smaller quantity of rice. As suggested by the estimate of quality elasticity (0.2669), this smaller quantity of rice perhaps is higher quality rice.

5. DISCUSSION

What is puzzling is whether rice is an inferior good which is a mere relationship of increasing per capita income level and per capita consumption of rice. Neither previous studies that used cross-sectional data nor those used time-series data provided an absolute suggestion to this concern. If this relationship holds while other factors remain constant, there would be low and lower per capita consumption of rice in response to income growth in future. As experienced in the Rice Price Crisis 2008, the major factor to control perhaps is population growth in order to balance off the production and demand.

6. CONCLUSIONS

Regardless whether rice is an inferior good, the results from the analyses on the cross-sectional and time series data suggest that there has been a change from quantity to quality rice. Consumers are willing to pay more for quality rice. Amongst many factors, the emerging dimension of demand for rice is empowered by stronger buying (income) power and urbanization that relates to lifestyle. Though it cannot be empirically grounded, improvement in rice supply chain has shaped modern rice consumption. This is mostly attributed to information transmission - an enabler for farmers, millers, traders, wholesalers, and retailers to facilitate the marketing system and offer the desired quality rice. Rice is then marketed not only by its variety but also brand, country-of-origin, organic content, and pricing strategy. The marketing challenge is hence engaged in these elements for persuading and delivering quality rice products to consumers, on top of the knowledge that quality of rice may not be observed by consumers directly.

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Appendix 1: Results of Cross-Section Data

Appendix Table 1.1
OLS Estimates of Expenditure and Quantity Engels Functions (Cross-sectional)

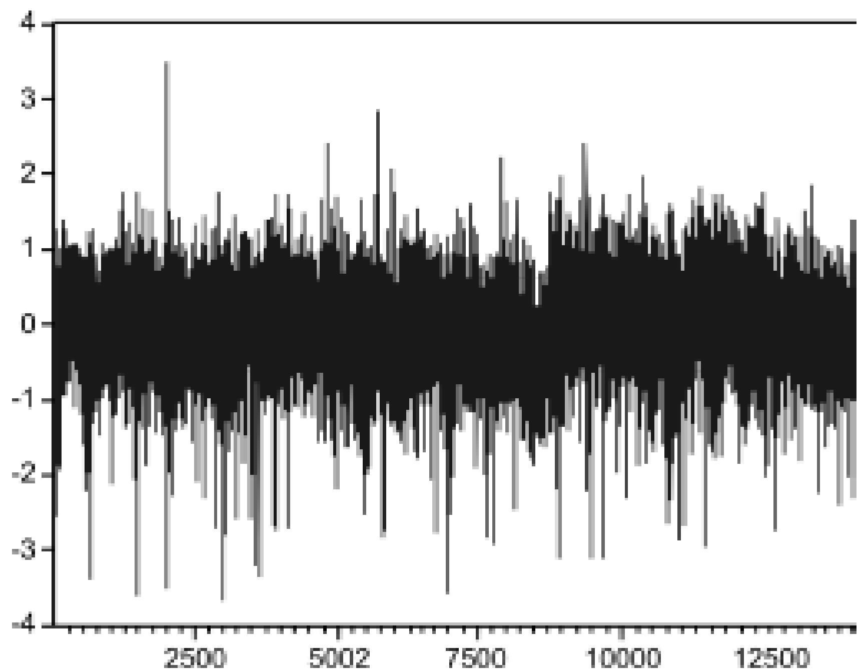
	Expenditure Engel Function		*Quantity Engel Function*	
Variable	*Coefficient*	*(Std. Error)*	*Coefficient*	*(Std. Error)*
Constant	1.1778	(0.1520)***	0.8130	(0.1535)***
1/ Per capita income	-1.5423	(5.0755)	-2.7775	(5.1282)
LN(Per capita income)	0.1147	(0.0178)***	0.0850	(0.0180)***
LN (Household size)	-0.4599	(0.0118)***	-0.4775	(0.0119)***
LN (Age of respondent)	0.3172	(0.0214)***	0.3050	(0.0216)***
Urban	-0.1073	(0.0125)***	-0.1097	(0.0126)***
Male	0.0410	(0.0164)**	0.0445	(0.0166)***
Employed	0.0389	(0.0159)**	0.0377	(0.0161)**
Malay	-0.4282	(0.0161)***	-0.3982	(0.0162)***
Chinese	-0.4092	(0.0198)***	-0.3965	(0.0200)***
Indian	-0.4265	(0.0269)***	-0.3885	(0.0272)***
R-squared	0.2267			0.2180

Note: Significance levels are denoted by *** for 1% and ** for 5%.

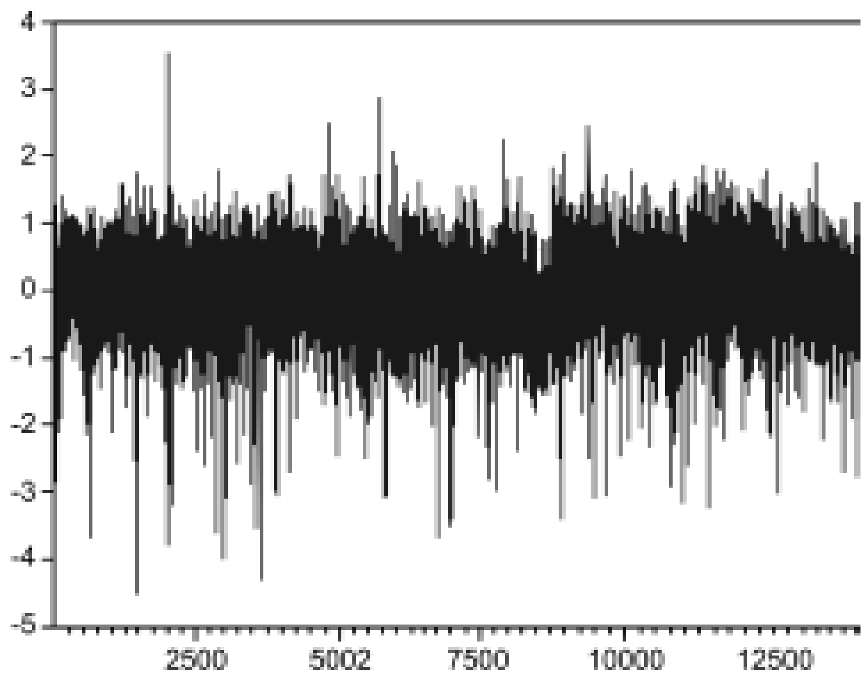
Appendix Table 1.2
Estimates of Breusch-Pagan-Godfrey Heteroskedasticity Test (Cross-sectional)

	Expenditure Engel Function	*Quantity Engel Function*
F-statistic	4.0269	3.70880
Prob. F	0.0000	0.0001
Obs*R-squared	40.1765	37.0116
Prob. Chi-Square	0.0000	0.0001

Appendix Figure 1.1: OLS Residuals of Expenditure Engel Function (Cross-Sectional)



Appendix Figure 1.2: OLS Residuals of Quantity Engel Function (Cross-Sectional)



Appendix 2: Results of Time-Series Data

Appendix Table 2.1
Estimates of Breusch-Godfrey Serial Correlation LM Test (Time Series)

	Expenditure Engel Function	*Quantity Engel Function*
F-statistic	0.2944	1.0770
Prob. F	0.7502	0.3714
Obs*R-squared	0.9354	3.0437
Prob. Chi-Square	0.6265	0.2183

Appendix Table 2.2
Estimates of Breusch-Pagan-Godfrey Heteroskedasticity Test (Time Series)

	Expenditure Engel Function	*Quantity Engel Function*
F-statistic	2.3228	0.79033
Prob. F	0.1083	0.5739
Obs*R-squared	9.0684	4.4025
Prob. Chi-Square	0.1064	0.4930