The economic impact of climate change on food security in Malaysia

Chuen Khee, Pek and Yet Mee, Lim and Chee Keong, Choong

The University of Nottingham Malaysia Campus, Universiti Tunku Abdul Rahman, Universiti Tunku Abdul Rahman

1 December 2011

THE ECONOMIC IMPACT OF CLIMATE CHANGE ON FOOD SECURITY IN MALAYSIA

Pek Chuen Khee[1], Lim Yet Mee[2] & Choong Chee Keong[3]

[1]Nottingham Business School, The University of Nottingham Malaysia Campus
[2]Faculty of Accountancy and Management, University of Tunku Abdul Rahman
[3]Faculty of Business and Finance, University of Tunku Abdul Rahman

Abstract

This study estimates the economic impact of climate change on food security in Malaysia. The contingent valuation technique is employed on 456 randomly selected households in the vicinities of Selangor Darul Ehsan. The study finds that climate change mitigation programmes to ensure food security are important. The public is willing to pay extra rice price in substitution of a rice subsidy reduction impact for the mitigation programmes. More specifically, the study ascertains that households on average are willing to pay 25% more for rice in replace of the subsidy reduction impact. This value conveys a total economic value of MYR557 million per annum, based on the total annual rice consumption of Malaysians who are willing to pay for the rice subsidy reduction impact. This substantial value may help give directions to the policy makers to draft more responsible food security and climate change mitigation bills in the future.

Key words: willingness-to-pay, climate change, food security, contingent valuation

Introduction

The world and Malaysian agriculture, in particular, are facing decline in their productivity as the global climate becomes warmer due to robust development that emits uncontrolled carbon dioxide and other greenhouse gases. Optimistically, the carbon dioxide emission should have reduced with the Kyoto Protocol but the pace of the reduction is far slower than what the world needs.

Climate change is the results of the accumulation of greenhouse gases in the atmosphere arising from the combustion of fossil fuels. Carbon dioxide, methane and nitrous oxide are the greenhouse gases that increase the earth temperature due to human activities like fossil fuels burning and deforestation.

In the IPCC [1] report, it has been ascertained that with the increase of 0.74°C in average global temperature during the last century, the same for the last decade of the 21st

century is estimated to rise by between 1.1°C up to 6.4°C. Kovats et al. [2] reported that at the same time the temperature for Asia Pacific region, where Malaysia is located, would be increasing around 0.5-2°C by 2030 and 1-7°C by 2070. It has also been observed by the Intergovernmental Panel on Climate Change (IPCC), that the impact of climate change on food security will be devastating and of great concern. Stern [3] concurs with this observation as climate change threatens the basic elements of life for example water, food, health, and environment.

This change in the temperature will bring negative impacts on food security in all aspects. Higher temperature would mean altering the climate patterns such like droughts, floods and occurrences of the El-Nino and La-Nina. Food security in this study shall be defined as *"when all people, at all times, have physical and economic aspect to sufficient, safe and nutricious food to meet their dietary needs and food preference for an active and healthy life"* (FAO [4]).

The impact of the decline in food production due to climate change will be more severe in developing countries than the developed nations, mainly because rich nations are located in the part of the world with lower temperature. In a report by the Centre for Global Development [5], many developing countries have reached the average temperature level which is near or above crops tolerance level. If the reduction of greenhouse gases emission and efforts to implement successful climate change adaptation projects are at status quo, the agricultural productivity will decline by 10 to 25% come 2080 in the developing countries. This productivity decline is far lower for developed countries of a maximum 6% but may also increase to around 8%.

This prediction creates huge tension to the governments of developing nations as they are normally agricultural dependent states. Not only will the food production be affected, the entire state economy may be at stake. Malaysia, though a more advanced developing nation, is not being spared due to its geographical location that is very near to the equator with high temperature around 27°C to 34°C. Food security in Malaysia is levelled down further to mean maintaining main staple food like rice, in particular.

A study undertaken by Ng, Camerlengo and Abd. Wahab [6] from the Technological University of Malaysia reports that the warming trend has increased significantly in the

country by 1.35°C to 6.33°C per l00 years in the past 30 years. This result concurs well with that of the IPCC report. With the estimation from The Malaysian Agricultural Research and Development Institute (MARDI) of a 1°C increase in daily average temperature reducing 10 percent of the rice yield (Abdullah [7]), it is estimated that the minimum drop in rice yield will be at least 13.5 percent based on the earlier study in the next century, assuming mitigation efforts remain at status quo.

MARDI also reported that the country's balance of trade of food stuff has been in deficit since the 90s at about an average of MYR4 billion (MYR1.00:USD0.33 at the time of study) from 1998 to 2006. Currently, the rice consumption of Malaysian is about 2.4 million ton per year (mtpy) with 30 percent imported mainly from Thailand (The Business Times [8]). The aim of the government is to reduce the rice import dependence to 10 percent by 2010. However, without more effective implementation of climate change adaptation projects, such aim may have to remain as a paper plan. As of now, the efforts to create awareness and educate the public about climate change are still very minimal, what more efforts to mitigate the possible threat to food security of the country.

With the given background of the study, it is the aim of the researchers to shed lights on the public's perception about food security and their willingness-to-pay (WTP) for such basic necessity.

The objectives of this study more specifically are:

1. To identify the understanding of public's awareness, attitude and perception of climate change on food security,

2. To estimate the economic impact of climate change on food security through the WTP for higher rice price through a rice subsidy reduction impact scheme and,

3. To identify the factors influencing the WTP.

Significance of the study

This study reveals the demand-side perspective of Malaysians for food security. Rice as the staple food is employed to study the WTP for higher rice price in substitute of the rice

subsidy reduction impact. The rice subsidy impact is measured against the change in the percentage of rice subsidy given by the government. If the rice subsidy changes from 20% to 15%, then 5% will be the rice subsidy reduction impact. These reduced subsidies will be used to fund climate change mitigation and adaptation projects. The results of this research can be used as a reference by the Ministry of Agriculture and Agro-based Industries and Ministry of Natural resources and Environment for policy decision-making.

It would be inspiring if the study could create greater awareness of Malaysian on the issues of climate change and also to enhance greater efforts of the policy makers to look more into climate change adaptations projects to mitigate the externalities of the global warming before it brings greater destruction not only to our generation but future ones to come.

Methodology

Contingent Valuation as the Measurement Method

Contingent valuation method (CVM) is a survey-based economic technique which elicits the maximum willingness to pay (or willingness to accept) of individual respondent to obtain improvement (or compensate for damages) on non-market resources in a hypothetical market. The non-market resources such like the ecosystem, biodiversity and tropical forest give significant utility to the consumers but do not have a market price. Through CVM, a stated preference valuation model, the utility of 'consuming' the non-market resources can be quantified into monetary values and thus giving these non-market resources their prices.

CVM, which is flexible in application, has been widely used to estimate the willingness to pay (WTP) of even goods and services with no observable behavior but are easily understood and identified by respondents. It can provide defensible estimates that are easy to analyse and describe. CVM is often used to value total economic value, including the use and non-use values of an environmental good or service. Use values are the present or future benefits derived from the use of the environmental goods and services, while non-use values are benefits gained indirectly by acknowledging the presence of those environmental commodities.

The application of CVM in this study is to elicit the respondents' WTP to avoid future damages on food security due to climate change. As such the framework of equivalent surplus (ES) is employed. The ES of a price increase (in the context of higher rice price) is

the amount of income, when taken away from the consumer, will leave him/her as well off as without the price change as if it had occurred. This will keep the consumer on his/her post-change utility level. The following is the expenditure function to illustrate the ES:

$$\begin{aligned} ES &= e(p_0,u_1) - e(p_0,u_0) \\ &= e(p_0,u_1) - w \\ &= e(p_0,u_1) - e(p_1,u_1) \end{aligned}$$

where w is the wealth level, p_0 and p_1 are the old and new prices respectively, and u_0 and u_1 are the old and new utility levels respectively.

The public's WTP, socio-economic and attitudinal variables can be specified as:

$$WTP_i = X_i'\beta + e_i$$

where X_i = vector of explanatory variables and β = vector of coefficients. The e_i term is assumed to be independent, identically normally distributed random variable with zero mean and variance σ^2, $i = 1, 2, \ldots, n$ denotes respondents in the sample. The conditional distribution of the WTP is given by:

$$WTP_i \mid X_i \sim N(X_i'\beta, \sigma^2), \qquad i = 1, 2, \ldots, n$$

Although CV has been widely used in economic valuation, critiques are skeptical of its ability to accurately and adequately measure the WTP for any environmental goods or services (Diamond & Hausman [9]). However, the CV results can be reliable if the recommendations reported by The National Oceanic and Atmospheric Administration's (NOAA) Panel, are closely followed. The validity and accuracy of CV can be further enhanced by respondents' familiarity with the issues at hand and interviewed by well-trained interviewers (Yoo & Kwak [10]). This research follows those conditions as closely as possible to ensure reliability of the findings.

The Proposed Policy

The CVM questionnaire was designed to elicit the value of the proposed policy of rice subsidy reduction impact to fund climate change mitigation and adaptation projects to secure food security of the country. The rice subsidy on average is about MYR1.5 billion (USD430 million) per year based on a 2008 report (The Brunei Times [11]). The net present value for the next 30 years at 10 percent will be MYR14.14 billion (USD4 billion).

Adaptation projects such like dam construction, monitoring weather extremes, developing disaster preparation strategies and communal capacities buildings are costly. Malaysia, a developing country may have limited resources to run effective implementation of such projects. However, some priority action, such like the reduction of vulnerability to climate change cannot be disregarded and is immediately required for short-term adaptation. The vulnerable groups must be avoided hardship due to climate change by ensuring that their livelihood will not be at stake.

In any cases, Malaysia's has plans for the climate change programmes for 2008 – 2012 and they are (i) improving data management system of greenhouse gas emissions and ozone depleting substance consumption targeted at establishing of an improved data management system, (ii) removal of barriers for increased energy efficiency and renewable energy initiatives implementation targeting at increased renewable energy mapping and physical capacity, establishing an institutional framework for implementing building energy efficiency and identification of energy efficiency potential in the transportation sector, and (iii) extension of rural electrification utilizing renewable energy sources targeting at establishing a policy framework for rural electrification on renewable energy.

The respondents were asked their willingness to allow a rice subsidy reduction impact, which means they have to pay more for rice. This is corresponding to the WTP for higher rice price in order for the government to reallocate the rice subsidy to fund the climate change mitigation and adaptation projects. For example, an acceptance to forgo a 10% subsidy reduction impact on rice price of MYR1.80 per kilogramme for government subsidised Super Tempatan 15, the most popular rice variant (The Business Times [8]), would mean a WTP extra 18 sen for each kilogramme of rice purchased.

Sampling and Survey Methods

A total of 456 households were interviewed in the Klang Valley, comprising areas like Cheras, Petaling Jaya, Subang, Klang, Kepong and Puchong. The survey was conducted in the months of January to March 2011 on head of households, normally the 'father' but in the absence of this person, the 'mother' was interviewed. Otherwise, the household was skipped. This was to ensure that the respondents were decision-makers with purchasing power.

The questionnaires were finalised after a pre-test and pilot study took place between mid of November to end of December 2010. The pre-test helped to identify the rice subsidy reduction impacts (in percentages) which were between 5 to 25%. The pilot study served to check and ensure the issues and questions were understood by the public. After taking into consideration the comments from these exercises, improvements were made on the questionnaires before they were used in the actual survey.

The survey was conducted by face-to-face interviewing as the other methods such like mail or telephone interviews could not allow the interviewers to explain the actual issue in detail and clearly to the interviewees. Face-to-face interview is expected to obtain more accurate and complete responses. The average time to complete the questionnaires was about 20 to 30 minutes as the survey context had to be properly explained and appropriate time was given to the respondents to think of their WTP.

The interviewers were properly trained through training session and mock interviews before the actual surveys were administered. The interview sessions were done more efficiently and co-operatively between the respondents and interviewers when good rapport can be built between the two parties.

Survey structure, Payment vehicle and WTP elicitation format

At the initial stage of the face-to-face interview, a description of the survey issues like climate change and food security was explained by the interviewers to the respondents to give them some idea about the survey objectives. The respondents were asked introductory questions like areas of socioeconomic and growth of the country (for example, education, public safety, food security and others) which are of their concern according to their ranking

of preferences, their awareness of and care about climate change and national food security and their membership to any environmental organisations.

Next, the enumerators explained the impact of climate change on food security of the country. The respondents were given details on how the changes in the world temperature can bring negative effects on the rice yield of the country which has a direct impact on food security of Malaysia. Next, the hypothetical market for food security was told to the interviewees. They were given the knowledge that in order to minimise the drop in rice yield of the country, climate change adaptation and mitigation projects such like dams construction, monitoring weather extremes and communal capacities building have to be implemented. However, Malaysia as a developing country has limited financial resources and hence would need to reduce rice subsidy to fund and mobilize these costly projects.

After the respondents understood the proposed policy, they were then asked of their intention to participate in the climate change mitigation and adaptation initiatives by allowing a rice subsidy reduction impact, which meant paying more for rice. Those respondents who agreed to support the cause were then directed with the CVM question:

"If you are willing to participate in contributing towards the climate change adaptation and mitigation projects by accepting a reduction in rice subsidy, what is the percentage of ***rice subsidy reduction impact*** *that you are willing to forgo?*

The respondents were reminded of the meaning of rice subsidy reduction impact which meant that in agreeing to participate in the proposed policy, if they were willing to forgo a 10% rice subsidy reduction impact, it would meant that they were WTP an extra 18 sen for each kilogramme of rice price at MYR1.80 per kilogramme.

The respondents were continuously shown bidding cards with incremental percentage of rice subsidy reduction impact until they reached their final bid by the enumerators. The percentages of 1%, 5%, 10%, 15%, 20%, 25% and 30% rice subsidy reduction impact shown to the respondents were identified from the pre-test and pilot study. The 1% and 30% reduction impact were identified by taking a level below and above the minimum 5% and maximum 25% identified from the pre-test and pilot study. When the respondents agreed to forgo a 1% rice subsidy reduction impact, they were then shown the 5% bidding card and this

went on until their final bid.

For those respondents who did not agree to support the cause were asked of the reasons for the 'protest bid' (not supporting the proposed policy) such like 'do not wish to support', 'it is the responsibility of the government' and others.

Following the key WTP questions, socio-demographic information about the household was recorded. These include asking questions like their age, sex, household income, qualification, type of profession, number of kids, and household, and others.

Potential biases of CVM

According to Mitchell and Carson [12], it is important to anticipate potential biases in the implementation of CVM and this study had taken steps to minimise them. CV respondents may not be familiar with the environmental goods posed to them for WTP elicitation. This information bias would influence their stating of the true monetary values. Besides, these respondents may have just revealed their opinions on the scenario given to them than expressing value for the good. Respondents may state agreement to WTP to show their support for environmental protection but not the monetary values they give to the environmental good itself. In this study, the interviewers spent significant time explaining the actual scenario and proposed policy to the respondents. This is to ensure that the interviewees understood the actual good in study and could understand better their WTP in support or reject the proposed policy.

Hypothetical bias occurs when the actual payments by the respondents are lower than the hypothetical values pledged (List and Gallet [13]). The hypothetical market error was taken care of by specifying a feasible payment vehicle which is the rise in rice price when there is a subsidy reduction impact. The face-to-face interview reduced the scenario misspecification bias where clarification could be made throughout the interview process. The use of bidding cards as the elicitation method greatly reduced the starting point bias.

Censored Tobit estimation

Since the dependent variable has zero values, a Tobit model is used to estimate the WTP function. However, an ordinary least square (OLS) model is also analyzed and results compared with that of Tobit. Unlike Tobit, the OLS estimator disregards the zero WTP.

A censored Tobit model was used to estimate the WTP extra for rice price in substitution of rice subsidy reduction impact and explain the factors influencing the WTP. This model has been employed as respondents may decide not to pay any extra price for rice due to different reasons and as such the data is then censored at zero. Although the ordinary least squares model can be used as the regression but the results may be biased and inconsistent. The biasness will increase when there are more zero WTP data collected.

The Tobit regression takes the form drawn from the work of Kim and Cho [14]:

$$WTP_i^{Tobit} = X_i'\beta + \varepsilon_i$$

where WTP_i^{Tobit} is an unobserved continuous dependent variable, and ε_i is an independently distributed error term assumed to be normal with zero mean and variance σ^2, $i = 1, 2, \ldots, n$.

The observed WTP variable takes the form:

$$WTP_i = \begin{cases} X_i'\beta + e_i & \text{if } WTP_i^{Tobit} > 0, \\ 0 & \text{if } WTP_i^{Tobit} \leq 0. \end{cases}$$

The log likelihood for the censored regression model is given by:

$$\ln L(\beta, \sigma) = \sum_{WTP_i=0} \ln\left[1 - \Phi\left(\frac{\mathbf{X}_i'\beta}{\sigma}\right)\right] + \sum_{WTP_i>0} \left[\ln\left(\frac{1}{\sqrt{2\pi\sigma^2}}\right) - \left(\frac{1}{2\sigma^2}\right)(WTP_i - \mathbf{X}_i'\beta)^2\right].$$

The maximum-likelihood estimator of β_{Tobit} is obtained as a solution to the first order condition for maximization, $[\delta \ln L(\beta)/\delta\beta] = 0$. Once the optimal values of β_{Tobit} and σ are estimated, the expected value of WTP_i when censored at zero can be obtained from:

$$E[WTP_i] = \mathbf{X}_i'\beta^e_{Tobit}\Phi(\mathbf{X}_i'\beta^e_{Tobit}/\sigma^e) + \sigma^e\phi(\mathbf{X}_i'\beta^e_{Tobit}/\sigma^e)$$

where β^e_{Tobit} and σ^e are the estimated values of β_{Tobit} and σ, respectively; Φ is the normal cumulative distribution function; and ϕ is the normal distribution function.

In this study, the WTP estimated by the Tobit model is an equivalent surplus measure, i.e. the WTP to avoid future degradation on food security due to climate change (Bateman and Turner [15]).

Data Analysis

The respondents ranked public safety as the most concerned and defense as the least concerned socioeconomic issues among the eight areas listed in Table 1. Lower mean values indicate a greater concern of the corresponding issue. It is surprising to see that environmental sustainability and food security were not of their major concerns, at the fourth and seventh placing, respectively.

Table 1: Ranking of concerns of socioeconomic issues

Socioeconomic issues	Mean	Ranking
Public safety	3.06	1
Public health	3.08	2
Education	3.60	3
Environment sustainability	4.40	4
Housing	5.02	5
Unemployment	5.08	6
Food security	5.36	7
Defense	6.38	8

Source: Survey study

Almost all the respondents (99%) reported that they were aware of climate change but less of them (71%) showed care about it. Approximately 61% of the respondents were aware that due to climate change, food security of the country is at substantial risk but only 41% of them were concerned that the nation's food security is at risk. These findings show that on

average the respondents are aware of the climate change and food security issues but showed little concern with majority giving reasons like climate change will not have such a great impact on food security, the government is responsible for sustained food security, and do not bother about it since nothing much can be done.

The responses to the WTP were analysed and the results show that 235 (51.5%) agreed to the proposed policy while 221 (48.5%) of the respondents did not agree to support. This high protest bids is rather surprising but concurs with the lack of concern of the public on climate change and food security. The protest bids were further analysed and majority of the respondents stated that it is the responsibility of the government to continue with the rice subsidy and fund the climate change mitigation and adaptation initiatives at the same time.

Profile Analyses and Results

The respondents' profile for the total sample of 456 is analysed according to their socio-demographic and attitudinal variables as per Table 2.

Table 2: Socio-demographics of respondents

Variables	Average
Age	42
Gender	Female
Race	Chinese
Kids	0 – 1
Household member	5
Educational level	Tertiary education
Household income	MYR6,500

Note: MYR- Ringgit Malaysia. Exchange rate MYR1.00: USD0.33
Source: Study survey

The average age of the respondent was 42 years old with majority being Chinese female respondents. The average number of household member was 5 with an average of 1 kid residing in the house. On the average, the respondents held tertiary qualifications with household incomes of MYR6,500 per month.

Sample WTP

Table 3: Sample WTP (%) measures of centrality

	With protest bids	Without protest bids
Mean	5.44	10.56
Median	1.00	10.00

Source: Study survey

The mean and median for the sample is shown in Table 3. The sample mean WTP is 10.56% and median WTP is 10% when the protest bids are omitted. This would mean that the respondents are willing to accept a 10.56% of rice subsidy reduction impact, implying they are WTP 19 cents in replacement of the reduction of rice subsidy, assuming the current rice price is MYR1.80 per kg. These highlight that the respondents are willing to participate in the contribution of the climate change mitigation projects. However, when the protest bids are included into the calculation of the measures of centrality, the two measures are naturally lower at mean of 5.44% and median of 1%.The maximum WTP is up to 30% while the lowest is 1%. This evidently shows a wide variation of the WTP.

Tobit Estimation

In the Tobit regression results as shown in Table 4, four regressors are significant, namely the scale concerned on the nation's food security is at risk (SCALE), membership of environmental groups indicating the respondent being an environmentalist or otherwise (ENV), gender (GENDER) and educational level (EDU).

Table 4: Tobit model estimation

Variables	**Coefficients**	**Marginal Effects**	**Means**
CONSTANT	-19.6074 (-1.7986)	-10.1858	
RISK	-0.8052 (-0.5205)	-0.4183	0.6118
SCALE	2.07787*** (5.07045)	1.07943***	1.4101
ENV	5.5524* (1.7038)	2.8844*	0.0329
LAGE	0.8353 (0.2981)	0.4339	1.6206
GENDER	-2.9395** (-2.2195)	-1.5271**	1.3290
RACE	0.5567 (0.4376)	0.2892	1.9057
KIDS	-0.1730 (-0.2476)	-0.08985	0.6075
HMMB	0.2432 (0.7482)	0.1263	4.5746
TYPROF	1.6189 (1.1050)	0.8410	1.8750
EDU	6.6511*** (4.4906)	3.4552***	5.1711
LHINC	1.3867 (1.4720)	0.7204	3.8034
Estimated Mean WTP	25.00		
Log likelihood	-1043.334		
count R^2	0.7675		
R^2	0.1759		
VIF	1.2134		
n	456		

Note: The figures in the parentheses are the Z (standard normal) values. *, **, *** indicate statistic significance at the 10%, 5%, and 1% level, respectively.

Model specification

$$WTP = -19.6074 - 0.8052RISK + 2.07787SCALE + 5.5524ENV + 0.8353LAGE - 2.9395GENDER + 0.5567RACE - 0.1730KIDS + 0.2432HMMB + 1.6189TYPROF + 6.6511EDU + 1.3867LHINC$$

where; RISK= concern for food security at risk (Yes=1; No=0), SCALE = level of concern for RISK (1 – 5), ENV= membership of environmental organisation (Yes=1; No=0), LAGE= natural logarithm of age, GENDER (Male=1; Female=0), RACE (Chinese=1; 0=Others), KIDS = number of kids below age of 10, HMMB= number of household member, TYPROF= type of profession (Management and Administration=1; Others=0), EDU= level of education (1= Graduate and Post-graduate; 0=Others), LHINC= natural logarithm of household income.

Coefficient of Tobit regression cannot be interpreted directly (Gujarati [16]). To make the Tobit model relatively easy to interpret, the marginal effects of a change in regressors and the consequent response to changes in the regressand (WTP) have to be computed. The results show that the higher the concerned scale, the higher is the value of WTP. An environmentalist is more willing to pay as compared to non-environmentalist by 2.8844 units. The female's WTP is 1.5271 units lower than their counterpart, the male. The WTP is also higher from households with higher educational levels.

The R^2 denotes that about 17% of variation in WTP is explained by the regressors. This model fit is acceptable as a minimum R^2 of 15% is recommended (Mitchell & Carson [12]). Besides, this model is free from serious multicollinearity problem with VIF value (1.2134) that is less than 10. Furthermore, another comparatively simple measure of goodness of fit is the count R^2. In this model, the count R^2 is 0.7675, which simply means that 76.75 percent (correct predicted percentage) suggest that this model is valid and reliable.

Table 5: Correlation Matrix between Variables included in the Tobit Model

Correlation	WTP	RISK	SCALE	ENV	LAGE	GENDER	RACE	KIDS	HMMB	TYPROF	EDU	LHINC
WTP	1.00000											
RISK	0.12450	1.00000										
SCALE	0.25110	0.53690	1.00000									
ENV	0.20450	0.14690	0.23470	1.00000								
LAGE	-0.08881	0.03367	0.02962	-0.03678	1.00000							
GENDER	-0.13100	0.12240	-0.01970	0.02445	0.15810	1.00000						
RACE	0.12010	0.07755	0.06943	-0.09252	-0.05402	-0.19300	1.00000					
KIDS	0.03835	-0.01714	0.04115	0.05232	-0.21690	-0.02494	-0.11350	1.00000				
HMMB	0.03651	0.10090	0.02157	-0.03991	0.23200	0.16980	-0.10120	0.11280	1.00000			
TYPROF	0.07674	-0.06591	0.00878	-0.03232	-0.13050	-0.07423	0.01303	-0.00294	-0.06256	1.00000		
EDU	0.29610	0.09839	0.10280	0.10010	-0.43520	-0.05235	0.18690	0.06174	-0.10840	0.15260	1.00000	
LHINC	0.20200	0.20800	0.14530	0.10100	0.08186	0.06508	0.09871	0.19060	0.34760	0.05105	0.30250	1.00000

From Table 5, it is clearly shown that there is no high pair-wise correlation between regressors. As the suggested rule of thumb, if the pair-wise correlation coefficient between two regressors is high (excess 0.8), then multicollinearity is a serious problem (Gujarati [16]). Thus, there are no independent variables showing correlation with the WTP.

OLS Estimation

As in Table 6, the OLS regression includes only 235 observations who were WTP. OLS regression does not consider the zero responses in the sample and hence may encourage biased and inconsistent estimates of the parameters (Gujarati [16]). However, the results are presented for comparisons (if need arises) with the Tobit model.

Table 6: OLS regression results

Variables	**OLS estimates**
CONSTANT	9.3447 (3.3625)
RISK	-0.5789 (-0.4568)
SCALE	-0.2322 (-0.7414)
ENV	7.7413*** (3.3562)
AGE	-0.0689 (-1.1895)
GENDER	-3.1288*** (-3.0433)
RACE	1.6682* (1.6725)
KIDS	-0.2194 (-0.3986)
HMMB	0.4156* (1.6818)
TYPROF	0.7926 (0.7209)
EDU	2.6353** (2.3692)
HINC	0.0003*** (3.0743)
R^2	0.2424
Adjusted R^2	0.2050
n	235

Note: The figures in the parentheses are the *t* values.
*, **, *** indicate statistic significance at the 90, 95, and 99% confidence levels, respectively.

In the OLS model, 6 socioeconomic variables are significant in influencing the WTP and they are membership of environmental groups, gender, race, number of household members, educational level and household income.

Comparing the empirical results from the OLS and Tobit models, Whitehead, Hoban, and Clifford [17] suggested that in situation whereby the zero responses is high, the

probability of biasness in the OLS regression is higher relative to the Tobit model. Hence, it is suggested that while the OLS shows more significant variables than the Tobit model, its application should be used with precaution.

Estimated Mean and Total Economic Value

From the Tobit results, the estimated mean WTP is 25% and it is an encouraging value. It suggests that the population in general is WTP 25% extra for rice price by accepting rice subsidy reduction to support climate change mitigation projects. This suggests that the public on average would be WTP 0.45 cents more for a MYR1.80/kg rice by accepting a rice subsidy reduction impact to support the climate change mitigation project. This WTP amount is possible in local valuation works as Malaysians are even WTP up to additional MYR3.41 per month for improvement in solid waste disposal in the work of Pek & Jamal [18]. The amount of 0.45 cents makes up the rice subsidy reduction impact for about 8 kg of rice per month.

With the estimated mean of WTP, the total economic value (TEV) of climate change on food security can be computed. The economic impact calculated stands at MYR557 million per year (0.45 cents * 235/456 * 2.4 million). The computation can be done by translating the WTP% into monetary value (25% * MYR1.80) = 0.45 cents and then multiple it with the ratio of WTP respondents and total respondents (234/456) and rice consumption of Malaysian per year at 2.4 million tonnes (The Business Times [8]).

Policy Implications and Conclusion

The moderate public WTP by accepting a rice subsidy reduction impact of 25% shows an encouraging response in support of the climate change programmes. This reveals a further opportunity for the public to participate more in climate change activities and the government to provide more resources to mitigate the climate change effects on rice production. Since rice is the staple food for Malaysians, ensuring its continuous production would mean enhancing the food security of the country.

The substantial economic impact of climate change on food security of MYR534 million per year shows a significant concern of the public for food security of the country. This reveals to the policy makers that more responsible climate change mitigation programmes to ensure food security is in demand. The government may have to re-look and improve on the current climate change and food security bills if they are not being effective in their implementations.

In closing, the contingent valuation application can be used to evaluate the economic impact of climate change on food security. The estimates derived from this study, which have been aggregated to determine the TEV accrued to the wider community would be useful in the benefits and costs analysis of climate change mitigation programmes to sustain food security. Policy makers in the environment and natural resources ministries or other regulators can identify responsible mitigation plans that yield the greatest net benefit to the society.

References

[1] IPCC. 2007. Summary for Policymakers. In: Solomon, S./Qin, D./Manning, M./Chen, Z./Marquis, M./Averyt, K.B./Tignor, M./Miller, H. (eds.): Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge u.a.: Cambridge University Press. Available at: http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_SPM.pdf

[2] Kovats S, Ebi KL, Menne B, Campbell-Lendrum D, Canziani OF, Githeko A, et al. Methods of assessing human health vulnerability and public health adaptation to climate change. Health and global environmental change. Series no.1. Copenhagen, Denmark: WHO/EURO; 2003.

[3] Stern, N. 2006. The economics of climate change, Cambridge University Press.

[4] FAO. 1996. Rome declaration on world food security and world food summit plan of action. In: World Food Summit: 13-17.

[5] Center for Global Development. 2007. World Agriculture Faces Serious Decline from Global Warming. Available at: http://www.cgdev.org/content/article /detail/14404

[6] Ng, M.W., Camerlengo, A. & Abd. Wahab, A.K. 2005. A study of global warming in Malaysia. *Jurnal Teknologi* 42(F): 1-10.

[7] Abdullah, M.Y. (undated). Climate change and food security. MARDI.Available at: http://www.undp.org.my/uploads/g_Food_security_MARDI.pdf

[8] The Business Times. Available at http://wwwl.btimes.com.my/current_news/BTIMES/articles/benas/Article. Print dated 22 July 2011.

[9] Diamond, P. & Hausman, J. 1994. Contingent valuation: is some number better than no number? *Journal of Economic Perspectives* 8: 45-64.

[10] Yoo, S.H. & Kwak, S.Y. 2009. Willingness to pay for green electricity in Korea: A contingent valuation study. *Energy Policy* 37: 5408-5416.

[11] The Brunei Times. Available at http://www.bt.com.bn/node/40943. print dated 14 May 2008.

[12] Mitchell, R.C. & Carson, R.T. 1989. Using surveys to value public goods: The contingent valuation method. *Resources for the Future*, Washington, D.C.

[13] List, J. A. and Gallet, C. A. 2001. "What Experimental Protocol Influence Disparities between Actual and Hypothetical Stated Values? Evidence from a Meta-analysis," *Environmental and Resource Economics*, 20: 241-254.

[14] Kim, H. J. and Cho, Y.S. 2002."Estimating the Willingness to Pay for Reduced Copper Contamination in Southwestern Minnesota," *Journal of Agricultural and Resource Economics,* 27(2): 450-463.

[15] Bateman, I. J. and Turner, R.K.1993. "Valuation of the Environment, Methods and Techniques: The Contingent Valuation Method," in *Sustainable Environmental Economics and Management*: *Principle and Practice*, R.K. Turner ed., Chichester: Wiley: 120-191.

[16] Gujarati, D.N. 2003. *Basic Econometrics.* New York: McGraw-Hill/Irwin.

[17] Whitehead, J.C., Hoban, T.J., & Clifford, W.B. (1995). Measurement Issues with Iterated, Continuous/ Interval Contingent Valuation Data. *Journal of Environmental Management*. 43: 129-139

[18] Pek, C.K. & Jamal, O. 2010. Household demand for solid waste disposal options in Malaysia. *International Journal of Human and Social Sciences* 5: 905-910.