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Research on the consumption behavior of green agricultural products based on the perspective of substitutive ability

Guocheng Xiang, Shihu Zhong and Shaofeng Han

Hunan University of Science and Technology, Xiangtan, Hunan 411201, China.
New Classical Research Institute of Hunan, Xiangtan, Hunan 411100, China.

Abstract[1]

According to the consumer's behavior theory, Michael Porter diamond model and Hanemann theory, this paper constructed the theoretical model of the measurement of substitutive ability of green agricultural product, and proposed three related hypotheses. Then we use this model to analyze the data of the consumption behavior of the green agricultural products of the urban residents. The empirical results show that: The substitutive ability can significantly reflect the purchase behavior of green agricultural products. Even if the green agricultural product overflow price is in line with the expectations of consumers, and switching desire is strong, affected by the switching costs, consumers will not also tend to choose green agricultural products. There is a difference between purchase intention and purchase behavior. Compared with the ordinary agricultural products, urban residents are willing to pay more 0. 093 dollars per kilogram for no carbon tag certification of green agricultural products, urban residents are willing to pay more 0. 1541 dollars per kilogram for carbon tag certification of green agricultural product.

Keywords: green agricultural products, substitutive ability, WTP, CVM, consuming behavior

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[1]*Hunan University of Science and Technology,Xiangtan, Hunan 411201,China*
[1]*New Classical Research Institute of Hunan,Xiangtan, Hunan 411100,China*

INTRODUCTION

"Green upgrades" which as the important part of ecological civilization construction has An irreplaceable significance. China's green upgrade tend to focus on the industrial sector while ignoring the traditional agricultural sector. According to the fourth assessment report of IPCC in 2007, the total amount of greenhouse gases such as carbon dioxide emissions from agricultural production is second only to electric heating, it accounts for about 13. 5% of the global total and becomes the second largest greenhouse gas emissions[1]. The total greenhouse gas emissions account for about 17% of the country's total emissions in china[2]. Therefore, it is urgent to promote the consumption of green agricultural products.

The development of any product can not be separated from the market. Compared with the developed countries, China's consumption of green agricultural products is still quite low[3]. Most of the existing researches have been focused on the measurement of the consumer will of green agricultural products, while ignoring the distance that the consumption will be transformed into the consumer behavior[4-5]. There is no system to consider the size of the substitutive ability associated with the green agricultural products and general agricultural products.

Therefore, the purpose of this paper is to construct the measurement model of the substitutive ability and study on the consumption behavior of green agricultural products[6-7].

MATERIALS AND METHODS

Hypothesis propose:

The green agricultural products has the dual value structure, including the basic value of meeting the consumer's demand and the environmental value of the reduction of carbon emission in the disposal process of production, consumption, and consumption. Urban residents which as a will maximize their own utility by the choice of the consumption. This utility includes direct and indirect effects. According to the "Michael Porter diamond model" and "Hawkins model", we can build a flow chart of the purchasing behavior of green agricultural products[8-10]. It is shown in Fig. 1.

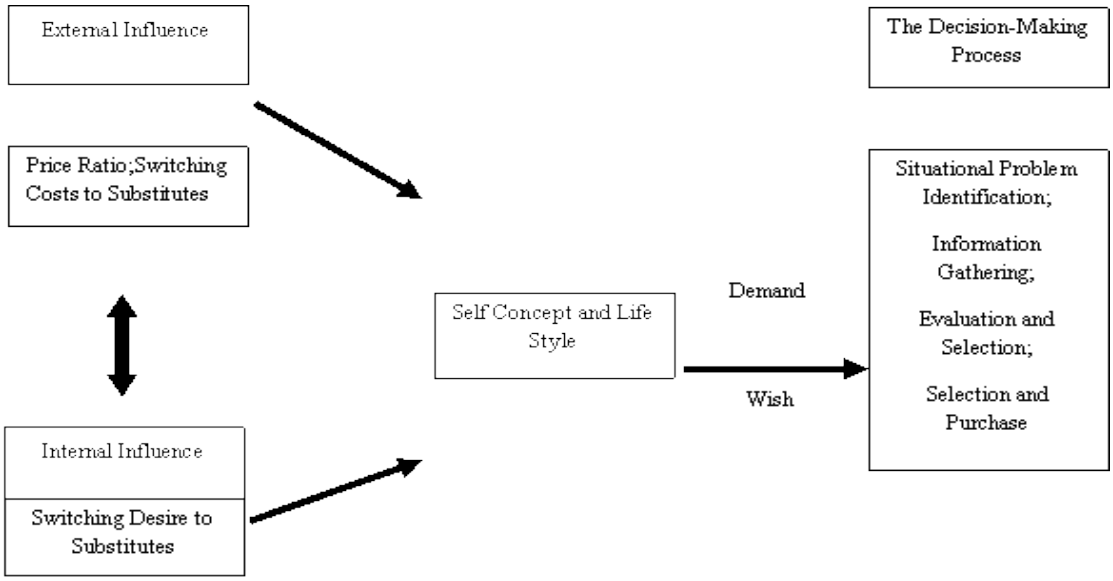

Figure 1: Factors affecting the purchase behavior of green agricultural products by urban residents

To sum up, we put forward the following hypothesis:

Hypothesis 1: When the substitutive ability of the green agricultural products is equal to 1, consumers believe that there is no difference between the green agricultural products and general agricultural products.

Hypothesis 2: When the other external conditions is fixed, the greater the substitutive ability of the green agricultural products, the greater the possibility of the purchase behavior of the consumer's green agricultural products.

Hypothesis 3: The substitutive ability of green agricultural products is proportional to the WTP, and is inversely proportional to the switching costs, which is proportional to the switching desire.

RESEARCH DESIGN

Questionnaire design:

Based on the theory of the consumption behavior of green agricultural products, the questionnaire of the consumption of green rice was designed. the consumption of green rice is determined by the price ratio of green rice and ordinary rice, the switching costs and desire of urban residents who switch to purchasing green agricultural products. The price are randomly set based on the base period price.

At present, the scholars mainly use the contingent valuation method, the disease cost estimation method, the test market auction, and so on to study the willingness of the payment for environmental resources of consumers. The application of contingent valuation method (CVM) in the field of environmental value assessment has been quite mature, and is considered to be the most suitable research method. The CVM method is based on Hicks's theory of consumer surplus, imagining a virtual market for a product that does not have an actual transaction to make monetary estimate, so as to draw the consumer's willingness to pay(WTP). In this paper, the specific scenarios are as follows: You go to the market to buy rice, rice is divided into ordinary rice and green rice. The taste and quality of the two types' rice is the same, but the production process of carbon emission levels are different. The carbon emission in the process of the production of green rice was significantly less than that of ordinary rice, and carbon emissions are harmful to the environment. In addition, the corresponding data and case studies are also included to illustrate the health risks posed by environmental pollution, to enable consumers to understand the situation more clearly. The specific questions using the semi double step two select type. Firstly, we asked consumers, in the initial price of 0. 5 dollars, which is consistent with the average price of ordinary rice, whether they are willing to buy green rice. If the consumer's answer is “yes”, we will continue to use a random price which is higher than the average price of ordinary rice, to asked consumers whether they are willing to buy green rice in order to the value of environment. If the consumer's answer is “no”in the conditions of the initial price, then the interview is end.

Investigation method:

Research group's survey site is Changsha City, Zhuzhou city and Xiangtan city, and we mainly used the questionnaire survey method. The object of investigation is the major buyers of rice, survey sites include community market, supermarket and agricultural market. In order to ensure the dispersion of samples, we have roughly equal proportion of the questionnaire in the three places above, and it is 180, 140 and 120 respectively. We adopt the method of random sampling to completed 440 questionnaire from March 2015 to July, and 410 of them were effective sample. The effective rate of sample was 93. 18%. The questionnaire what mainly includes two parts contents are as follows. On the one hand it is the question related to the conversion cost and desire, on the other hand it is the question linked to the WTP.

Data statistics:

Switching costs:

The switching costs of urban residents who switch to purchasing green agricultural products is mainly affected by personal characteristics, family characteristics and the convenience of purchase in three aspects. The measure is mainly through the

information reflected by the questionnaire. Personal characteristic variables include gender, age and education level of 3 items. Family characteristics variables include monthly income of 1 items. Purchase convenience include the purchase of the main ways of 1 items. Data is shown in Table 1.

Table 1: Data associated with switching costs

Features	Classification	Number	Ratio
Sex	Male	134	32. 68%
	Female	276	67. 32%
	19 years old and below	20	4. 88%
	20~29 years old	126	30. 73%
Age	30~39 years old	152	37. 07%
	40~49 years old	64	15. 61%
	50 years old and above	48	11. 71%
	Junior high school and below	98	23. 90%
Education	High school	132	32. 20%
	Junior college or university	140	34. 15%
	Master's degree and above	40	9. 75%
	500 dollars and below	70	17. 07%
Income	500~1000 dollars	144	35. 12%
	1000~1500 dollars	112	27. 32%
	2000 dollars and above	84	20. 49%
	Community market	42	10. 24%
Way	Supermarket	278	67. 81%
	Agricultural market	66	16. 10%
	Others	24	5. 85%

Switching desire:

The switching desire of urban residents who switch to purchasing green agricultural products is mainly affected by habits, motivation, subjective cognitive ability and objective cognitive ability in four aspects. Buying habit variables include purchase frequency of 1 items. Motivational variables include two item, such as “Whether the purchase of green agricultural products can reduce environmental pollution?”. Subjective cognitive ability variables includes two items, such as “What is the impact of environmental pollution on everyday life?” Objective cognitive ability variables include two items. Data is shown in Table 2.

Table 2: Data associated with switching desire

What is the impact of environmental pollution on everyday life?				
Influence degree	Large	Small	Moderate	No
Number	68	104	194	44
Comparison of pollution degree	Ordinary rice has larger pollution		Green rice has larger pollution	
Number	272		138	
Ratio	66. 34%		33. 66%	
What is the effect of the purchase of green agricultural products can reduce environmental pollution				
Effect size	Large	Small	Moderate	No
Number	124	82	166	38
Ratio	30. 24%	20. 00%	40. 49%	9. 27%
Category	Way	Number	Ratio	
	Once a week	16	3. 90%	
The frequency of buy rice	Once a month	250	60. 98%	
	Once in two months	86	20. 97%	
	Once in three months	58	14. 15%	

WTP:

The CVM method was used to inquire whether the urban residents are willing to choose to buy green rice at a given price in the survey. The survey results show: When the price of green rice and ordinary rice are 0. 5 dollars, there are 32 people choose ordinary rice accounted for 7. 8% of the total number. In the case of the same price of green rice and ordinary rice, the reason why they do not want to buy green rice is as follows. Firstly, they do not realize the harm of environmental pollution. Secondly, the understanding of agricultural carbon emissions is not enough, they are not aware of the importance of green agriculture. Thirdly, it is a kind of attitude of “none of my business, hang up”. Finally, they do not dare to buy green agricultural products, because they do not know if green agricultural products is safe. As can be seen from the table 3, the propensity to purchase of green rice is significantly decreased with the increase of the price, and at the same price, they tend to spend more when green agricultural products have carbon tags.

Table 3: Data associated with WTP

Carbon tags	Random price	Number	Willing to buy	Ratio
	0. 6	78	38	48. 72%
	0. 7	72	24	33. 33%
Not have	0. 8	70	20	28. 57%
	0. 9	118	26	22. 03%
	1. 0	40	6	15%
	2. 5	78	62	79. 49%
	3. 0	72	40	55. 56%
Have	3. 5	70	30	42. 85%
	4. 0	118	38	32. 20%
	4. 5	40	10	25%

Model Construction

The computing method is shown as follows. Firstly, according to Hanemann theory, in the case of a given price, the probability of the willingness of payment can be estimated by using Probit or Logit model. So the basic relationship can be gained:

$$\Pr ob(Yes) = 1 - \{1 + \exp[b_0 - b_1(x)]\}^{-1} \quad (1)$$

Among them, b_0 and b_1 are coefficients of Probit or Logit regression function, x is the number of the bids that the respondent has been asked to pay.

Secondly, when the willingness to pay(WTP) is greater than or equal to zero, Hanemann gives the formula for calculating the expected value of WTP from the above equation:

$$E(WTP) = (1/b_1) * \ln(1 + e^{b_0}) \quad (2)$$

In formula, b_1 is the effect of random money payment on the behavior of purchase of green rice. If there are no other explanatory variables in the model, b_0 is the constant term in the equation. If there are other explanatory variables in the model, b_0 is the product of the coefficient of the constant term and other explanatory variables and their mean values.

Thirdly, according to the purpose of research and the specific needs, we set multiple linear regression model to represent the direct effect and indirect effect of urban residents to buy rice (green rice or ordinary rice). In order to the convenience of

discussions, the direct effect and the indirect utility are unified by U, the model is as follows:

$$U = \alpha + \beta X + \gamma p + e \tag{3}$$

Among them, *X* represents factors affecting consumer utility, such as age, cognition, habit. *P* is the purchase of price of rice. *e* is a random perturbation term. Next, we use the index 1 and 0 respectively on behalf of the purchase of green rice and buying ordinary rice.

So, the utility of urban residents to buy green rice can be obtained:

$$U_1 = \alpha_1 + \beta_1 X_1 + \gamma_1 p_1 + e_1 \tag{4}$$

The utility of the purchase of ordinary rice can be acquired:

$$U_0 = \alpha_0 + \beta_0 X_0 + \gamma_0 p_0 + e_0 \tag{5}$$

Therefore, the difference between the utility for both can be achieved:

$$\Delta U = (\alpha_1 - \alpha_0) + (\beta_1 X_1 - \beta_0 X_0) + (\gamma_1 p_1 - \gamma_0 p_0) + (e_1 - e_0) \tag{6}$$

Fourthly, setting the price of ordinary rice as the base price, so we can make assumptions:

$$\gamma p = \gamma_1 p_1 - \gamma_0 p_0 \tag{7}$$

And in a certain price range, the price elasticity of consumer's demand remains unchanged, that's:

$$\gamma = \gamma_1 = \gamma_0 \tag{8}$$

Then, we make hypothesis, $\alpha = \alpha_1 - \alpha_0$, $\beta X = \beta_1 X_1 - \beta_0 X_0$, $e = e_1 - e_0$, So, the utility difference can be expressed:

$$\Delta U = \alpha + \beta X + \gamma p + e \tag{9}$$

Therefore, the probability of choosing to buy green rice can be gained:

$$\Pr ob(Y = 1) = \Pr ob(\Delta U > 0) = \Pr ob[e > -(\alpha + \beta X + \gamma p)] \tag{10}$$

We assume that the residuals obey the logical distribution, thus:

$$\Pr ob(Y = 1) = 1 - 1/(1 + e^{\alpha + \beta X + \gamma p}) = e^{\alpha + \beta X + \gamma p}/(1 + e^{\alpha + \beta X + \gamma p}) \tag{11}$$

Transformed into the basic form of Logistic equation:

$$Logit(p_1) = \ln(p_1/(1 - p_1)) = \alpha + \beta X + \gamma p \tag{12}$$

In expression, p_1 is the probability of occurrence of the behavior of urban residents to buy green rice, X represents the switching costs and desire of urban residents who switch to purchasing green agricultural products, p is the difference between the price of green rice and ordinary rice, α is the intercept, β, γ are the regression coefficients for X, p respectively.

Finally, WTP can be obtained:

$$E(WTP) = [1/(-\gamma)] * \ln(1 + e^{\alpha + \beta E(X)}) \quad (13)$$

Then, the calculation formula of substitutive ability(SA) can be gained:

$$Sa = (p_0 + WTP) / p_0 * e^{\beta} \quad (14)$$

Variable specification:

We use the binary logistic model to analyze the choice behavior of green rice of the urban residents in the case of a given random price. The explanatory variable is whether the urban residents choose to buy green rice. Explanatory variables include the price of green rice, the switching costs and desire of urban residents who switch to purchasing green agricultural products. Specific variable settings are as follows.

Table 4: Variable setting and value

Variable	Value	Meaning and description
Purchasing behavior	0-1	0=NO； 1=YES
Price	0.5-1	Consumers' willingness to pay for green rice
Sex	0-1	0=Male, 1=Female
Age	1-4	1=19 years old and below or 50 years old and above 2=20~29 years old, 3=30~39 years old, 4=40~49 years old
Income	1-4	1=500 dollars and below, 2=500~1000 dollar, 3=1000~1500 dollars, 4=2000 dollars and above
Education	1-4	1=Junior high school and below, 2=High school, 3=Junior college or university, 4= Master's degree and above
Pollution	1-2	1=Yes, 2=No
Influence	1-4	1=Large, 2=Moderate, 3=Small, 4=No
Know	1-4	1=Never, 2= Hear, 3=Understand, 4=Very understanding

Comparison	1-4	1=Green rice has larger pollution, 2=Ordinary rice has larger pollution
Effect size	1-4	1=No, 2=Small, 3=Moderate, 4=Large
Way	1-4	1=Agricultural market, 2=Others, Community market, 4=Supermarket
Frequency	1-4	1=Once in three months, 2=Once in two months, 3=Once a month, 4=Once a week

RESULTS AND DISCUSSION

Estimation results of the model:

This paper use Stata13. 0 statistical software to analyze the data of 378 urban residents in the case of no carbon tag and carbon tag. The results are shown in Table 5 and Table 6.

Table 5: Regression results without carbon tag certification

Variable	*Coefficient*	*SE*	*Wald*
Price	-5. 6502**	0. 1021	8. 3641
Age	0. 8312**	0. 0115	3. 7261
Sex	-1. 2290*	-0. 4350	2. 6252
Income	0. 9063***	0. 1121	5. 8927
Education	0. 8726*	0. 1639	4. 6233
Pollution	0. 6324	2. 3651	0. 2645
Influence	0. 7762	3. 1635	1. 3571
Know	0. 1652	3. 7231	0. 8637
Comparison	0. 2132	3. 6172	0. 6730
Effect size	0. 8427	3. 1136	1. 2615
Way	-0. 5326*	-0. 2342	3. 1361
Frequency	0. 1211*	0. 0265	3. 9702
Intercept	0. 5306	1. 2381	2. 3201

*Note: *, **, *** respectively expressed in the 10%, 5% and 1% of the confidence level is significant.*

Table 6: Regression results with carbon tag certification

Variable	*Coefficient*	*SE*	*Wald*
Price	-3. 5502**	0. 0736	3. 5130
Age	0. 8633***	0. 0172	4. 6301
Sex	-0. 3106*	-0. 4163	3. 3420
Income	0. 9620***	0. 1020	6. 8312
Education	0. 7327*	0. 0630	3. 7832
Pollution	0. 7161	1. 2356	0. 9612
Influence	0. 8324	2. 1143	1. 5276
Know	0. 2173	2. 5340	2. 7361
Comparison	0. 3641	1. 7361	1. 7612
Effect size	0. 8956	3. 0821	1. 1032
Way	-0. 5963*	-. 01710	3. 2331
Frequency	0. 2371*	0. 1021	5. 3202
Intercept	0. 7231	0. 2033	4. 6301

*Note: *, **, *** respectively expressed in the 10%, 5% and 1% of the confidence level is significant.*

WTP and SA:

Based on the calculation formula of the average willingness to pay (WTP) and the substitutive ability, the calculated results can be obtained:

When there is no carbon tag certification:

$E(WTP) = 0.093 dollars$, $Sa = 0.8488$.

When there is carbon label certification:

$E(WTP) = 0.1541 dollars$, $Sa = 1.2149$.

Analysis of measurement results:

Through the above empirical analysis, we can know: Compared with the ordinary rice, urban residents are willing to pay more 0. 093 dollars per kilogram for no carbon tag certification of green rice, the rise in the price of payment is 18. 6%, the substitutive ability is 0. 8488. Compared with the ordinary rice, urban residents are willing to pay more 0. 1541 dollars per kilogram for carbon tag certification of green rice, the rise in the price of payment is 30. 82%, the substitutive ability is 1. 2149. This indicates: In the absence of certification of carbon tag, even if the low carbon overflow price is in line with the expectations of consumers, they will also tend to choose ordinary agricultural

products. In the case of certification of carbon tag, and the price is in line with the expectations of consumers, they will tend to buy green agricultural products. The substitutive ability can significantly reflect the purchase behavior of green agricultural products. Hypothesis1, Hypothesis2 and Hypothesis3 are reasonable.

CONCLUSION

This paper is based on the Hanemann theory, constructed the measurement model of the substitutive ability of green agricultural product, and did the related test based on the data obtained through the questionnaire survey of the research group. The following conclusions are gained:

The purchasing behavior of green agricultural products is in inverse proportion to the price of green agricultural products, which is directly proportional to the price of common agricultural products. This is due to the substitutive effect and income effect of the price change. The buying behavior of green agricultural products is proportional to the age level (except for the age of 50 years), This is because the 50 year old and above the consumer level is generally conservative, the ability to accept new products is weak, the desire to buy green agricultural products is low. The purchase behavior of green agricultural products is directly proportional to the income and education level.

The effects of other variables were not significant. This is due to people's awareness of green agricultural products is not high, and green agricultural products market is not perfect.

In the absence of certification of carbon tag, consumers will also tend to choose ordinary agricultural products. This is due to the existence of information asymmetry, in the inferior position of the buyers cannot very good understanding of green agricultural products, they can not accurately identify the identity of the seller, leading to the emergence of adverse selection. And because the extra utility of green agricultural products is mainly positive externality, it will appear the phenomenon of moral hazard and free rider. Thus, it can further reduce the substitutive ability of green agricultural products.

In the case of carbon label certification, consumers will tend to buy green agricultural products. And consumers are less sensitive to price, and other factors that influence the significant variables are greater, so the behavior of purchase of green agricultural products is more likely to occur. This is due to certification has eased the information asymmetry between the producer and the consumer. To a certain extent, it has played a role in enhancing people's confidence in green agricultural products.

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