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# **Food Expenditures: The Effect of a Vegetarian Diet and Organic Foods**

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## **Food Expenditures: The Effect of a Vegetarian Diet and Organic Foods**

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## **Introduction**

This paper examines the effect of following a vegetarian diet as well as purchasing organic foods on monthly food expenditures. The following section will provide an introduction to the general problem to be addressed in this paper followed by the motivation driving the research. We will then present a review of recent literature that focuses on organic food purchasing behavior. There are several studies that address the consumption of organic foods, however, few studies have been conducted on the costs and benefits of vegetarianism. Consequently, we focus on one paper (Lusk and Norwood, 2009) that evaluates those specific aspects of vegetarianism – i.e. costs and benefits of following a vegetarian diet. After reviewing these studies, the empirical model used – ordered probit model – will be presented followed by a description of both the dependent and independent variables. The paper will conclude with an analysis of results found as well as a discussion of future research possibilities.

## **Problem and Motivation: Organic Foods and Vegetarianism**

Food consumption and expenditure studies are essential parts of market research. They allow us to better understand the motivation behind individual and household purchase behavior. They also aid us in determining factors driving these behaviors to better implement marketing strategies, funding initiatives and food safety regulations. Recent research has focused its attention on a trend that has grown exponentially over the past decade, one that has captured the attention of agriculture communities all over the world. Organic agriculture has proven its popularity with growing sales over the past decade. On average, organic products have generated \$5 billion in sales per year over the last decade (Guido et al. 2009) and can now be found in any conventional supermarket. Before the commercialization of organic foods, nearly two thirds of

available organic products were sold by natural products retailers. A consumer searching for organic products would always have to seek a specialty grocer or natural retailer to purchase these types of foods. According to a USDA report, these natural retailers only occupied 1% of all food stores in the United States (Dimitri and Greene, 2002). Consequently, organic foods were not readily available until large supermarkets began to identify and adapt to the growing trend in organic agriculture. By the year 2000, conventional supermarkets were selling 49% percent of organic products and some were also outselling natural retailers in categories such as organic milk and tofu (Dimitri and Greene, 2002).

The decision to purchase organic goods can depend on several factors and many studies (Guido et Al, 2009; Honkanen et al. 2006) have evaluated and tested these features. It was found that consumer ethical values and particular attitudes had a great deal of influence when making the decision to purchase organic goods (Honkanen et al. 2006). When evaluating these attitudes towards organic foods, “ecological motives had the strongest impact on attitudes, indicating the important role of environmental and animal welfare concerns in forming attitudes towards consuming organic food.” (Honkanen et al. 2006, p. 426). Considering the importance attributed to environmental friendliness and the recent growth in “green” initiatives in today’s society, these results are not considerably shocking. If environmental and animal welfare is atop the list of important things to consider when purchasing organic foods, then new research must consider the driving factors that create these types of behaviors. Consequently, what type of consumer considers these aspects, environmental and animal welfare, when purchasing foods? To help answer this question, this study will focus on the comparison of a consumer following a vegetarian diet with one who is non-vegetarian. In particular, we will examine the purchase

behavior of a vegetarian consumer as well as organic food consumption to analyze the effect on food expenditures.

The choice to compare a vegetarian to a non-vegetarian consumer is driven by recent food trends and increased pressure from advocacy groups and both alternative and mainstream media to convert to vegetarianism. NVW (National Vegetarian Week), PETA (People for the Ethical Treatment of Animals), and VegSoc (The Vegetarian Society) can easily be cited by vegetarian or vegan consumers but have little meaning to non-vegetarian followers. These are all examples of groups determined to promote this type of diet as the future of going green with food.

Vegetarianism is not only a diet choice but it is also part of a growing, global trend as a way to become animal and environmentally friendly. According to Canadian Food Trends 2020, “Generation Y consumers know where and how to get reliable food information, understand the importance of healthy eating, and will demand cutting edge convenient, exotic, vegetarian, and organic food options.” (Consumption Trends to 2020). Generation Y is defined as all consumers born in the 1980s and early 1990s. This report also indicated that 1 in 10 people responding to a survey are classifying themselves as a vegetarian.

Media groups that are continuing to emphasize the importance and needfulness of a vegetarian diet are also fueled by the influence of pop culture trends. Musicians and actors are among the top influential people when it comes to popular fads. A large portion of these icons have converted to vegetarianism to promote their outlook on the environment and aversion to animal cruelty. If this trend is to continue, a greater amount of research needs to be conducted in order to evaluate the benefits and costs associated with vegetarianism. We must be able to

evaluate the driving factors behind the vegetarian consumption behavior in order to fully understand the decisions to convert and maintain this lifestyle.

## **Recent Literature**

Studies cited above were motivated by the increased organic agriculture sales in the last decade. They focused on factors driving organic consumption such as ethics, moral norms and attitudes. They did not consider the effect of income or food expenditures on this consumption nor did they incorporate the different types of food regimes that could influence the necessity or desire for organic foods. Honkanen et al. did consider the effect of religious motives. One could interpret this factor as a food regime specification since many religions prohibit certain types of food. However, religious values did not demonstrate a strong influence on the purchase of organic foods (Honkanen et al. 2006). This finding begs more research to determine the effect of different types of food regimes on food consumption behaviors and expenditures.

Another study conducted by Onyango et al. showed that the consumption of organic foods was positively affected by naturalness, vegetarian-vegan labeling and production location. This study did not account for a vegetarian diet being followed by the consumer, but rather the labeling of foods as vegetarian-vegan and their effect on organic purchases (Onyango et al. 2009). On the other end of this argument, instead of evaluating the effects of different factors on organic purchases, Lusk and Norwood focused their study on a vegetarian consumer. Their study was motivated by the lack of economic research on vegetarianism. As this study was motivated by the increased promotion of vegetarianism and lack of empirical work in the field, Lusk and Norwood 2009 also felt that the literature was limited in this subject. “A search for the word ‘vegetarian’ in the database EconLit yielded only 5 peer-reviewed journal articles, and only one

of these explicitly attempted to investigate the economic effects of vegetarianism.” (Lusk and Norwood. 2009, p. 111). The authors evaluated the differences between energy consumption of animal protein production and plant based sources. As expected, they found that the production cost of plant based protein was much lower than the cost of animal based protein. However, the important thing to consider is the nature of the result. This cost was evaluated at the farm level and as a consumer, many products undergo a processing stage. When food products are subject to a type of transformation and processing procedure, these processes always entail more economic activities which can cause increased pollution and thus decrease the overall environmental friendliness of the product. They also evaluated the costs at a retail level and found that the costs were still lower for commodity goods but much less pronounced. The interesting part of this study was when the authors examined the importance of meat products and the value attributed to meat by consumers. They showed that meat is actually the most valued food source of Americans (Lusk and Norwood. 2009). Therefore, promoting the vegetarian diet as an environmentally friendly diet would have to overcome the high value given to the purchase and consumption of meat. The authors also claimed that the inclusion of meat products in one’s diet increased their overall food costs. “Other studies have shown that, consistent with our results, vegetarian diets reduce food costs.” (Lusk and Norwood. 2009, p.114). This was a relatively minor section of their study. However, if vegetarian advocates continue to promote the idea that meat production is inefficient and that converting to vegetarianism would decrease farm pollution (Lusk and Norwood. 2009), then evaluating the costs related to food expenditures under this type of diet merits considerable attention.

After reviewing the literature, there seems to be a large disconnect between the advocacy for a vegetarian diet and the research proving the benefits of this lifestyle. To fill this gap, this

study will focus on food expenditures and how a vegetarian diet and organic food consumption affects overall food costs. Specifically, what is the probability of a vegetarian household spending more money on groceries than a non-vegetarian household?

### **The Vegetarian Consumer**

Let us consider a few general assumptions regarding the consumer and their choices relative to their food consumption. Consumer choice economics tells us that consumers are always looking to maximize their utility when purchasing goods. This involves making choices based on budget constraints and preferences. If we take this into account, then we can suppose that converting to a vegetarian diet is benefitting the consumer in some way. As mentioned above, a claim has been made that food costs associated with a vegetarian diet are less than that of a non-vegetarian diet. If food expense is at the top of a consumer's priority list, then converting to a vegetarian diet might be beneficial, so long as the claim is in fact true. However, there has been no empirical work done proving this claim and thus we cannot conclude that a vegetarian has a smaller food bill than a non-vegetarian consumer.

Claiming that food expenses are one of the only factors driving a consumer's decision to convert to vegetarianism would be a large misinterpretation. Analyzing a consumer's choice to become a vegetarian becomes a little more involved than the general assumption that consumers seek to minimize their costs. This is not implying that all other consumers only consider costs. Other factors such as quality, origin and brand might play an important role when deciding to purchase goods. A vegetarian, however, also needs to consider other factors such as ingredients, environmental friendliness and animal treatment. These are only a few examples of the different



types on consideration that a vegetarian consumer might regard as important when purchasing foods.

If we consider a vegetarian consumer in a grocery store, we must remember that minimizing costs might not always be an option. A vegetarian consumer might not be able to purchase a cheaper good because it may contain animal products or by-products. Thus they are forced to buy the more expensive product because of their dietary restrictions. This can be applied to any type of dietary restriction including allergies, lactose-intolerance and the demands of a kosher diet. These examples all include some type of restriction that is forced upon by either health reasons or religious beliefs. However, a vegetarian is not obligated to restrict foods based on such reasons. With the exception of having allergies against animal products, a vegetarian lifestyle is otherwise a personal choice. A consumer is not born a vegetarian, like someone possessing an allergy. There are underlying factors that determine the choice to convert to vegetarianism.

As mentioned above, this paper is solely concerned with food expense and the effect of different factors on this variable. We are not concerned with the reasons one might have to convert to a vegetarian diet. Given that the literature is very limited, it should be noted that the recent popular trends around vegetarianism merit further research. Aside from the various reasons to convert, studying the expenses related to this diet seems to be an appropriate starting point.

## **Empirical Framework**

To examine the claims set forth above, this study will employ a survey conducted by Ipsos-Reid in 2006 to examine the consumer perceptions of food quality and Safety titled “Food

Safety and Quality, 2006 Tracking Study”. Data was collected for a total of 1600 respondents and 35 questions were included in the survey. Only a particular section of the survey will be used in this study. We wish to address the total amount of monthly food expenditures for a given household and how it is affected by a consumer’s diet preference and organic purchase behavior. A total of 9 questions will be used and described in more detail below. Each question represents a different characteristic of the consumer responding to the survey. This characteristic will then be used as a variable in our selected model. They will address whether a consumer follows a vegetarian diet, purchased organic foods in the last year, the number of children under the age of 18 living in the household, the age and gender of the respondent.

Given the nature of the survey and data, the model that best fits the estimation process is the Ordered Probit model. This type of analysis allows for the estimation of an ordinal dependent variable given a vector of independent variables and a vector of coefficients to be estimated. The Ordered Probit is a particular case of the Probit model. The latter uses the dependent variable as a binary response variable taking on a value of 1 given a particular outcome and 0 otherwise. The Ordered Probit allows us to have several different categories of responses for the dependent variable. Therefore, the dependent variable is an ordinal variable taking on the values of 0 through m, where m is the number of categories. Before describing each variable to be used and estimated, it would be beneficial to describe how the model is constructed.

The model is composed of the following components:

$$Y_i^* = X_i' \beta_i + e \quad \forall i = 1 \dots n \quad (1)$$

- $Y_i^*$  is the ordinal dependent variable with several different outcomes or categories. ( $J = 0 \dots m$ , where J is the outcome of  $Y_i^*$  and m is the number of outcomes for  $Y_i^*$ ).

- $X'_i\beta$  is the deterministic component or the index function where  $X'$  is a vector of independent variables and  $\beta$  is a vector of coefficients to be estimated.
- $e$  is the error term and assumed to be normally distributed with mean zero and standard deviation of one (Greene, p.737).

The index function can be thought of as the predictors of our dependent variable. Thus we are interested in determining how the change in these predictors translates into the probability of observing a certain ordinal outcome. Once the model is estimated, we are able to retrieve threshold parameters, which we will denote as  $u_i$ . These parameters are usually estimated by a maximum likelihood procedure. The number of threshold parameters depends on the number of ordinal outcomes in the model being estimated. For example, if the ordinal dependent variable has 4 categories ( $J=0, 1, 2$  and  $3$ ), then there will be 3 ( $m-1$ )  $u_i$  parameters estimated. The probabilities associated with each ordinal outcome can then be estimated with the help of these parameters and can be denoted as follows:

$$Prob(Y_i^* = 0) = Prob(Y_i^* \leq u_1) \quad (2)$$

$$Prob(Y_i^* = 1) = Prob(u_1 < Y_i^* \leq u_2) \quad (3)$$

$$Prob(Y_i^* = 2) = Prob(u_2 < Y_i^* \leq u_3) \quad (4)$$

$$Prob(Y_i^* = 3) = Prob(Y_i^* > u_3) \quad (5)$$

Each parameter  $u_i$  represents a threshold for the probability of the dependent variable switching from one category to the other.

The primary interest is to determine the affect of particular independent variables on the dependent variable. Once a model has been estimated, coefficients are then computed to determine these effects. If, for example, a linear regression model is estimated and coefficients for each independent variable are computed, we can predict the change in the dependent variable

given a change in the independent variable *ceteris paribus*. These marginal effects are estimated directly from these coefficients. For the ordered probit model, however, estimating these marginal effects becomes a little more involved. The coefficients estimated in this type of model do not represent the marginal effects and have no direct interpretation. This can be true for any nonlinear regression analysis. To determine these effects, we can use the estimated coefficients to calculate the probabilities of each ordinal outcome as well as their corresponding marginal probabilities. The next section is intended to provide an explanation of each variable to be included in the model and how it will be employed within the ordered probit model for this study.

### **Dependent and Independent Variables**

As mentioned above, the ordered probit model is used when the dependent variable can have an outcome of more than two categories. Unlike the probit model which uses a binary response, the ordered probit uses an ordinal response variable. The model to be estimated is as follows:

$$Y_i^* = \beta_0 + \beta_1 Vegornon + \beta_2 Buyorganic + \beta_3 yage + \beta_4 sage + \beta_5 male + e \quad (6)$$

The dependent variable in this study,  $Y_i^*$ , is the amount of food expenditures for a household in a given month. Respondents were given a scale with 11 different categories to identify the respective food costs for the household. The first category represented the lowest food expenditures and the eleventh represented the highest food expenditures. The ordered probit model will allow us to determine the probability of our dependent variable taking on a value between one and eleven given the presence of our independent variables. The expenditure categories on the survey range from under \$100 to over \$1,000 on a monthly basis. For

simplicity and regression analysis purposes, these categories have been condensed into 4 smaller groups and will be labeled as follows:

1.  $Y_i = 0$  if food expenditures are less than \$300.
2.  $Y_i = 1$  if food expenditures are between \$300 and less than \$600
3.  $Y_i = 2$  if food expenditures are between \$600 and less than \$900
4.  $Y_i = 3$  if food expenditures are \$900 or over

The hypothesis being put forth is that the existence of a vegetarian diet will increase the probability of food expenditures being high. It is also hypothesized that purchasing organic foods will also increase overall food expenditures.

The first independent variable present in our index function is the choice to follow a vegetarian diet. It should be noted that a vegetarian diet can be a term which encompasses several definitions. The two most common categories are the lacto-ovo-vegetarians and vegans. Lacto-ovo-vegetarians abstain from all meat, fish and shellfish (Lusk and Norwood. 2009). However lacto-vegetarians do not eat eggs whereas an ovo-vegetarian does include eggs in their diet (Alley, 1995). Vegans are a much stricter version of these two types of vegetarians. In addition to abstaining from all foods excluded from a lacto-ovo vegetarian diet, they also eliminate all dairy and any other animal by-product. They can go as far as to exclude honey and gelatin from their diet. When a respondent answered that they were following a vegetarian diet, the answer recorded did not specify a particular type of vegetarian diet. Therefore, given the higher percentage of lacto-ovo vegetarians compared to vegans, we will restrict our definition to lacto-ovo vegetarians.

1.  $veggie = 1$ ; *Respondent is a vegetarian*
2.  $veggie = 0$ ; *Otherwise*

If a respondent was following a vegetarian diet, the variable will take on the value of one and zero otherwise. Therefore, if the probability of our dependent variable being in a higher category increases when the variable takes on a value of one, then we can assume that being a vegetarian consumer increases your overall food expenditures.

The second independent variable is the purchase of organic foods. When responding to the survey, consumers were not given a formal definition of organic agriculture. In this study, we define organic agriculture as one that does not employ pesticides, herbicides, inorganic fertilizers, antibiotics and growth hormones (Honkanen et al. 2006). Due to the nature of the response, we are unable to predict how much organic foods were purchased by the household. However, we are able to observe whether the purchase took place or not.

1. *organic = 1 ; Respondent bought organic foods*
2. *organic = 0 ; Respondent did not buy organic foods*

If the respondent purchased organic foods in the last year, the latent variable will take on a value of one. If the respondent did not purchase organic foods in the last year, the latent variable will take on a value of zero.

In addition to the use of these two variables, the probability of our dependent variable (food expenditures) will also be evaluated with the presence of three other dummy variables. The first dummy variable will allow us to control for the presence of children under the age of 18 in the household. There were 12 different categories in this section. The two categories containing the highest amount of respondents were one and two children. Since this needs to be treated as a dummy variable, it must be restricted to an outcome of 1 and 0 otherwise and will be defined as follows:

1. *children = 1 ; Household has one or more children under the age of 18*

2.  $children = 0$  ; *No children present in the household*

Given the nature of a dummy variable, this type of compartmentalization needed to be done. Thus, when *children* takes on a value of 1, it will include all responses from one child up to 12 children in the household whereas the alternative only includes one category (no children). This may create some difficulty in terms of evaluating the marginal effects of this variable. It is apparent that a household will have larger food expenditures when there are several children present as opposed to one child in the household. Nevertheless, this variable must be included to account for the larger expenditures when there are children present in the household.

The second dummy variable (*yage*) is a sub category of the age of the respondent. The survey included six different categories for this response. Each respondent was classified in one of three age categories (18-34, 35-54, 55+) and each one was labeled with a respective gender specification. In order to treat this as a dummy variable, the age and gender specifications were separated into 3 different categories. The variable *yage* represents the younger aged category (18-34).

1.  $yage = 1$ ; *Respondent is aged 18 – 34*
2.  $yage = 0$ ; *Otherwise*

Thus, the dummy variable *yage* will take on the value of 1 if a respondent falls into this category and 0 otherwise.

The second age category will be represented as *sage* and will denote the senior age category of 55 or over. This dummy variable will be 1 if the respondent is of aged 55 or over and will be 0 otherwise.

1.  $sage = 1$ ; *Respondent is aged 55 +*
2.  $sage = 0$ ; *Otherwise*

The middle aged category will not be represented as a dummy variable because if we specify this type of variable for each category, a dummy variable trap will be created. If all three age categories were included, then all three dummy variables would sum to one and cause perfect multicollinearity. Thus the 35-54 aged category has been dropped to avoid this problem.

The third and last dummy variable (*male*) will represent the gender of the respondent. If a respondent is a male, the dummy variable will take on the value of 1 and 0 otherwise.

1. *male* = 1; Respondent is a male
2. *male* = 0; Respondent is a female

Similar to the logic of dropping one of the age categories, we must also drop one of the gender categories to avoid the dummy variable trap. Specifically, there is no need for a female dummy variable because a respondent will be a female if the variable *male* takes on a value of 0.

## Analysis and Results

The model described above was estimated using the program Stata/IC 12.0. The ordered probit model was estimated as follows:

$$Y_i^* = \beta_0 + \beta_1 veggie + \beta_2 organic + \beta_3 children + \beta_4 yage + \beta_5 sage + \beta_6 male + e \quad (7)$$

A summary of the model estimates is represented in Table 1. Since the ordered probit model uses a maximum likelihood procedure, it is subjected to an iterative process. The first iteration (0) is testing the model with no predictors or the “null” model. The next iteration adds the predictors to the model and thus we can confirm that the model converged once the differences between the successive iterations are very small. The goal is to maximize the log likelihood which, in our case, happened at a log likelihood of -1629.5543 after 3 iterations. We then use this log likelihood value in the Likelihood Ratio Chi Square test (LR  $\chi^2$ ) to test



whether at least one coefficient estimate is not equal to zero. As Table 1 shows, the LR  $\chi^2$  is 288.82 with six degrees of freedom and has a small p-value  $<0.000$ . Thus we can confidently reject the null that at least one coefficient estimate is equal to zero. Since the ordered probit model does not have an equivalent to the R-Square value generated by an ordinary least square (OLS) regression, a Pseudo R-Square is computed in its place. It is an attempt to evaluate the goodness of fit of the model. This is very low R-squared value. However, it is a Pseudo R-Square and cannot be interpreted similarly to a regular R-Squared value. The model only used 1524 observation out of the 1600 that were available. The 76 observations that were dropped were not used either for a declination to answer a question posed by the surveyor or an unavailable response.

**Table 1. Ordered Probit Estimation Results**

<b>FoodExp</b>	<b>Coef.</b>	<b>Std. Err.</b>	<b>z</b>	<b>P&gt; z </b>	<b>[95% Conf. Interval</b>	
<b>veggie</b>	0.14	0.06	2.21	0.03	0.02	0.27
<b>organic</b>	0.17	0.06	2.85	0.00	0.05	0.29
<b>children</b>	0.81	0.07	12.08	0.00	0.68	0.94
<b>yage</b>	-0.56	0.07	-7.63	0.00	-0.70	-0.42
<b>sage</b>	-0.34	0.07	-4.50	0.00	-0.48	-0.19
<b>male</b>	-0.01	0.06	-0.22	0.83	-0.14	0.11
<b>/cut1</b>	-0.39	0.08			-0.54	-0.24
<b>/cut2</b>	1.11	0.08			0.95	1.27
<b>/cut3</b>	2.01	0.09			1.83	2.19

The Z value follows a standard normal distribution and is testing a two-sided null hypothesis that the coefficient for each independent variable is not equal to zero. This indicates that we can reject the null hypothesis if our Z value is outside the interval of -1.64 to 1.64. Thus we can reject the null hypothesis for all variables except *male*. Thus we must conclude that this

variable is not statistically different from zero given the presence of the other variables in the model.

Another key component of our analysis is the evaluation of the threshold points. Table 1 shows these at /cut1, /cut2 and /cut3. The coefficient estimates are the values of the threshold parameters that determine the change in the ordinal outcome of our dependent variable. This relationship is provided in equations (2), (3), (4) and (5) where /cut1, /cut2 and /cut3 are represented by  $\mu_1$ ,  $\mu_2$  and  $\mu_3$  respectively. The standard errors of these parameters are testing whether these coefficients are equal to zero. However, we are not concerned if they are equal to zero since they represent the threshold points of our dependent variable progressing from one outcome to the other. Given this relationship, we want to test whether these parameters are equal to each other. If they are equal to each other, this would eliminate some of the categories of our dependent variable. Table 2 summarizes the results of each test performed.

<b>Table 2. Test of Threshold Parameters (<math>\mu_i</math>)</b>		
	<b>Chi<sup>2</sup>(1)</b>	<b>Prob&gt;Chi<sup>2</sup></b>
$\mu_1 - \mu_2 = 0$	1049.46	0.0000
$\mu_1 - \mu_3 = 0$	1350.71	0.0000
$\mu_2 - \mu_3 = 0$	289.63	0.0000

All three tests had a p-value of 0.000. Thus we can confidently reject the null that these three parameters are equal.

We now must calculate the probability of each ordinal outcome of our dependent variable given the presence of our independent variables. These probabilities were calculated with equation (7) and the results are given in Table 3. Recall equations (2), (3), (4) and (5) and we can now plug in our threshold points into the probability measures:

$$Prob(Y_i = 0) = Prob(Y_i^* \leq -.3895) \quad (8)$$

$$Prob(Y_i = 1) = Prob(-.3895 < Y_i^* \leq 1.111) \quad (9)$$

$$Prob(Y_i = 2) = Prob(1.111 < Y_i^* \leq 2.1) \quad (10)$$

$$Prob(Y_i = 3) = Prob(Y_i^* > 2.1) \quad (11)$$

The highest and lowest probabilities for the dependent variable were given by group two and four, respectively. Hence, given the independent variables in our model, the probability of spending between \$300 and \$600 on food expenditures was the most frequently answered category and spending over \$900 was the least common category among respondents.

**Table 3. Probabilities for each ordinal outcome**

<b>P(Y=J)</b>	<b>%Probabilities</b>
Pr(Y= 0)	26.96%
Pr(Y= 1)	54.28%
Pr(Y= 2)	15.04%
Pr(Y= 3)	3.71%

Notice that the sum of these probabilities is equal to one. This must hold for our model to be consistent with our theory that the sum of all probabilities needs to equal one. If this holds, then we can also expect the sum of all marginal effects to equal zero. The figures in Table 3 are simply the probabilities of being in that particular group given the presence of the independent variables. However, the main focus is on the effect of each independent variable on this probability.

As mentioned earlier, the marginal effects of each independent variable on the dependent variable cannot be interpreted as the coefficients of the estimated model. In order to calculate these effects, let us re-define the equations from (2), (3), (4) and (5) as conditional probabilities:

$$Prob(Y_i^* = 0|x_i) = \Phi(-X'\beta) \quad (12)$$

$$Prob(Y_i^* = 1|x_i) = \Phi(u_1 - X'\beta) - \Phi(X'\beta) \quad (13)$$

$$Prob(Y_i^* = 2|x_i) = \Phi(u_2 - X'\beta) - \Phi(u_1 - X'\beta) \quad (14)$$

$$Prob(Y_i^* = 3|x_i) = 1 - \Phi(u_2 - X'\beta) \quad (15)$$

The function  $\Phi(.)$  is commonly used to represent the standard normal distribution (Greene, p.666). This is the general notation given by Greene for the ordered probit probabilities and is represented in vector notation. However, in our case,  $X'\beta$  is simply the first threshold and can be replaced by our value of  $u_1$  which would give us the following:

$$Prob(Y_i^* = 0|x_i) = \Phi(-.3895) \quad (16)$$

$$Prob(Y_i^* = 1|x_i) = \Phi(1.111 - .3895) - \Phi(-.3895) \quad (17)$$

$$Prob(Y_i^* = 2|x_i) = \Phi(2.1 - .3895) - \Phi(1.111 - .3895) \quad (18)$$

$$Prob(Y_i^* = 3|x_i) = 1 - \Phi(2.1 - .3895) \quad (19)$$

The impact of a continuous explanatory variable on probabilities of being part of a particular category of food expenditures can be calculated by taking the partial derivative of equations (16), (17), (18), and (19) (Greene, p. 668).

$$\frac{\partial P(Y=0|veggie)}{\partial veggie} = [\Phi - .3895] * \beta hat_1 \quad (20)$$

$$= -0.046$$

$$\frac{\partial P(Y=0|veggie)}{\partial veggie} = [\Phi(1.111 - .3895) - \Phi(-.3895)] * \beta hat_1 \quad (21)$$

$$= 0.007$$

$$\frac{\partial P(Y=0|veggie)}{\partial veggie} = [\Phi(2.1 - .3895) - \Phi(1.111 - .3895)] * \beta hat_1 \quad (22)$$

$$= 0.027$$

$$\frac{\partial P(Y=0|veggie)}{\partial veggie} = [\Phi(2.1 - .3895)] * \beta hat_1 \quad (23)$$

$$= 0.012$$

Note that  $\hat{\beta}_1$  is simply a notation to indicate that  $\hat{\beta}_1$  is an estimate of our coefficient  $\beta_1$  for our independent variable *veggie* in equation (7). The results above for the impact of being a vegetarian on overall food expenses are summarized in Table 4. The independent variable *organic* is also summarized in Table 4. These results represent the effect of a 1 unit increase in the independent variables on the probability of being in a particular category of food expenses. Recognize that the sum of all the marginal effects is zero which is consistent with the sum of all probabilities being equal to one. This allows us to control for the change in different probabilities. In particular, if one probability increases, another one must decrease for this property to hold.

Let us first evaluate the outcome of  $P(Y=0|X)$  for the independent variable *veggie* of  $-.046$ . This value represents a discrete change of the variable *veggie* from 0 to 1. Recall that a respondent was a vegetarian if *veggie* took on a value of 1 and 0 otherwise. Therefore, being a vegetarian negatively affects the probability of being in the first category of food expenses (\$0 to \$300). This is consistent with our hypothesis that vegetarians tend to have larger food bills than non-vegetarian consumers. This value,  $-.046$ , has a standard deviation of 0.020 and Z value of -2.25 which indicates that the marginal effect is statistically significant. Thus, a non-vegetarian consumer has a 4.46% higher chance of being in the lowest food expenditure category than a vegetarian consumer.

**Table 4. Marginal Effects of IVs *veggie* and *organic***

Marginal Effects - Pr(Y=0)							
Variable	dy/dx	Std. Err.	z	P> z	[ 95%	C.I. ]	X
<b>veggie</b>	-0.046	0.020	-2.250	0.024	-0.085	-0.006	0.287
<b>organic</b>	-0.059	0.021	-2.810	0.005	-0.100	-0.018	0.658
Marginal Effects - Pr(Y=1)							
Variable	dy/dx	Std. Err.	z	P> z	[ 95%	C.I. ]	X
<b>veggie</b>	0.007	0.003	2.360	0.018	0.001	0.012	0.287
<b>organic</b>	0.013	0.006	2.240	0.025	0.002	0.024	0.658
Marginal Effects - Pr(Y=2)							
Variable	dy/dx	Std. Err.	z	P> z	[ 95%	C.I. ]	X
<b>veggie</b>	0.027	0.012	2.170	0.030	0.003	0.051	0.287
<b>organic</b>	0.032	0.011	2.880	0.004	0.010	0.054	0.658
Marginal Effects - Pr(Y=3)							
Variable	dy/dx	Std. Err.	z	P> z	[ 95%	C.I. ]	X
<b>veggie</b>	0.012	0.006	2.060	0.039	0.001	0.024	0.287
<b>organic</b>	0.014	0.005	2.880	0.004	0.004	0.023	0.658

All other marginal effects of our variable *veggie* are positive. The second largest affect is in the third category of food expenditures. We can interpret this as being a vegetarian increases the probability of spending between \$600 and \$900 by 2.70%. As demonstrated in table 4, all marginal effects of the variable *veggie* are statistically significant. Thus, aside from the first food expenditure category, begin a vegetarian increases the probability of spending over \$300. Specifically, as food expenditures increase, being a vegetarian will increase the probability of being part of a higher ordinal category of monthly food expenditures.

Now let us consider the effect of organic food purchases. Recall that the variable *organic* will take on a value of 1 if the consumer purchased organic foods in the past year and 0

otherwise. The largest affect is in the first ordinal category. A consumer that purchases organic foods is 5.90% less likely of spending less than \$300 on food expenditures than a consumer that has not purchased organic foods. All marginal effects of *organic* are statistically significant. Therefore, we can reject the null for all values and conclude that buying organic foods has a significant effect on overall food expenditures. Specifically, as food expenditures increase, there is a higher probability of being in a higher ranked ordinal category when a consumer has purchased organic foods.

This particular trend is also the case for our dummy variable *children*. Similar to the independent variables *veggie* and *organic*, there is a negative effect on the first ordinal category of food expenditures and all other higher ranked ones are positive (refer to Table 4). The first marginal effect for *children* is the largest effect in this study. However, this is expected due to the nature of the dummy variable *children*. Recall that the marginal effect is the discrete change of the dummy variable *children* from 0 to 1. If there were no children under the age of 18 present in the respondent's household, then *children* took on the value of 0 and 1 otherwise. Thus, the probability of spending less than \$300 on food expenditures decreased by 24.87% if there were one or more children present in the household. Conversely, the probability of spending between \$600 and \$900 increased by 15.29% when there were one or more children under the age of 18 present in the household. This dummy variable also had the largest Z value for all affects (except for the marginal effect on the  $P(Y=1|children)$  where we failed to reject the null) which indicates that it is the most statistically significant variable in our model.

The three variables discussed above all have a similar trend when it came to the probability of our dependent variable, food expenditures. All three variables *veggie*, *organic* and *children* negatively affected the lowest food expenditure category. The other three higher ranked

categories were positively affected by the presence of these variables. However, the three remaining dummy variables (*yage*, *sage* and *male*) have the exact opposite effect on our dependent variable.

*Yage* and *sage* are the two subcategories of the age specification of the respondent. Recall that the middle aged category of 35 to 54 was dropped to avoid the dummy variable trap. The dummy variable *yage* represents the younger aged group of 18 to 34. Evaluating Table 3, we can see that there is a rather large effect on the probability of spending less than \$300 on overall food expenditure when the respondent was part of this age category. Specifically, the probability of being in the first ordinal category of the dependent variable, food expenditures, increased by 19.87% if the respondent was aged 18 to 34. In contrast, the probability of being in a higher ranked category of food expenditures decreased when the respondent was of this age category. This result was expected given the type of respondent that would fall into this category. Particularly, college and university students tend to spend less than a middle aged consumer that might possess a family or significant other. It should also be noted that all values were statistically significant for the dummy variable *yage*.

The dummy variable *sage* had a similar affect on the dependent variable. The probability of spending less than \$300 on food expenditures increased by 11.50% when the respondent was aged 55 or over. Its affect on higher ranked ordinal categories was identical to the dummy variable *yage* but slightly less pronounced and all values were also statistically significant.

The last dummy variable in our model identified the gender of the respondent. Similar to the logic of dropping one of the age categories as mentioned above, the dummy variable for females was dropped. The *male* coefficient estimate as well as all marginal effects of this variable was not found to be statistically significant. Thus, we must conclude that the gender of a



consumer does not affect the probability of being in a particular ordinal outcome of food expenditures. It should be noted that the relationship between gender and food expenditures might not be prevalent in this study. However, further empirical work should consider the impact of gender on vegetarian diets. Considering that our dependent variable was food expenditures, this study was unable to identify the likelihood of being a vegetarian when one is male or female. The study of this relationship might shed some light on the frequency of vegetarian diets as well as the purchase behavior of this lifestyle.

### **Discussion and Final Remarks**

As discussed previously, the literature on the economics of vegetarianism is very limited. There have been no attempts, to this study's knowledge, at evaluating the food expenditures a consumer might face when following a vegetarian diet. Considering the amount of attention and popularity this diet has accumulated, it is shocking that most of the claims being put forth are not supported by empirical research. To fill this gap, this study attempted to address the claim that vegetarians tend to have lower food expenditures than non-vegetarian consumers. We were able to show that the probability of spending less than \$300 on food expenditures decreased when a consumer was a vegetarian. Conversely, the probability of being in a high ranked ordinal category of food expenditures increased when a consumer followed a vegetarian diet.

In addition to evaluating the effects of a vegetarian diet, we also estimated the impact of purchasing organic foods on food expenditures. Similar to the effect of a vegetarian diet on the lowest ordinal outcome of food expenditures, purchasing organic foods also decreased the probability of being in this category. Furthermore, every observation was statistically significant in our model and thus we showed with confidence that purchasing organic foods increases

overall food expenditure. The next step to consider is the relationship between organic foods and vegetarians. This study did not consider this relationship but does recommend further research on this topic. Given that the market for organic foods will continue to increase, we need to understand how particular food regimes affect purchasing behavior. If organic agriculture is part of the “going green” initiative, then gathering information on “green” consumers and what type of diet they are following is crucial for capturing the true potential of this market.

One thing to consider when analyzing these results is the fact that vegetarians are more likely to be in the younger aged group. As mentioned earlier, generation Y consumers (born in 1980s and 1990s) demanded more cutting edge, exotic and vegetarian foods than any other generation. We can also assume that a younger aged consumer will spend less on food expenditures. They are more likely to be living a student life or have less income than a middle aged consumer with a family and children to provide for. If this is the case, we would expect vegetarians to fall within the lower food expenditure category. Taking this into consideration, it should be noted that results found by this study are very sensitive to the current characteristics of a vegetarian consumer. The relationship between a vegetarian and food expenditures might be more pronounced if this study were to be evaluated in ten years from now. By that time, generation Y will now be part of the middle aged category and possess more purchasing power and disposable income. This might drastically alter the results found by this study.

Given all this information, we were still able to statistically prove that the probability of spending less than \$300 on food expenditures decreased when a consumer followed a vegetarian diet and increased when food expenditures were higher than this amount. As mentioned earlier, vegetarianism is a growing trend among today’s green society. We cannot ignore its growth nor can we assume that its followers have little impact on the overall food market. Canada’s market

for vegetarian foods might be minimal, but we must also consider the type of consumer currently living and immigrating to this country. Between the years 1990 to 2000, 40% of Canada's immigration came from several Asian countries such as China, Pakistan, Taiwan and India (Oliveira, 2003). Although some of these countries do not follow a pure vegetarian lifestyle, they tend to consume more plant-based foods.

Although still a young market, vegetarianism is proving itself as an emerging force within today's food demand market. It is also very versatile in terms of its overall marketability. Specifically, it is not restricted to pure vegetarians or vegans. Non-vegetarians seeking a healthier or meat-less option once or twice a week can also purchase these types of foods. Also, the number of vegetarian restaurants continues to grow, and vegetarian options are being added to everyday restaurant menus in order to accommodate for this new demand. A new market is emerging and in order to fully capture its potential, new research is needed to empirically understand its benefits as well as its costs.

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