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Heterogeneity in frequency of common beans consumption in Malawi: the case of red kidney variety in Lilongwe city

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Abstract

A large body of literature has linked bean consumption to improved nutrition and health for consumers. Yet, there is also evidence that consuming the beans is not a sufficient condition for benefitting from the nutrients found in the legume. Due to anti-nutrition factors that limit bioavailability of these nutrients to the human body, literature recommends eating beans "frequently" to increase the bio-availability of the nutrients to humans. Unfortunately, literature on what determines frequent consumption is too scant to help stakeholders develop workable programs aimed at achieving this goal. In contributing towards addressing this problem, we apply an ordered probit model to bean consumption data collected in Lilongwe city to assess effects of consumer characteristics and consumer preference for bean attributes on frequency of kidney beans consumption. We innovate by eliciting the heterogeneous effects of these attributes on marginal probabilities of eating beans at different levels of frequency. We find that female consumers have higher probabilities of eating the beans at least once weekly than males. Furthermore, increasing consumer education and incomes increases the probabilities of more frequent consumption. We do not find any price or bean attribute effects, though. We discuss the implications of these results for policymaking.

Key words: bean consumption, common beans, red kidney beans, frequency of consumption, ordered probit

1. Introduction

Nutrient deficiency continues to be an important public health issue in most of the developing world (Kumar, et al., 2017). Ruel and Menon (2002) have noted that nutrition outcomes in most households in these countries are compromised by monotonous diets that centre on starchy foods with little animal source foods and plant proteins. Consequently, members of such households fail

to meet requisite nutrient intake levels to achieve proper growth and development (Kumar et al., 2017). In many developing countries, nutrient deficiency is usually associated with low protein, iron and zinc intake. Whereas empirical evidence suggests that individuals from poor and rich households have similar probabilitiues of being malnourished, the problem is generally prevalent in poor households. Alleviating malnutrition, therefore, requires policies that recognize people's socioeconomic characteristics.

Legumes, especially common beans, are considered among the cheapest and widely available sources of proteins and other nutrients. A large body of literature has linked common bean consumption to improved nutrition and health for consumers (for example Venter et al., 2013; Broughton et al., 2003; Anderson, Smith, & Washnock, 1999). Consumption of common beans has been related to gains in proteins, iron and zinc (among many nutrients) to human bodies (Petry et al., 2015). Consumption of beans has also been related to improved market demand of the commodity, which provides a market for farmers, traders and other players in the common bean value chain. This helps create wealth for these players, thereby impacting their welfare and nutrition through improved incomes pathway (Xavery et al., 2006).

Despite the potential for common beans to contribute to the fight against malnutrition, literature review shows only one published article on common bean consumption behaviour in Malawi. Recently, Tumeo et al. (2017) have applied a series of univariate double hurdle models to assess factors affecting consumption quantities of beans. Their study has shown that both the characteristics of the household as well as the bean attributes affect the choice as well as the quantities to consume. Being an area yet to be properly understood, there is a lot that needs to be studied about common bean consumption behaviour if the legume is to be used in addressing malnutrition.

An area that needs immediate attention is on facilitating bioavailability of nutrients in beans to the human body. Petry et al. (2015) and Petry et al. (2010) have shown that polyphenols and phytic acids found in beans radically limit the bioavailability of nutrients like iron and zinc to the human body. Given the affordability of beans to most poor households and due to absence of biofortified bean programs to help supplement on the nutrients, they recommend frequent bean consumption to provide the body with the necessary nutrients. It is therefore important to understand how consumer characteristics and bean attributes condition the probabilities of frequent consumption of the legume. This paper, therefore, seeks to understand how consumer characteristics and preference for common bean attributes affect the frequency with which households consume common beans.

Our contributions in this paper are twofold. Firstly, to the best of our knowledge, this is the first study that fuses the random utility theory (Manski, 1977) with the Lancasterian theory of demand (Lancaster, 1966) to explain how consumer and product attributes affect probabilities of frequency of food consumption. Previous studies have disproportionately concentrated on consumer attributes to explain the frequency with which consumers eat food items, neglecting how product attributes condition probabilities of such consumption. Secondly, this is the first study that leverages on marginal predicted probabilities to elicit the differential effects of the aforementioned consumer and product attributes on how frequently households consume beans. We believe that prediction of these probabilities and illustration of how they affect consumption probabilities

provides valuable information to guide private and public policy formulation on how best to target interventions for frequent common bean consumption.

The paper develops as follows. The next section presents the theroetical model which combines the random utility theory with Lancaster's (1966) theory of the consumer. The theoretical model is followed by an empirical model that operationalizes it. After presenting data sources and sampling, we discuss the key findings from our analyses, paying particular attention to the differential effects of the explanatory variables on predicted probabilities of frequency of consumption. The paper ends with a discussion of implications of the findings on private and public policy intervention. We present limitations of our study and suggest areas for future research.

2. A theoretical model of frequency of consumption of common beans

We use the random utility theory (Manski, 1977) with the Lancasterian consumer theory (Lancaster, 1966) to motivate the empirical analysis in this study. We assume a rational consumer who is trying to maximize some utility function U by consuming red kidney beans under a food budget constraint C. The consumer is faced with a finite choice set A comprising how often they can eat the common beans. The consumer can decide not to eat the beans at all or to eat the beans once or more times in a given time period T. This presents us with an ordinal consumption outcome, with the frequency of bean consumption in the specified time period having a natural ordering.

In line with the aforementioned random utility model, we are not able to observe a continuous latent variable U^* that measures the consumer's assessment of the utility associated with eating red kidney beans at a specified frequency in period T. What we are able to observe is the frequency with which the consumer eats the beans. We know, however, that the consumer does not eat red kidney beans if U^* does not cross a certain threshold k_1 above which they obtain the utility they assessed. Considering a period of one month as is the case in the current study, for example, we can present the consumption decision by mapping utility to frequency of consumption as

"Never eat red kidney beans" if $U^* < k_1$;

"Less than once a month" if $k_1 < U^* < k_2$;

"Once a month" if $k_2 < U^* < k_3$; (1)

"At least once fortnightly" if $k_3 < U^* < k_4$; and

"Once or more per week" if $k_4 > U^*$.

These threshold (or cutoff) parameters are very important in mapping the consumer's utility to the frequency with which they consume the beans (Greene & Hensher, 2010). They provide the censoring mechanism through which the continuous latent utility is expressed as a set of discrete frequency of consumption levels by the consumer. The researcher can observe these discrete outcomes. Beyond observing the discrete frequency of consumption levels for the variety, we are also able to observe some factors like age, gender, education level, and others, that may affect the frequency with which a consumer will eat the beans. Some of the determinants of frequency of

consumption, however, are unobservable to the researcher such that the consumer's utility function can be decomposed accordingly as

$$U = \beta' x + \varepsilon\,, \tag{2}$$

with β being marginal utilities of consumption to be estimated (Greene and Hensher, 2008); x being the observed factors; and ε being the unobserved factors that are assumed to be random (Train, 2003). According to Train, the distribution of the error term in (2) determines the distribution of the probability of a consumer to fall in the five frequencies of consumption in (1). Knowing the distribution of the error term, then, allows for an exact calculation of the probability that a consumer will eat the beans at any given level of frequency. For example, assuming a standard normal distribution results in an ordered probit model as developed by Zavoina and McKelvey (1975) whereas assuming a logistic distribution results in an ordered logit model. Choice between which distribution to use is usually researcher-specific as the two models generally produce very similar estimates.

For this type of a discrete outcome model, there is no logical relationship between the covariates and the dependent variable since the left-hand side variable is just a convenient numerical representation of the frequency of consumption of beans (see Greene and Hensher, 2010). This makes the interpretation of the marginal utilities β quite meaningless. Indeed, Greene and Hensher (2010) note that both the direction as well as the magnitude of the relationships in ordered outcome regression models are uneducative of the relationships between the covariates and the dependent variable. The ordered probit's usefulness arises in its ability to describe the exact probability of the outcome (Greene & Hensher, 2010).

From (2), the probability of the outcomes is obtained as

$$prob\left[y_i = a \mid x_i\right] = prob\left[\varepsilon_i \le \mu_a - \beta' x_i\right] - prob\left[\mu_{a-1} - \beta' x_i\right], \quad a = 0,1,\ldots,A\,. \tag{3}$$

This model maximizes the following log-likelihood function

$$L = \sum_{i=1}^{n}\sum_{a=i}^{i} \log\left(\Phi\left(\alpha_i - \beta' x\right) - \Phi\left(\alpha_1 - \beta' x\right)\right), \tag{4}$$

where $\Phi(\bullet)$ is the standard normal cumulative distribution function.

As discussed already, the coefficients and the sign of the ordered probit model are not educative whatsoever (Greene & Hensher, 2010). For this reason, we use the marginal effects after the model to determine the magnitude by which each independent variable alters the probability of consumers to eat the red kidney beans at each level of frequency in each of the five categories of the response variable. According to Chen et al (2002) and Liao (1994), marginal effects for the model can be obtained as

$$\frac{\delta\left(y_i = a\right)}{\delta x_i} = \left[\Phi\left[\alpha_{a-1} - \sum_{\alpha-1}^{\alpha}\beta_i x_i\right] - \Phi\left[\alpha_a - \sum_{\alpha-1}^{\alpha}\beta_i x_i\right]\right]\beta_i\,, \tag{5}$$

where a is the frequency of red kidney bean consumption. The rest of the variables are as defined in the equations above.

3. Empirical model and choice of variables

We estimate the following model as an operationalization of the ordered probit model developed above:

$$freq_{ia} = D_{i1}female_i + D_{i2}educ_i + D_{i3}location_i + D_{i4}purchaser_i + D_{i5}complement_i + \beta_{i1}age_i + \beta_{i2}\ln_income_i + \beta_{i3}hhsize_i + \gamma_{i1}grainsize_i + \gamma_{i2}gravyqual_i + \gamma_{i3}Ctime_{ik} + \alpha_{i1}price_i + \varepsilon_{ia}. \quad (6)$$

In this empirical model, $freq$ is the ordered dependent variable capturing household i's frequency a of consuming the common bean variety; D and β are parameters to be estimated. The variable *female* is a binary variable indicating gender of the respondent; *educ* is a categorical variable indicating the education level of the respondent; *ln_income* is the log of household i's total monthly income; *location* is a categorical variable indicating the residential area of the household; *age* is the age of the respondent, while *hhsize* is the size of household i. The common bean attributes of grain size, gravy quality, cooking times as well as prices are captured by variables *grainsize*, *gravyqual*, *ctime* and *price*, respectively. The variable *purchaser* defines the influence of the one who purchases the beans. This variable takes a value of 1 if the respondent was the purchaser and zero otherwise. *Complement* is a dummy variable that equals to 1 if the household regards the variety as a complement to a main meal and zero if otherwise. ε is the error term with mean zero and variance Σ.

Inclusion of these variables in the ordered probit model has been informed mainly by Steenkamp's (1991) proposed taxonomy of determinants of food consumption behaviour and Lancaster's (1966) reasoning about consumer demand. Steenkamp's taxonomy categorizes determinants of the said behaviour into three components namely 1) the attributes of the food; 2) the attributes of the consumers; and 3) the environment.

Steenkamp (1991) presents the determinants of food consumption behavior sequentially. He takes this approach to present the taxonomy systematically. He notes, however, that such a presentation is necessary as researchers usually deal with one aspect of the taxonomy at a time. For a proper understanding of consumption behaviour, however, a comprehensive approach that uses all the dimensions of the taxonomy is necessary as food consumption is complex and the boundaries amongst the three components of the taxonomy are quite fuzzy. In the rest of this section, we discuss the theory behind including each variable in the model.

The size of the household is one of the most important variables in understanding household food consumption behaviour. The household size has important implications on household food demand and budget, as well as the specific types of foods that the household consumes. According to Mazunda (2017), household size has a direct implication on the household budget.

Household income is among the the main drivers of food consumption in urban Malawi (Mazunda, 2017). This is especially true given that a vast majority of households in the city do not rely on own production for food. The household's total monthly income, therefore, has important

implications on the frequency with which the households consume the commodity as well the amounts of income that they allocate to buying different food items. Total monthly income in this study comprised the total amounts that various household members earned from various sources.

Education is an important factor in household and individual food consumption choice. Rajika and Smith (2000), for example, found that higher levels of education are correlated with consumption of nutritious foods. Given the relatively higher levels of proteins, iron and zinc found in beans compared to other legumes, more educated consumers are likely to eat it on the account of its superior nutrition profile.

A household's residential area tells a lot about its general welfare. Low population density areas, for example, tend to be a reserve for high-income households as property prices in these areas tend to be relatively high, and vice versa. Furthermore, households in different residential areas are likely to have heterogeneous food consumption behaviours. The heterogeneity may be more pronounced where membership to a residential area is governed by incomes. This generally results in profoundly different food consumption behaviours in the various locations. This variable, therefore, is included in the model to assess if

Lancaster (1966) argued that consumers essentially demand the attributes associated with a good, and not the good in its totality. He argued that each attribute of the good has a partial contribution to the total utility associated with the good. For this reason, we include three variables that aim at assessing if and to what extent consumer preference for common bean attributes affect the frequencies with which they consume the legume. We assess whether consumers preference for gravy quality, the duration it takes to cook the beans as well as the bean grain size affect the frequencies with which the beans are consumed.

Given that most of the beans consumed in the city are bought on the market (Mazunda et al., 2017) rather than own-produced, prices could limit the availability of the legume to consumers. For example, Larochelle, Katungi and Cheng (2016) found that a 1 percent increase in own prices reduce bean demand by about 0.89 percent in lowest wealth quintiles of urban Uganda and reduce the demand for the same by about 0.65 percent amongst households in the highest quintile. Bean prices, therefore, are likely to affect the frequency of common bean consumption.

4. Data and summary statistics

We use common bean consumption data collected in 2015 in Lilongwe City for a project that assessed consumer preference for common bean attributes. The data collection method used a sample size determination procedure that is recommended for conducting a discrete choice experiment since the initial study had a choice experiment module. A total of 687 households were interviewed for the study. This paper, however, uses data from 519 households that reported consuming kidney beans. For detailed sampling procedure refer to Tumeo (2017).

In Table 1, we present a descriptive summary of the consumers. A majority (87%) of them are female with a mean age of 37 years. The average household in our sample is slightly larger than the average for the country as well as for Lilongwe city. Whereas National Statistics Office (2017) reports that the average household size in Malawi is 4.3 and in Lilongwe is 4.6, the average size of households interviewed for the bean consumption survey is 5.2.

Table 1. Summary statistics (n=521)

Variable	Variable description	Mean	Std. Err.
Gender	Sex of the consumer, equal to 1 if female and zero if otherwise.	0.87	0.02
Education	Highest academic level of the consumer defined as None=0; Primary=1; Secondary=2; Technical/vocational=3; University/college=4.	1.96	0.05
Age	Age of the consumer in years.	36.77	0.57
Residential area	Residential area of the household. It equals to 0 if household resides in high density/low income area; 1 if it resides in a medium density/medium income area; and 2 if it resides in a low density/high income location.	0.16	0.02
Monthly household income	Total monthly household incomes in Malawi Kwacha (MWK).	149234.60	11205.98
Household Size	Total number of household members.	5.19	0.09
Purchase influencer	Person who influences food purchasing decisions in the household. It equals to 1 if respondent influences food purchases and zero if otherwise.	0.85	0.016
Main meal complement	Whether or not the beans are consumed as a complement to a main meal. It equals one if they do and zero if otherwise	0.94	0.01
Price	Price of the beans in MWK per kilogram	2172.05	116.97
Consider grain size	Whether or not the consumer takes into consideration grain size when making bean purchasing decision. It equals one if they do and zero if otherwise.	0.22	0.02
Consider cooking time	Whether or not the consumer takes into account the duration it takes to cook the beans when making bean purchasing decision. It equals one if they do and zero if otherwise.	0.58	0.02
Consider gravy quality	Whether or not the consumer takes into consideration grain size when making bean purchasing decision. It equals one if they do and zero if otherwise.	0.79	0.02

The survey asked consumers about common bean attributes that they consider when making bean purchasing decisions. About 80 percent of the consumers reported taking into account gravy quality, compared to 58 percent who considered the duration that it takes to prepare the beans and another 22 percent that considered the size of the bean grains. This seems to suggest some consumer preference for red kidney bean attributes. Given these proportions, quality gravy is preferred to shorter cooking times; which are themselves preferred to any grain size.

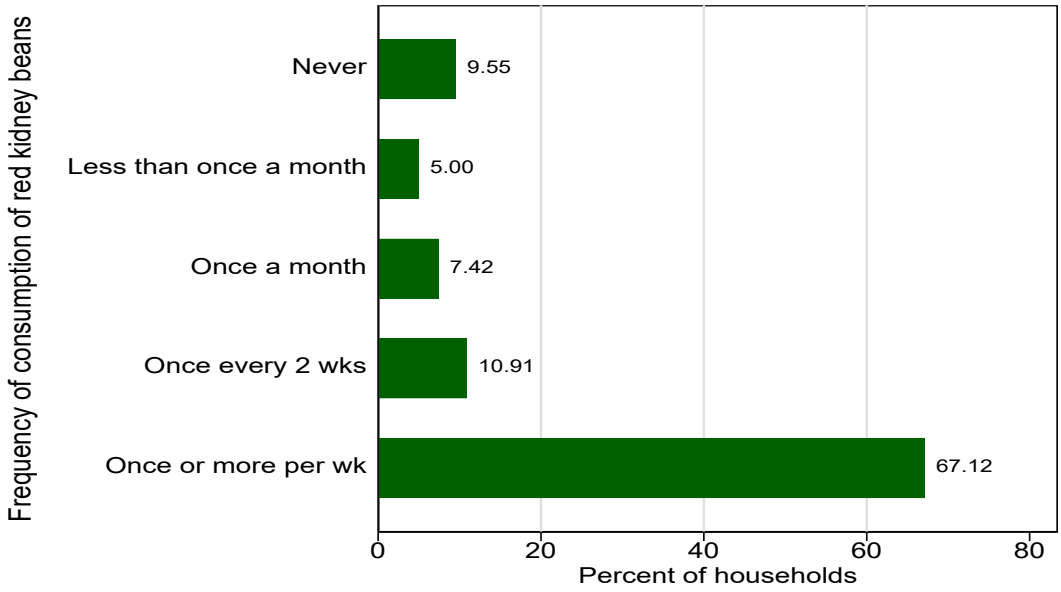


Figure 1. Proportions of households that reported eating red kidney beans at different levels of frequency

There is variation in how frequently households in Lilongwe consume red beans. As figure 1 summarizes, about 67 percent of the households that reported consuming the kidney beans reported eating them at least once a week. There is also a number of consumers in the city who reported not eating beans at all, an area which has been well addressed by Tumeo et al. (2017). There is interesting variation in the proportions of households that report consuming beans at various measures of frequency.

5. Empirical Results

Table 2 summarizes the results of the ordered probit model and the associated average marginal effects of the independent variables on the probability of a household consuming the red kidney beans at a given level of frequency. We present the robust standard errors for each estimate in the parentheses below it. Average marginal effects for the dummy variables present a change in probability of a household consuming the beans at a given level of frequency when the variable changes from the base level. For continuous variables, the margins present the actual change in frequency of consumption for a unit change in the variable.

Table 2. Ordered probit results, with marginal effects

Explanatory variable	**Coefficient**	**Marginal effects**				
		Never	Less than once a month	Once a month	Once or more fortnightly	Once or more a week
Female (=1)	0.44***	-0.01	-0.04**	-0.05**	-0.05***	0.14**
	-0.16	-0.01	-0.02	-0.02	-0.02	-0.06
Education level of the respondent (base variable=None)						
Primary (=1)	0.67**	-0.01	-0.05	-0.07*	-0.08**	0.20*
	-0.31	-0.01	-0.04	-0.04	-0.03	-0.11
Secondary (=1)	0.28	0.00	-0.03	-0.03	-0.03	0.10
	-0.32	-0.01	-0.04	-0.04	-0.03	-0.11
Technical (=1)	0.47	-0.01	-0.04	-0.05	-0.05	0.15
	-0.38	-0.01	-0.04	-0.04	-0.04	-0.13
University (=1)	0.03	0.00	0.00	0.00	0.00	0.01
	-0.37	-0.01	-0.04	-0.04	-0.04	-0.13
Age of respondent	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
Medium density (=1)	0.08	0.00	-0.01	-0.01	-0.01	0.02
	-0.30	0.00	-0.02	-0.03	-0.03	-0.08
Low density (=1)	0.00	0.00	0.00	0.00	0.00	0.00
	-0.28	0.00	-0.02	-0.03	-0.04	-0.09
Log monthly Income	0.14**	0.00	-0.01*	-0.01**	-0.02**	0.04**
	-0.06	0.00	-0.01	-0.01	-0.01	-0.02
HH Size	0.01	0.00	0.00	0.00	0.00	0.00
	-0.03	0.00	0.00	0.00	0.00	-0.01
Purchase influencer(self=1)	-0.22	0.00	0.02	0.02	0.02	-0.06
	-0.16	0.00	-0.01	-0.02	-0.02	-0.05

Complements main meal (=1)	0.53**	-0.01	-0.04**	-0.05**	-0.06**	0.15**
	-0.23	0.00	-0.02	-0.02	-0.03	-0.06
Log price	0.01	0.00	0.00	0.00	0.00	0.00
	-0.06	0.00	0.00	-0.01	-0.01	-0.02
Bean attribute considerations when making purchasing decision						
Consider grainsize (=1)	0.02	0.00	0.00	0.00	0.00	0.01
	-0.15	0.00	-0.01	-0.01	-0.02	-0.04
Consider cooking time (=1)	-0.01	0.00	0.00	0.00	0.00	0.00
	-0.12	0.00	-0.01	-0.01	-0.01	-0.04
Consider gravy quality (=1)	0.16	0.00	-0.01	-0.02	-0.02	0.05
	-0.14	0.00	-0.01	-0.01	-0.02	-0.04
Threshold 1	0.01					
	-0.84					
Threshold 2	1.03					
	-0.82					
Threshold 3	1.59*					
	-0.82					
Threshold 4	2.12***					
	-0.82					
Observations	521	521	521	521	521	521

Notes: Robust standard errors are reported in parentheses; ***indicates significance at 1% level; ** indicates significance at 5% level; * indicates significance at 10% level; HH=household; dy/dx for factor levels is the discrete change from the base level.

Given the importance of the threshold parameters in linking frequency of bean consumption to consumer utility, it is only important to first pay attention to their estimates. Maddala (1983) notes that the threshold parameters are actually important indicators of goodness of fit of the ordered response model. In a well specified model, the parameters are expected to be positive and in ascending order. The positiveness of these parameters is not imposed by the researcher but rather a result of the maximum likelihood estimation procedure used to solve the model. Table 2 shows that our model meets both requirements. All our threshold parameters are positive and are in an ascending order; indicating that our model is indeed well specificied.

6. Effect of Household and red beans characteristics on frequency of consumption

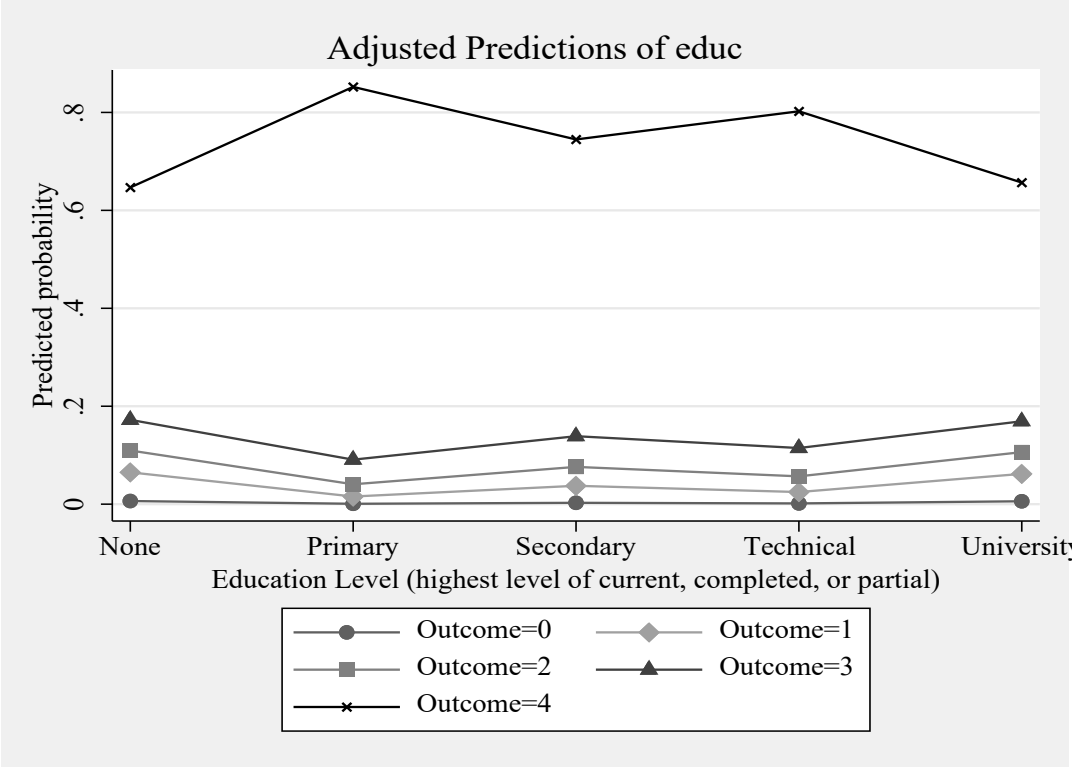
We start by discussing the effect of gender of the consumer on the frequency of red kidney bean consumption. The results summarized in table 2 show that gender of the respondent seems to have a heterogeneous effect on frequency of consumption. Keeping all factors constant, we find no differences in probability of male and females to not consume the beans at all. As we move from consuming red beans at least once a month to consuming at least once fortnightly, however, female respondents' probabilities continually decline compared to their male counterparts. The trend reverses radically with respect to consuming the beans at least once a week, though. Compared to male respondents, females seem to have a 14 percent higher probability of consuming red kidney beans at least once a week. Generally, females have higher predicted probabilities of consuming the beans more than once a week compared to males while the males have slightly higher predicted probabilities of consuming the beans for the other levels of frequency.

The results seem to agree with Tumeo et al. (2017) to some extent. Using a double hurdle model, they found that female respondents generally consume 2.7 kilograms lower quantities of red kidney beans compared to males. Since increasing quantities consumed is closely correlated with frequency of consuming the variety, we see that our results agree with theirs for consumers that eat beans at most once fortnightly. However, the direction of the relationship changes with respect to consuming red kidney beans once or more times per week. At this level of frequency, females actually have a higher probability of consuming the beans than males. This suggests a mixed effect of sex on the probabilities of consuming red kidney beans at the various measures of frequency.

Whereas as table 2 suggests that only primary education has a significant effect on frequency of consumption of red kidney beans, perhaps figure 2 provides a "fuller" understanding of how various levels of consumer education affect the predicted probabilities of consuming beans at different measures of frequency. The marginal effects in table 2 show a decreasing propensity to consume the beans once a month and at least once a fortnight for respondents with primary school education only, but a positive effect on probability of consuming the beans at least once a week compared to respondents with no formal education, other factors controlled. Specifically, we find that when compared to consumers who reported having no formal education whatsoever, consumers with primary school education have a seven percent lower probability of consuming the beans once a month, an 8 percent lower probability of consuming red kidney beans at least once fortnightly and a 20 percent higher probability of consuming them at least once a week.

Figure 2 shows heterogeneous effects of level of consumer education on the predicted probabilities of frequency of consumption of red kidney beans. For example, consumers who reported having attended primary school only have the highest probability to consume the variety once or more times per week compared to consumers with other levels of education. The predicted probabilities of consuming the beans at this level seem to generally take an inverted "U" shape with respondents

who reported having no formal education and those who reported having university education having the lowest probability of consuming the beans at least once a week. On the other hand, and although a bit inconspicuous, education level of the respondent seems to have a "U" shape for consuming the variety between less than once a month and once fortnightly; with no discernible change on the probability of never consuming the variety at all.



Notes: Outcome 0 represents never consuming red kidney beans at all; outcome 1 is less than once a month; outcome 2 is once a month; outcome 3 is at least once fortnightly while outcome 4 is once or more per week.

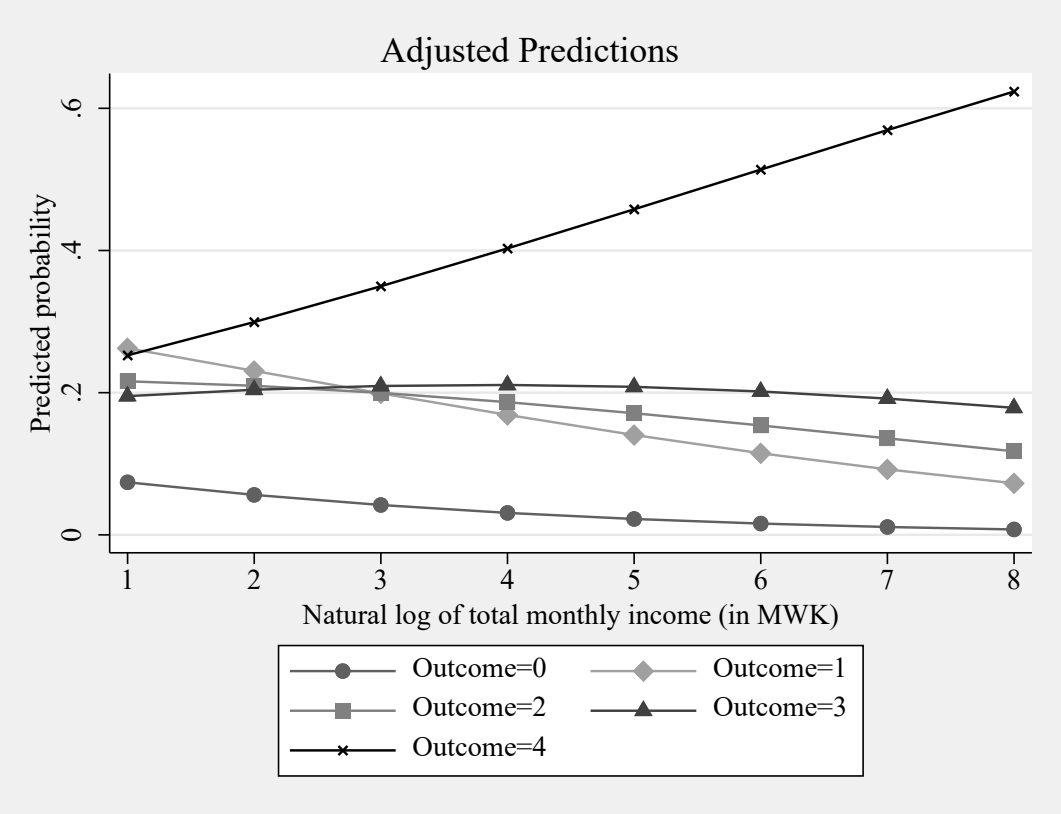
Figure 2. Predicted frequency of consumption probabilities by education of respondent

The finding on the heterogenous effects of education on predicted probabilities of frequency of kidney beans consumption seems to generally disagree with Tumeo et al. (2017). In trying to understand the determinants of quantity of red kidney beans consumed in Lilongwe, they found that quantity of the red kidney beans consumed linearly increased with increasing education. In our case, we find that education does not have this linear effect on frequency to consume the beans. The effect of consumer education changes with the specific level of frequency under consideration. Comparing our results with theirs, we find that their results only agree with ours with respect to consuming the red kidney beans once or more times per week.

Turning to the marginal effects of income on frequency of consumption in table 2, with increasing incomes, we find evidence of decreasing probabilities of consuming red kidney common beans less than once a month; at least once a month; as well as at least once a fortnight as monthly household income increases and a positive effect on the probability of consuming beans once or more per week, other things held constant. The marginal effects suggest that, all factors controlled for, a percentage increase in monthly household income decreases the probability of consuming

the beans once or more per month by 1 percent; the probability of consuming it at least once a month by 1.3 percent and the probability of eating the beans at least fortnightly by 1.6 percent.

Figure 2 is more revealing of the effect of monthly incomes on frequency of common bean consumption in Lilongwe. Generally, the figure shows that increasing household incomes reduces the predicted probability that the household will consume the beans less often (at levels less than once a fortnight) and increases the probability that the households will consume the beans once or more per week, ceteris paribus. Looking at the specific curves, as incomes increase, the probability of not eating the beans at all are lower than the probabilities of eating it at least once a month, which is themselves are lower than the probability of consuming it at least once a fortnight, et cetera. The probabilities of consuming this variety very often (at least once a week) positively increase with increasing incomes. This behaviour that the variety is a normal good as its consumption increases with increasing household incomes.

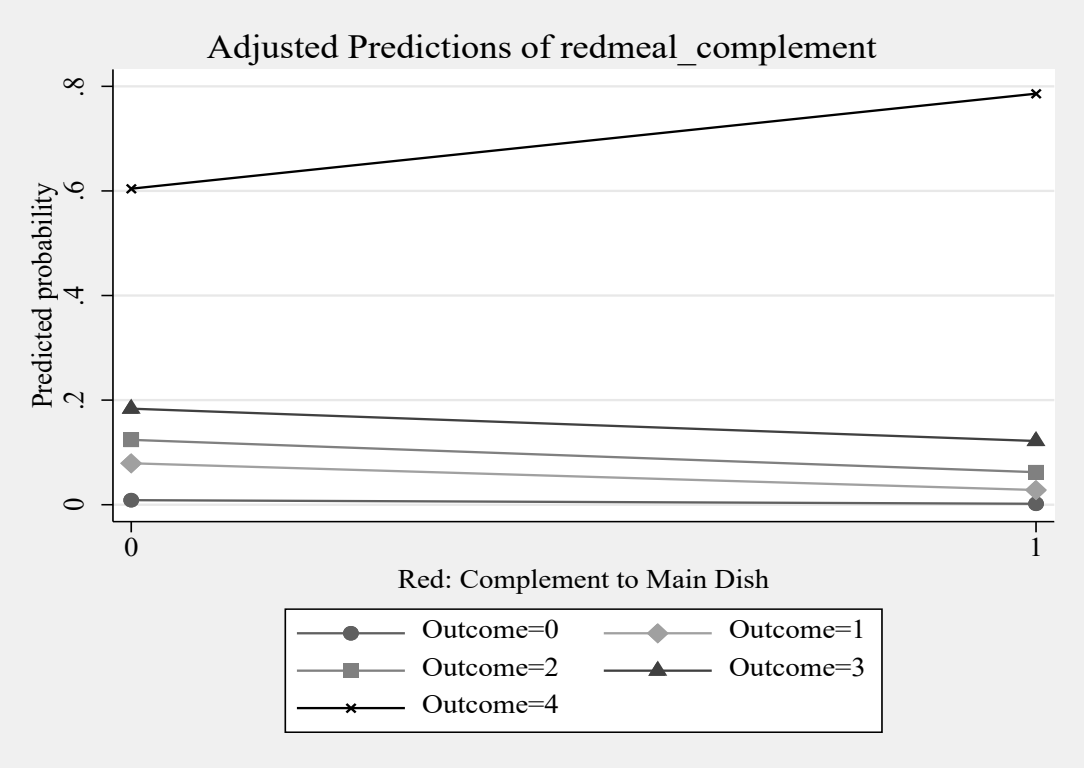


Notes: Outcome 0 represents never consuming red kidney beans at all; outcome 1 is less than once a month; outcome 2 is once a month; outcome 3 is at least once fortnightly while outcome 4 is once or more per week.

Figure 3. Effect of monthly income on predicted probabilities of consuming red kidney bean variety

Finally, the marginal effects of the role of the beans as a complement to a main meal shows a mixed effect on probability of consuming the beans frequently. Generally, considering red kidney beans as a complement to a main meal reduces the probability of its consumption at all levels between less than a month and at least once fortnightly but increases the probability of its

consumption once or more times per week. Controlling for the other independent variables, we find that regarding the beans as a complement to a main meal increases the probability that it will be consumed at least once a week by about 15 percent (table 2). However, it reduces the probabilities that the beans will be consumed at least once a fortnight or less frequently than this by between 4% and 6%. This finding agrees with Tumeo et al. (2017) who found that 94 percent of red kidney beans consumers take it as complement to a main meal. Taken as a complement to the staple food like this, it is sensible that frequency of consuming it weekly increases as *nsima* is eaten mostly twice a day in almost all Malawian households. Figure 3 illustrates how considering the variety as a meal complement affect the predicted probabilities of consuming it at the five levels of frequency.



Notes: Outcome 0 represents never consuming red kidney beans at all; outcome 1 is less than once a month; outcome 2 is once a month; outcome 3 is at least once fortnightly while outcome 4 is once or more per week.

Figure 4. Effect of the role of red kidney beans as a complement to a main meal on predicted probabilities of consuming the variety at different levels of frequency

7. Conclusions and limitations

This study has assessed factors affecting frequency of consumption of common beans. We used consumption of red kidney common beans in Lilongwe city as the variety is consumed by a vast majority of households in the city, and in Malawi at large. The main innovation of our study has been the assessment of the heterogeneous effect of the socioeconomic characteristics of the consumers on frequency of consumption of the beans. Unlike other studies that only estimate the marginal effect of independent variables on frequency of consumption of foods, we have gone

further to elicit how changes in various characteristics of an "average" consumer conditions the probabilities of frequent consumption of the beans.

Our results show that only the socioeconomic characteristics of the consumers have an effect on how frequently they eat the beans. We have found that female consumers have higher probabilities of eating the beans once or more times per week while males have higher probabilities of consuming the beans at levels of frequency lower than weekly consumption. Furthermore, education of the consumer seems to affect frequency of consumption of red kidney beans, with consumers with primary school education consuming the beans more frequently compared to respondents without any formal education. Household incomes as well as regarding the beans as a complement to a main meal all affect frequency of consumption of the beans heterogeneously. Perhaps more interesting is the finding that there is no significant effect of putting into consideration the attributes of kidney beans when making purchasing decision on predicted probabilities of consuming this variety at all measures of frequency.

As a recommendation for policy and program planning, in the short term, nutrition education programmes should consider presenting the beans to consumers as a complement to main meals. As opposed to the present case where bean consumption promotion is mostly independent of other foods, the beans should be marketed to the consumer as being a necessary complement to other relishes that consumers eat staple foods with. Emphasizing the nutrition benefits associated with eating the beans could help convince the consumers eat the beans regularly. In the medium to long run, investing in formal education as well as policies that improve household incomes could help improve the frequency of consumption of the legume.

Limitations of the study

Although we have tried to explain the determinants of frequency of consumption of kidney beans, there is a need to replicate the study in other contexts. This study has used data that were collected in Lilongwe city. The geographical coverage as well as the characteristics of the city residents mean that, at most, inference drawn from the study is restricted to cities and urban centres in the country.

Additionally, the study has concentrated on common bean attributes as well as socioeconomic and demographic characteristics of households to explain common beans consumption behavior. This is just part of taxonomy of determinants of food consumption behavior. There are other factors like consumers' perception about the acceptability of the beans as food that also affect common beans consumption behavior. To a large extent, however, the product attributes and socioeconomic and demographic factors assessed in this study ably explain the economics of common beans consumption behavior in Lilongwe City.

Finally, it is important to note that consumption as well as frequency of consumption of the red kidney beans may be affected by consumption and frequencies of consumption of other common bean varieties. Assessing the joint consumption on these varieties on the probabilities of frequent consumption of the beans could help provide more detailed information on consumption behavior.

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