AN EMPIRICAL ANALYSIS OF HOUSEHOLDS' DEMAND FOR ORGANIC AND CONVENTIONAL FLOUR IN THE UNITED STATES: EVIDENCE FROM THE 2014 NIELSEN HOMESCAN DATA

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Abstract

Using the 2014 Nielsen Homescan panel data, the Heckman two-stage sample selection model is used to estimate the likelihood of purchasing organic or conventional flour as well as the quantity purchased of organic and conventional flour. A number of demographic variables are found to be statistically significant impacting the likelihood of purchasing organic and conventional flour. Conditional on the decision whether to buy organic or conventional flour, the estimation of the second-stage equations shows that the statistically significant factors of the demand for organic flour are own price, household income, household size, age, employment status, and race, while for conventional flour significant factors are own price, organic flour price, household income, household size, education level, marital status, and race.

Based on the calculated own-price elasticities of demand for organic and conventional flour, the demand for both flour types is inelastic. Cross-price elasticities of demand suggest an asymmetric pattern between organic and conventional flour demand. Finally, based on the negative income elasticity estimates, organic and conventional flour are inferior goods.

Key Words: organic and conventional flour, household demand, the Heckman procedure

JEL Classification: D12

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Introduction

The United States (U.S.) organic foods are one of the fastest growing market segments (Dettmann & Dimitri, 2007). The sales of organic products increased from $1 billion in the 1990 up to $17 billion in 2006 (Smith, 2008). Before the 2008 world economic crisis, the organic food market displayed a two-digit growth (Hamzaoui-Essoussi & Zahaf, 2012). However, the crisis had a negative impact on the organic product sales due to a decrease in consumers' purchasing power (Hamzaoui-Essoussi & Zahaf, 2012). The sales of organic products continued to increase in the years following the crisis (Hamzaoui-Essoussi & Zahaf, 2012), recording the highest sales in 2015 (McNeil, 2016). According to the Organic Trade Association's 2016 Organic Industry Survey, the total sales of organic products in 2015 were $43.3 billion, of which $39.7 billion was organic food sales and $3.6 billion was a contribution from non-food organic sales (McNeil, 2016).

The production of wheat has declined over the past 20 years (United States Department of Agriculture, 2017). Relatively low wheat profitability and pesticide resistance compared to other crops, government programs (Acreage Reduction Program, Conservation Reserve Program), and changes in tastes and preferences adversely influencing the consumption of wheat products account for this decline in production (Bond & Liefert, 2016). Despite the decline in wheat production, the U.S. demand for organic grains and seeds has gone up by 20% annually since 1995 (Montana Flour & Grains, 2018). According to the Nielsen Scantrack data, in 2016, the sales of organic grain-based products in the U.S. were estimated to be approximately $1 billion (Gelski, 2017). As the demand for organic grain-based food increases rapidly, the United

States Department of Agriculture (USDA) provides opportunities through its various programs (the National Organic Certification Cost Share Program [NOCCSP], the Agricultural Marketing Assistance [AMA] Act, risk management options for organic and transitioning farmers, organic transitional labeling program) for producers to increase the number of organic farms in the U.S. and produce enough organic wheat to meet the growing demand (National Organic Coalition, 2016). As a result, in 2015, the number of certified organic farms in the U.S. reached 12,818, producing $6.2 billion in certified organic products, which was greater by 13% in 2014 (USDA, 2015). Also, in 2016, the domestic acreage of the organic wheat was around 482,207 acres, up almost 40% from 344,644 acres in 2011 (Gelski, 2017). At the same time, Ardent Mills, North America’s leading flour supplier, started Organic Initiative 2019 program, the main objective of which is to help farmers significantly increase the organic wheat acreage in the U.S. by 2019 (Gelski, 2017).

Flour is the main ingredient in the production of cookies, noodles and other pasta products (Vocke, 2015). According to the International Pasta Organisation’s 2014 report, in 2013, the U.S. produced and consumed 2 and 2.7 million tons of pasta, respectively, with per capita pasta consumption of around 8.8 kg (International Pasta Organisation, 2014), which had positive implications for the demand for flour. In addition, Vocke (2015) noted that people’s desire to eat outside, relatively low prices of fast food restaurant products, and saving the time spent on preparation of food have led to an increase in per capita flour consumption by approximately 20 lbs. As well, a promising compound annual growth rate associated with the organic flour segment is also projected by the Transparency Market Research (2017).

The increasing demand for organically produced products, the importance of flour as a major ingredient in the production of bakery products and its consumption and production growths, the opportunities that the USDA presents for transitioning to organic and expanding organic production of wheat (eventually leading to the expanded production of flour), and a projected increase in the demand for organic flour create a need for a research dealing with the analysis of household demand for organic and conventional flour. This study adds to the extant literature by analyzing the impact of household demographic variables on the likelihood of purchasing organic and conventional flour, as well as evaluating the effects these characteristics have on the quantity purchased of organic and conventional flour.

The objectives of this study are to: (1) profile households that buy organic and conventional flour; (2) identify household demographic characteristics that influence the likelihood of purchasing organic and conventional flour; (3) estimate demand for organic and conventional flour as a function of a set of household socio-economic characteristics; and (4) compute own-price, cross-price, and income elasticities of demand for organic and conventional flour. The objectives are accomplished by estimating the Heckman two-stage sample selection model. The first stage of Heckman's model deals with determining household demographic characteristics that affect the probability of purchasing organic and conventional flour. After the purchasing decision is made, the second stage of Heckman's model evaluates the factors that affect the quantity purchased of organic and conventional flour.

The results of this study can assist flour manufacturers and distributors in (1) developing products that are better tailored to consumer tastes and preferences, (2) designing various marketing strategies targeting specific demographic groups beyond their traditional consumer base, (3) developing demand forecasts to facilitate input procurement and inventory management, and (4) developing pricing strategies in order to maximize sales revenue.

The paper is structured as follows. Next section consists of the discussion of the empirical specification of the Heckman's model. Then, the data and variables used in the estimation of the model are presented and discussed, followed by the estimation results. Concluding remarks and recommendations for future research comprise the final section.

Empirical Specification

According to Heckman (1976, 1979), the problem of sample selection bias occurs if researcher limits the sample (Heckman, 1976, 1979). For this study, similar problem can arise by limiting the sample and including those households who purchase only organic flour or those who purchase only conventional flour. To account for this issue, Heckman's two-stage procedure can be used. In the first stage of the Heckman procedure, the probit model is estimated to analyze the probability of purchasing organic or conventional flour. In the second stage, the model uses the OLS method to estimate the demand for organic and conventional flour (Heckman, 1979).

In the first stage of the model, the inverse mills ratio (IMR), also known as non-selection hazard, is calculated that includes the effects of omitted variables. Next, the calculated IMR is incorporated as an independent variable in the second stage of the model. The presence of sample selection bias can be determined by conducting a test of statistical significance of the parameter estimate associated with the IMR. If the parameter estimate associated with the IMR is statistically significant, then sample selection bias exists in the model. If the parameter estimate associated with the IMR is not statistically significant, then omitting observations will not affect the results of the model.

The probability of purchasing organic flour is estimated as a function of household demographic variables related to household size, age and presence of children aged below 18 in the household, household head's age, employment status, education level, marital status, race, and ethnicity and geographic location of the household. The empirical specification of the probit model associated with the organic flour looks as follows:

$$
\begin{aligned}
P(q_i = 1|X_i) = {} & \alpha_0 + \alpha_1 hhsize1_i + \alpha_2 hhsize2_i + \alpha_3 hhsize3_i + \alpha_4 hhsize4_i \\
& + \alpha_5 age\_pres\_child\_atleast1_i + \alpha_6 head\_age\_und25_i + \alpha_7 head\_age\_25\_44_i \\
& + \alpha_8 head\_age\_45\_64_i + \alpha_9 head\_empl\_und35_i + \alpha_{10} head\_empl\_35above_i \\
& + \alpha_{11} head\_edu\_lths_i + \alpha_{12} head\_edu\_hs_i + \alpha_{13} head\_edu\_somecoll_i \\
& + \alpha_{14} mar\_stat\_mar_i + \alpha_{15} mar\_stat\_wid_i + \alpha_{16} mar\_stat\_div\_sep_i \\
& + \alpha_{17} race\_white_i + \alpha_{18} race\_black_i + \alpha_{19} race\_asian_i + \alpha_{20} hisp\_yes_i \\
& + \alpha_{21} region\_east_i + \alpha_{22} region\_central_i + e_{i,} \qquad (1)
\end{aligned}
$$

where q_i is 1 if household purchased organic flour, and 0 otherwise. Additionally, in (1), $i = 1,2, \ldots, n$ shows the number of observations (households) and e_i is the disturbance term. All independent variables included in (1) are dummy variables. To avoid the dummy variable trap, one of each variable subcategory is dropped and is used as a base category. Table 1 shows the variables entering (1) and their definitions along with indicating the corresponding base categories. Once the decision to purchase organic flour is made, the second stage of Heckman's procedure estimates parameters of variables hypothesized to affect the quantity purchased of organic flour (i.e. the demand model for organic four). The empirical specification of second-stage demand model for organic flour is as follows:

$$
\begin{aligned}
Y_i = {} & \beta_0 + \beta_1 unitval\_org_i + \beta_2 unitval\_con_i + \beta_3 medhhinc_i + \beta_4 hhsize1_i + \beta_5 hhsize2_i \\
& + \beta_6 hhsize3_i + \beta_7 hhsize4_i + \beta_8 age\_pres\_child\_atleast1_i \\
& + \beta_9 head\_age\_und25_i + \beta_{10} head\_age\_25\_44_i + \beta_{11} head\_age\_45\_64_i \\
& + \beta_{12} head\_empl\_und35_i + \beta_{13} head\_empl\_35above_i + \beta_{14} head\_edu\_lths_i \\
& + \beta_{15} head\_edu\_hs_i + \beta_{16} head\_edu\_somecoll_i + \beta_{17} mar\_stat\_mar_i \\
& + \beta_{18} mar\_stat\_wid_i + \beta_{19} mar\_stat\_div\_sep_i + \beta_{20} race\_white_i \\
& + \beta_{21} race\_black_i + \beta_{22} race\_asian_i + \beta_{23} hisp\_yes_i + +\beta_{24} IMR_i \\
& + \varepsilon_i \qquad (2)
\end{aligned}
$$

Table 1. Definition of Variables used in the Heckman Sample Selection Model

Category	Variable	Definition
Household size	*hhsize1*	One member
	hhsize2	Two members
	hhsize3	Three members
	hhsize4	Four members
	*hhsize5**	Five and more members
Age and presence of children aged below 18 in the household	*age_pres_child_atleast1*	At least one child below 18 years of age
	*age_pres_nochild**	No children in the household below 18 years of age
Age of the household head	*head_age_und25*	Less than 25 years
	head_age_25_44	Between 25-44 years
	head_age_45_64	Between 45-64 years
	*head_age_65above**	65 and above
Employment status of the household head	*head_empl_und35*	Employed, working hours below 35 per week
	head_empl_35above	Employed, working hours more than 35 per week
	*head_unempl**	Unemployed
Education level of the household head	*head_edu_lths*	Less than high school degree
	head_edu_hs	High school only
	head_edu_somecoll	Some college degree only
	*head_edu_collabove**	More than college degree
Marital status of the household head	*mar_stat_mar*	Married
	mar_stat_div_sep	Divorced or separated
	mar_stat_wid	Widowed
	*mar_stat_none**	Single
Race	*race_white*	White
	race_black	Black
	race_asian	Asian
	*race_other**	Other (non-Black, non-White, non-Asian)
Ethnicity	*hisp_yes*	Hispanic
	*hisp_no**	Non-Hispanic
Region	*region_east*	East
	region_central	Central
	*region_west**	West
Price	*unitval_org*	Price (unit value) of the organic flour ($/lb)
	unitval_con	Price (unit value) of the conventional flour ($/lb)
Household income	*Medhhinc*	Median annual income ($)

Note: Asterisk indicates the base category.
Source: Data from The Nielsen Company (U.S.), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

In (2), Y_i represents the quantity purchased of organic flour by the ith household, IMR_i is the Inverse Mills Ratio obtained in the probit model, and ε_i is the disturbance term. The model in (2) is also estimated for the quantity purchased of conventional flour, using data only for households who chose to purchase conventional flour as determined in the first-stage probit model. In addition to the household demographic variables that are present in the first-stage probit model, the second-stage demand model includes own-price, $unitval\_org_i$, and cross-price, $unitval\_con_i$, (conventional flour price for the organic flour demand model and organic flour price for the conventional flour demand model) variables, and household income, $medhhinc_i$.

It needs to be noted that in case of a statistically significant parameter estimate of the IMR, the computation of the second-stage marginal effects associated with the variables common to both stages of the Heckman model has to be adjusted following the procedure suggested by Saha, Capps, and Byrne (1997). However, if the parameter estimate of the IMR is statistically insignificant, the parameter estimates associated with variables common to both stages of the Heckman model are the correct marginal effects and no adjustment is necessary.

Another issue addressed in this analysis is the potential endogeneity in unit values, which are used as proxies for prices. The endogeneity in unit values stems from the fact that the unit values reflect not only the market price variations but also quality variations, with the latter being determined by the composition of household purchases over the individual products (Deaton, 1988; Dong, Shonkwiler & Capps, 1998; Dong & Kaiser, 2005). The presence of the endogeneity issue in organic and conventional flour prices (unit values) is ascertained with the help of the Durbin χ^2 and Wu-Hausman tests, using household demographic variables (Alviola & Capps, 2010) related to household income, household size, age and presence of children aged below 18 in the household, age, employment status, education level, marital status, race, and ethnicity of household head, and household residence region, and the corresponding cross-price variables as instruments. Per the results from the Durbin and the Wu-Hausman tests, the organic flour price and the conventional flour price are treated as exogenous in the subsequent analysis.

Data

This study uses the 2014 Nielsen Homescan panel data[1]. The uniqueness of the dataset is that the data were collected directly from a nationwide panel of households on their purchases from a wide variety of retail outlets. For our analysis, the cross-sectional data covering the period from January 1 through December 27 for the year 2014 and consisting of 61,557 observations (households) were used. For each household, their purchases of organic and conventional flour were aggregated for the calendar year 2014. After aggregation, these households were labeled to be either conventional or organic. The use of scanner data allows for observations associated with organic flour purchases to be separated from those related to conventional flour purchases, enabling the categorization of the entire dataset into two distinct groups: organic buyers and conventional buyers. Households that purchased only organic flour at least once in 2014 were labeled as organic, while labeled conventional otherwise. As well, households that purchased only conventional flour at least once during 2014 were labeled as conventional and organic otherwise. In the final estimation, 5,355 households were included in the conventional panel and 1,363 households were included in the organic panel. While recognizing the possibility of leaving out those households that purchased both organic and conventional flour in 2014 as well as households that did not purchase flour at all in 2014, the present analysis focuses solely on pure organic or conventional buyers. Also, the possible sample selection bias associated with

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[1] The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

leaving out households is accounted for by the IMR. In addition, it needs to be mentioned that a polychotomous choice model is a viable option for accommodating all the possible choices of household purchasing behavior associated with organic and conventional flour and is something that is recommended for future research to focus on. Panelists do not report prices for organic and conventional flour, and unit values were used as proxies for these prices. Unit values for both types of flour were derived by calculating the ratio of reported total expenditure divided by the reported quantity purchased.

Table 2 depicts descriptive statistics of the variables used in the present study by flour type. As Table 2 shows, the average quantities of organic and conventional flour are 6.19 and 5.73 lbs., respectively, meaning that households on average purchased slightly more organic flour than conventional flour in 2014. The average prices for organic and conventional flour are 3.42 and 2.72 dollars/lb., respectively, indicating that on average organic flour was more expensive than conventional flour by $0.7/lb. The average median household income for organic flour buyers of $66,307.4 was greater than that of $60,899.03 for conventional flour buyers in 2014, suggestive of relatively richer households purchasing more organic flour than conventional flour. Also, a profile of a typical organic flour purchasing household would include a household with a white, non-Hispanic, married and unemployed head, aged between 45 and 64 and with more than college degree, with the household consisting of two members and no children aged below 18 and residing in the East. The same profile is observed for a conventional flour buying household, except for it being located in the Central region, unlike the East region for the organic buying household.

Table 2. Descriptive Statistics

	Organic Flour		Conventional Flour	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Quantity_organic/Quantity_conventional (lbs)	6.1912	6.8292	5.7290	9.6351
unitval_org/unitval_con ($/lb)	3.4196	2.3117	2.7192	3.4785
medhhinc ($)	66307.4	28458.85	60899.03	29070.17
hhsize1	0.1820	0.3859	0.1864	0.3894
hhsize2	0.4637	0.4989	0.4527	0.4978
hhsize3	0.1526	0.3597	0.1430	0.3502
hhsize4	0.1343	0.3411	0.1341	0.3408
hhsize5_andmore	0.0675	0.2510	0.0838	0.2772
age_pres_child_atleast1	0.2333	0.4231	0.2471	0.4313
age_pres_nochild	0.7667	0.4231	0.7529	0.4313
head_age_und25	0.0037	0.0605	0.0043	0.0654
head_age_25_44	0.2172	0.4125	0.2314	0.4217
head_age_45_64	0.5554	0.4971	0.5343	0.4989
head_age_65above	0.2238	0.4169	0.2301	0.4209
head_empl_und35	0.2076	0.4058	0.2084	0.4062
head_empl_35above	0.3397	0.4738	0.3330	0.4713
head_unempl	0.4527	0.4979	0.4586	0.4983
head_edu_lths	0.0139	0.1173	0.0174	0.1306
head_edu_hs	0.1827	0.3866	0.2037	0.4028
head_edu_somecoll	0.2795	0.4489	0.2979	0.4574
head_edu_collabove	0.5238	0.4996	0.4810	0.4997
mar_stat_mar	0.7410	0.4382	0.7253	0.4464
mar_stat_wid	0.0433	0.2036	0.0583	0.2343
mar_stat_div_sep	0.1240	0.3297	0.1145	0.3184
mar_stat_none	0.0917	0.2887	0.1020	0.3026
race_white	0.8635	0.3434	0.8273	0.3781
race_black	0.0682	0.2522	0.0697	0.2546
race_asian	0.0323	0.1768	0.0551	0.2282
race_other	0.0360	0.1862	0.0480	0.2138
hisp_yes	0.0528	0.2238	0.0596	0.2367
hisp_no	0.9472	0.2238	0.9404	0.2367
region_east	0.4329	0.4957	0.3668	0.4820
region_central	0.3059	0.4610	0.4004	0.4900
region_west	0.2612	0.4394	0.2329	0.4227

Notes: Total number of observations for organic and conventional flour is 1,363 and 5,355, respectively. All the variables are indicator variables, except for quantities, unit values, and median household income. As such, corresponding percentages are obtained when the means of indicator variables are multiplied by 100.
Source: Calculated based on data from The Nielsen Company (U.S.), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

Estimation Results

First-Stage Probit Model Analysis

The maximum likelihood parameter estimates and associated standard errors from the first-stage probit model of the Heckman sample selection procedure regarding the decision to purchase organic and conventional flour are reported in Tables 3 and 4, respectively. These probit model parameter estimates do not offer any direct economic interpretation, only suggesting how they impact the probability of purchasing the corresponding type of flour. As such, it is more intuitive to discuss the estimation results associated with the probit model in terms of marginal effects, which show the change in predicted probability given the change in an independent variable, everything else held constant. The computed marginal effects and the associated standard errors for organic and conventional flour are shown in Tables 3 and 4, respectively. The level of significance chosen for this analysis is 0.1 and the estimations were done using STATA 12 software package. The p-values associated with the $\chi 2$ statistic for both models is less than 0.1, meaning that the parameter estimates are jointly statistically significant in both probit models. The low values associated with the pseudo R^2 from the organic flour model (0.0218) and the conventional flour model (0.0155) are often obtained in cross-sectional data analysis.

According to the empirical results in Table 4, as the number of household members goes up, households become more likely to purchase conventional flour. In particular, for one-member and three-member households, the probability of purchasing conventional flour is lower by 0.0232 and 0.0114, respectively, compared to household size equal to or greater than five members. Age of household heads is an important factor in purchasing conventional flour. In comparison to households with heads aged 65 and above, for households with heads aged from 25 to 44, the probability of purchasing conventional flour increases by 0.0095. Household employment is found to be important for purchasing decision associated with both organic and conventional flour. The probability of purchasing organic and conventional flour is lower for household heads employed more than 35 hours/week by 0.0047 and 0.018, respectively, compared to unemployed household heads. Education level plays a significant role in purchasing decision for both organic and conventional flour, with the likelihood of purchasing organic and conventional flour increasing with advances though education levels. Hence, for household heads with less than high school education level, the probability of purchasing organic and conventional flour decreases by 0.016 and 0.0386, respectively, compared to household heads with more than college degree. For household heads with high school education level, the probability of purchasing organic and conventional flour declines by 0.0136 and 0.0337, respectively, compared to household heads with more than college degree. For household heads with education level corresponding to some college, the probability of purchasing organic and conventional flour decreases by 0.0077 and 0.0156, respectively, compared to household heads with more than college degree. Marital status also emerges as an important factor influencing households' decision to purchase organic and conventional flour. For married household heads, the probability of purchasing organic and conventional flour increases by 0.0109 and 0.0215, respectively, compared to household heads that are single. For divorced or separated household heads, the probability of purchasing organic flour increases by 0.0052, compared to household heads that are single.

Table 3. Parameter Estimates, Marginal Effects, and Associated Standard Errors from the First-Stage Probit Model of the Heckman Sample Selection Procedure for Organic Flour

	Parameter Estimates	Standard Error	Marginal Effects	Standard Error
hhsize1	0.0155	0.0746	0.0008	0.0039
hhsize2	0.0608	0.0603	0.0032	0.0031
hhsize3	0.0641	0.0569	0.0033	0.0030
hhsize4	0.0858	0.0546	0.0044	0.0028
age_pres_child_atleast1	-0.0382	0.0449	-0.0020	0.0023
head_age_und25	0.0096	0.1868	0.0005	0.0097
head_age_25_44	0.0469	0.0430	0.0024	0.0022
head_age_45_64	0.0387	0.0318	0.0020	0.0016
head_empl_und35	0.0081	0.0316	0.0004	0.0016
head_empl_35above	-0.0910*	0.0283	-0.0047*	0.0015
head_edu_lths	-0.3091*	0.0923	-0.0160*	0.0048
head_edu_hs	-0.2617*	0.0311	-0.0136*	0.0016
head_edu_somecoll	-0.1484*	0.0271	-0.0077*	0.0014
mar_stat_mar	0.2110*	0.0506	0.0109*	0.0026
mar_stat_wid	-0.0323	0.0644	-0.0017	0.0033
mar_stat_div_sep	0.0998*	0.0485	0.0052*	0.0025
race_white	0.1237*	0.0644	0.0064*	0.0033
race_black	-0.0523	0.0757	-0.0027	0.0039
race_asian	-0.0115	0.0898	-0.0006	0.0047
hisp_yes	-0.0377	0.0547	-0.0020	0.0028
region_east	-0.0593*	0.0296	-0.0031*	0.0015
region_central	-0.2606*	0.0308	-0.0135*	0.0016
constant	-2.0769	0.1053		
Pseudo R^2	0.0218			
# of observations	61,557			
LR $\chi^2(22)$	284.62			
p-value > χ^2	0.0001			

Note: Asterisk indicates significance at the 10% level.
Source: Calculated based on data from The Nielsen Company (U.S.), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

Table 4. Parameter Estimates, Marginal Effects, and Associated Standard Errors from the First-Stage Probit Model of the Heckman Sample Selection Procedure for Conventional Flour

	Parameter Estimates	Standard Error	Marginal Effects	Standard Error
hhsize1	-0.1485*	0.0456	-0.0232*	0.0071
hhsize2	-0.0442	0.0370	-0.0069	0.0058
hhsize3	-0.0731*	0.0348	-0.0114*	0.0054
hhsize4	-0.0138	0.0334	-0.0022	0.0052
age_pres_child_atleast1	-0.0362	0.0286	-0.0056	0.0045
head_age_und25	0.0363	0.1134	0.0057	0.0177
head_age_25_44	0.0611*	0.0271	0.0095*	0.0042
head_age_45_64	0.0184	0.0202	0.0029	0.0032
head_empl_und35	0.0244	0.0202	0.0038	0.0031
head_empl_35above	-0.1156*	0.0180	-0.0180*	0.0028
head_edu_lths	-0.2474*	0.0535	-0.0386*	0.0083
head_edu_hs	-0.2161*	0.0194	-0.0337*	0.0030
head_edu_somecoll	-0.1000*	0.0173	-0.0156*	0.0027
mar_stat_mar	0.1376*	0.0307	0.0215*	0.0048
mar_stat_wid	0.0287	0.0374	0.0045	0.0058
mar_stat_div_sep	0.0186	0.0302	0.0029	0.0047
race_white	-0.0290	0.0378	-0.0045	0.0059
race_black	-0.2092*	0.0450	-0.0326*	0.0070
race_asian	0.2154*	0.0509	0.0336*	0.0079
hisp_yes	-0.0246	0.0341	-0.0038	0.0053
region_east	-0.0757*	0.0199	-0.0118*	0.0031
region_central	-0.1005*	0.0196	-0.0157*	0.0031
constant	-1.1773	0.0639		
Pseudo R^2	0.0155			
# of observations	61,557			
LR χ^2 (22)	562.37			
p-value > χ^2	0.0001			

Note: Asterisk indicates significance at the 10% level.
Source: Calculated based on data from The Nielsen Company (U.S.), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

White households are more likely to purchase organic flour than households of other race types. For White households, the probability of purchasing organic flour increases by 0.0064, relative to households of other race types. At the same time, Black households are less likely, while Asian households are more likely, to purchase conventional flour, relative to households of other race types. For Black and Asian households, the probability of purchasing conventional flour decreases by 0.0326 and increases by 0.0336, respectively. The probability of purchasing organic flour is lower for households located in the Central region, relative to households residing in the West. Regionally, for households located in the East and Central regions, the probability of purchasing organic flour decreases by 0.0031 and 0.0135, respectively, compared to households located in the West. As far as the region of residence, the same purchasing pattern is obtained for the conventional flour. For households located in the East and Central regions, the probability of purchasing conventional flour decreases by 0.0118 and 0.0157, respectively, relative to households located in the West. Household size, age and presence of children aged below 18 in the household, age of household head, and ethnicity do not statistically significantly impact the probability of purchasing organic flour. At the same time, the effects of age and presence of children aged below 18 in the household and ethnicity are found to be statistically insignificant factors impacting the probability of purchasing conventional flour.

Second-Stage Demand Model Analysis

Conditional upon the decision to purchase organic or conventional flour, in the second stage of Heckman’s two-stage model, the corresponding demand equation is estimated. Before the discussion of the parameters estimates from the second-stage demand models of the Heckman two-stage procedure, it needs to be noted that the parameter estimates associated with the IMR (Inverse Mills Ratio) variable in both organic flour demand model and conventional flour demand model are statistically insignificant. This implies that the sample selection bias is not an issue in either model, and the second-stage parameter estimates presented in Table 5 are the correct marginal effects. The p-values of F statistic in both demand models are virtually equal to zero, indicating that all the parameter estimates are jointly statistically significant in both models. Per the results in Table 5, the R^2 for the organic flour model and is 0.048, meaning that 4.8% of the variation in the quantity of organic flour purchased is explained by the model. At the same time, the R^2 for the conventional flour model is 0.0492, suggesting that 4.92% of the variation in the quantity of the conventional flour purchased is explained the model. According to the estimation results in Table 5, own price (i.e., unit value) appears to have a significant negative effect on quantity purchased of organic and conventional flour. For every one dollar increase in the own price, the quantity purchased of organic and conventional flour decreases by 0.494 and 0.5662 lbs., respectively. At the same time, every one dollar increase in the price of organic flour leads to a 1.7505 lbs. decrease in the quantity purchased of conventional flour.

Household income emerges as a significant factor negatively influencing the quantity purchased of organic and conventional flour. Hence, as household income goes up by one dollar, the quantity purchased of organic and conventional flour decreases by 0.0000206 and 0.0000201 lbs., respectively. This finding can be possibly explained by fact that wealthier household heads might prefer to eat out rather than purchase ingredients (for example, flour) to prepare meals at home.

Table 5. Parameter Estimates and Associated Standard Errors from the Second-Stage Demand Models from the Heckman Sample Selection Procedure for Organic and Conventional Flour

	Organic Flour		Conventional Flour	
	Parameter Estimates	Standard Error	Parameter Estimates	Standard Error
unitval_org/unitval_con	-0.4940*	0.0796	-0.5662*	0.0370
pred_unitval_con/ pred_unitval_org	28.1595	20.8063	-1.7505*	0.9175
medhhinc	-0.0000206*	0.0000076	-0.0000201*	0.00000534
hhsize1	-2.4314*	1.2684	-1.9632	1.2683
hhsize2	-1.0563	1.0133	-0.8895	0.7338
hhsize3	-0.7766	0.9711	-1.5484*	0.7879
hhsize4	0.1306	0.9074	-0.9634	0.6096
age_pres_child_atleast1	-0.8877	0.7575	-0.0242	0.5841
head_age_und25	-2.5204	3.1186	-0.6041	2.1219
head_age_25_44	1.7764*	0.7267	0.1538	0.6361
head_age_45_64	1.1720*	0.5314	0.4137	0.3962
head_empl_und35	-0.0633	0.5102	-0.0336	0.3976
head_empl_35above	-1.2166*	0.5389	-1.3311	0.8198
head_edu_lths	-1.6513	1.8197	-0.5113	1.9082
head_edu_hs	-1.1961	0.9278	-1.9569	1.4282
head_edu_somecoll	-0.6523	0.6427	-1.1708*	0.7048
mar_stat_mar	1.2140	1.0740	2.0343*	1.0692
mar_stat_wid	0.8097	1.1251	0.1570	0.7569
mar_stat_div_sep	0.4288	0.8881	-0.1075	0.6078
race_white	2.2020*	1.1231	-0.2592	0.7258
race_black	0.7502	1.2825	-2.3181	1.6322
race_asian	1.5463	1.4892	3.1371*	1.6287
hisp_yes	-1.3133	0.8983	-0.6846	0.6435
constant	-79.7529	63.5678	2.1993	10.6296
IMR	4.4962	3.3271	7.3686	7.5692
R^2	0.0480	R^2		0.0492
# of observations	1,363	# of observations		5,355
F(23, 1339)	3.35	F(23, 5331)		13.84
p-value > F	0.0001	p-value > F		0.0001

Note: Asterisk indicates significance at the 10% level.
Source: Calculated based on data from The Nielsen Company (U.S.), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

Household size has a statistically significant effect on the demand for both flour types. Relative to households with five and more members, the quantity purchased of organic flour is lower by 2.4314 lbs. for one-member households, and the quantity purchased of conventional flour is lower by 1.5484 lbs. for three-member households. Age of household head has a positive impact on the demand for organic flour. Compared with household heads aged 65 and above, household heads aged between 25 and 44 and between 45 and 64 purchase 1.7764 and 1.172 lbs. more of organic flour, respectively. Employment status is found to be negatively associated with quantity of organic flour purchased. In particular, household heads who are employed more than 35 hours per week purchase less organic flour by 1.2166 lbs. than unemployed household heads.

Education level of household head is a significant factor only for the demand for conventional flour. In terms of purchases of conventional flour, household heads with some college degree purchase 1.1708 lbs. less flour, compared with household heads with more than college degree. Married household heads purchase more of conventional flour by 2.0343 lbs. than single household heads. Race is a significant determinant of the demand for flour, positively affecting the demand for both types of flour. Hence, relative to other race types, White households purchase more organic flour by 2.202 lbs., and Asian households purchase more conventional flour by 3.1371 lbs.

Price of the conventional flour, age and presence of children aged below 18 in the household, education level, marital status, and ethnicity are not statistically significant determinants of the demand for organic flour. As well, age and presence of children aged below 18 in the household, age, employment status, and ethnicity are not statistically significant factors of the demand for conventional flour.

Own-price, cross-price, and income elasticities of demand associated with organic and conventional flour and computed based on the parameter estimates of the corresponding demand models from the second-stage of the Heckman procedure are depicted in Table 6. Own-price elasticities of demand for both organic and conventional flour are negative and are equal to -0.2728 and -0.2687, respectively. These elasticities imply that a 1% increase in the price of organic flour decreases the quantity purchased of organic flour by 0.2728%, holding everything else constant. As well, a 1% increase in the price of conventional flour decreases the quantity purchased of conventional flour by 0.2687%, holding everything else constant. The own-price elasticities for both flour types suggest that the demand for both organic and conventional flour is inelastic (the absolute values of elasticities is less than one), meaning that flour manufacturers can increase their sales revenues in the short-run by increasing the price. The empirical result of inelastic demand for conventional flour compares favorably with the findings from prior studies by George and King (1971), Lamm (1982), and Huang (1993), who computed the own-price elasticity of demand for flour to be -0.30, -0.06, and -0.08, respectively, while Bergtold, Akobundu, and Peterson (2004) calculated the own-price elasticity for flour to be -1.01, suggestive of almost unitary elastic demand for flour.

Table 6. Own-Price, Cross-Price, and Income Elasticities of Demand for Organic and Conventional Flour

	With respect to the price of		
Demand for	Organic Flour	Conventional Flour	Income Elasticity
Organic flour	-0.2728	12.3757	-0.2206
Conventional flour	-1.0597	-0.2687	-0.2137

Note: Elasticities are computed at the sample means.
Source: Calculated based on data from The Nielsen Company (U.S.), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

Cross-price elasticity of demand for organic flour with respect to the price of conventional flour is equal to 12.3757, implying that organic and conventional flour are substitutes and that 1% increase in the price of conventional flour leads to a 12.3757% increase in the quantity purchased of organic flour, holding everything else constant. On the other hand, the cross-price elasticity of demand for conventional flour with respect to the price of the organic flour is -1.0597, indicating that both flour types are complements and that 1% increase in the price of organic flour leads to a 1.0597% decrease in the quantity purchased of conventional flour, holding everything else constant. This result can be possibly explained by the fact, that the cross-price elasticity between organic and conventional flour is an uncompensated cross-price elasticity, which reflects both the substitution effect and income effect, and the income effect must have dominated the substitution effect leading to the complementary relationship between the organic and conventional flour.

Finally, the values of the income elasticity of demand associated with organic and conventional flour are -0.2206 and -0.2137, respectively. The negative values of the income elasticity suggest that both organic and conventional flour are inferior goods. As household income goes up by 1%, the quantity purchased of organic and conventional flour goes down by 0.2206% and 0.2137%, respectively. Of the two flour types, organic flour is more responsive to changes in income than conventional flour, which is indicated by the absolute values of the income elasticities. By comparison, George and King (1971), Lamm (1982), Huang (1993), and Okrent and Alston (2012) found flour to be a normal good with the expenditure/income elasticities equal to 0.08, 0.15, 0.13, and 0.01, respectively, which is not consistent with the empirical result from the present analysis. However, Bergtold, Akobundu, and Peterson (2004) found the expenditure elasticity estimate to be around -0.04, which is in accord with the finding from the present analysis.

Concluding Remarks and Recommendations for Future Research

Using Nielsen Homescan panel data on household purchases for 2014, this study estimates the Heckman two-stage sample selection model to empirically analyze the effects of household demographic characteristics and prices on the probability of purchasing organic or conventional flour as well as on the quantity purchased of organic and conventional flour. The empirical findings from this study present evidence suggesting that a number of household demographic characteristics are important determinants of the probability of purchasing organic or conventional flour.

Conditional on the decision whether to buy organic or conventional flour, the estimation of the second-stage equations from the Heckman two-stage model for both flour types isolated the statistically significant drivers of the demand for organic and conventional flour and allowed for computation of demand elasticities. According to the computed own-price elasticities of demand for organic and conventional flour, the demand for both flour types is inelastic, indicative of consumer irresponsiveness to flour price changes. As such, flour manufacturers need to raise their prices in an attempt to maximize the short-run revenues. As far as cross-price elasticities, an asymmetric pattern is observed. In particular, the cross-price elasticity of the organic flour demand with respect to the price of conventional flour suggests a substitutability relationship between the two flour types. At the same time, the cross-price elasticity of the conventional flour demand with respect to the price of organic flour reveals a complementary relationship between the two flour types. Finally, per negative income elasticities, organic and conventional flour are inferior goods, meaning that an increase in income leads to a decrease in the quantity purchased of both flour types.

Besides assisting in designing revenue maximizing pricing strategies, demand elasticity estimates can aid flour manufactures in their input procurement and inventory management decisions via their role in forecasting the demand for flour and flour movement. Also, the results from this study can help flour manufacturers and retail marketers in enhancing their understanding of the most profitable customer base in order to identify market opportunities and develop effective marketing strategies and supply decisions.

A couple of recommendations for future research need to be noted. First, future research would benefit from extending the analysis by incorporating information on the households that purchased both organic and conventional flour, or did not purchase any flour at all by using a polychotomous choice model that would accommodate all possible choices. Also, future research is recommended to replicate this study incorporating the time dimension to capture potential dynamics in the household purchasing behavior associated with flour.

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