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# An Empirical Analysis of Household Demand for Organic and Conventional Flour in the United States: Evidence from the 2014 Nielsen Homescan Data

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Using the 2014 Nielsen Homescan panel data, the Heckman two-stage sample selection model estimates the likelihood of purchasing organic and conventional flour as well as the quantity purchased of each. A number of demographic variables are found to be statistically significant impacting the likelihood of purchasing organic and conventional flour. Own-price elasticities of demand for organic and conventional flour indicate that the demand for both flour types is inelastic. Cross-price elasticities of demand suggest an asymmetric pattern between organic and conventional flour demand. Finally, organic and conventional flour are found to be inferior goods.

***Key words:*** Conventional Flour, Household Demand, Heckman Procedure, Organic Flour

In the United States, organic foods are one of the fastest growing market segments (Dettmann and Dimitri, 2007). The sales of organic products increased from $1 billion in the 1990s 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 and Zahaf, 2012). However, the crisis had a negative impact on organic product sales due to a decrease in consumers' purchasing power (Hamzaoui-Essoussi and Zahaf, 2012). The sales of organic products continued to increase in the years following the crisis (Hamzaoui-Essoussi and 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 contributed by non-food organic sales (McNeil, 2018).

The production of wheat has declined over the past 20 years (U.S. Department of Agriculture (USDA), 2017). Relatively low wheat profitability and pesticide resistance compared to other crops, government programs (such as the Acreage Reduction Program and the Conservation Reserve Program), and changes in tastes and preferences adversely

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influencing the consumption of wheat products account for this decline in production (Bond and Liefert, 2017).

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 and Grains, 2018). According to the Nielsen Scantrack data, in 2016, the sales of organic grain-based products in the United States were estimated to be approximately $1 billion (Gelski, 2018). As the demand for organic grain-based food increases rapidly, the USDA provides opportunities for producers to increase the number of organic farms in the United States and produce enough organic wheat to meet the growing demand (National Organic Coalition, 2018) 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, and the organic transitional labeling program). As a result, in 2015, the number of certified organic farms in the United States reached 12,818, producing $6.2 billion in certified organic products, which was greater by 13% in 2014 (USDA, 2016). Also, in 2016, the domestic acreage of organic wheat was around 482,207 acres, up almost 40% from 344,644 acres in 2011 (Gelski, 2018). At the same time, Ardent Mills, North America's leading flour supplier, started the Organic Initiative 2019 program, the main objective of which is to help farmers significantly increase organic wheat acreage in the United States by 2019 (Gelski, 2018).

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 United States produced and consumed 2 and 2.7 million tons of pasta, respectively, with per capita pasta consumption of around 8.8 kilograms (International Pasta Organisation, 2018), which had positive implications for the demand flour. In addition, Vocke (2015) noted that people's desire to eat outside the home, relatively low prices of fast food restaurant products, and saving time spent on food preparation 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 (2018).

The increasing demand for organic products, the importance of flour as a major ingredient in 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 research analyzing household demand for organic and conventional flour. Additionally, household-level demand for organic and conventional flour is understudied. In fact, to our knowledge, this is the first study investigating household-level demand for organic and conventional flour. To fill the gap, this study adds to the literature by analyzing the impact of household demographic variables on the likelihood of purchasing organic and conventional flour, as well as evaluating the effects that these characteristics have on the quantity purchased of organic and conventional wheat 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 likelihood 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. The next section discusses the empirical specification of the Heckman model. Then, the data 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 the researcher limits the sample. For this study, a 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 likelihood of purchasing organic and conventional flour. In the second stage, the model uses the OLS method to estimate the demand for organic and conventional flour.

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.

Following prior studies dealing with the analysis of the effects of economic variables and household demographic characteristics on the likelihood of purchasing conventional and organic food, as well as on the consumption of conventional and organic food (Dettmann and Dimitri, 2007; Dettmann, 2008; LeBeaux, 2008; Zhuang, Dimitri, and Jaenicke, 2009; Alviola and Capps, 2010; Schroeter and Cai, 2012), in the present study, the likelihood of purchasing organic flour is estimated as a function of household demographic variables related to household size, age, and the presence of children below age 18 in the household, the household head's age, employment status, education level, marital status, race, ethnicity, and the geographic location of the household. The empirical probit model associated with organic flour is specified as follows:

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

where $q_i$ is 1 if the household purchased organic flour, and 0 otherwise. Additionally, in (1), $i = 1,2,\ldots,n$ shows the number of observations (i.e., households), $X_i$ is a set of independent variables, $e_i$ is the disturbance term, and $\alpha$s are the parameters to be estimated. 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.

**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 ($) of household |

*Notes: a. Asterisk indicates the base category. b. The head of household was woman if a female was present. When information on the female household head was not available, the male was considered to be the household head. c. 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.*

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 second-stage demand model for organic flour is specified as follows:

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

In (2), $Y_i$ represents the quantity purchased of organic flour by the *i*th household, $IMR_i$ is the Inverse Mills Ratio obtained in the probit model, $\varepsilon_i$ is the disturbance term, and the *β*s are the parameters to be estimated. 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[1]) variables, and household income, $medhhinc_i$, which was reported in brackets in the raw Nielsen data, and a median point for a bracket was recorded to represent the actual value for household income. The models in (1) and (2) are also estimated for conventional flour, using data only for households who chose to purchase conventional flour as determined in the first-stage probit model.

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.

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[1] Since the second-stage demand model of organic (conventional) flour used observations associated with the actual purchases of organic (conventional) flour, there were no missing observations for the own-price variable to be imputed. However, the values for the cross-price variable associated with the conventional (organic) flour price, *pred_unitval_con (pred_unitval_org*) that was included in the organic (conventional) flour demand model as an explanatory variable had to be imputed using regression analysis and regional dummies as explanatory variables following Alviola and Capps (2010). These missing values arose since households that purchased organic (conventional) flour may not have purchased conventional (organic) flour. To impute missing values for the organic (conventional) flour price, organic (conventional) flour price was first regressed on the regional dummy variables ($region\_east_i$ and $region\_central_i$), and then the predicted values of the organic (conventional) flour price variables were generated to be used as a cross-price variable in corresponding demand models to capture the potential impact of the competitive good price. It needs to be noted that no negative predicted values for either organic flour price or conventional flour price were generated in the imputation process. The estimated regression models run to impute the missing values for organic and conventional flour are available upon request.

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, and Capps, 1998; Dong and Kaiser, 2005). The presence of the endogeneity issue in organic and conventional flour prices (unit values) is ascertained with the help of the Durbin $\chi^2$ and the Wu-Hausman tests, using household demographic variables (Alviola and Capps, 2010) related to household income, household size, age, and the presence of children below age 18 in the household, age, employment status, education level, marital status, race, ethnicity of the household head, household residence region, and the corresponding cross-price variables as instruments. For the organic flour price, the p-value of the Durbin $\chi^2$ statistic is equal to 0.5508 and the p-value of the Wu-Hausman $F$ statistic is equal to 0.5545, thus failing to reject the null hypothesis that the organic flour price is exogenous at all conventional significance levels. For the conventional flour price, the p-value of the Durbin $\chi^2$ statistic is 0.3240, while the p-value of the Wu-Hausman $F$ statistic is 0.3252, implying that the null hypothesis of the conventional flour price being exogenous cannot be rejected at any conventional significance levels. As such, based on the results from the Durbin test and the Wu-Hausman test, 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.[2] 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 cover the period from January 1 through December 27, 2014, and consist of 61,557 observations (households). For each household, their purchases of organic and conventional flour were aggregated for 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

[2] The conclusions drawn from the Nielsen data are those of the researcher(s) 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.

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 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. 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/lb. and $2.72/lb., respectively, indicating that, on average, organic flour was more expensive than conventional flour by $0.7/lb. The average median household income of 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, between 45 and 64 years old, with more than a college degree, with the household consisting of two members, no children below age 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 flour 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 | 5.729 | 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* | 0.182 | 0.3859 | 0.1864 | 0.3894 |
| *hhsize2* | 0.4637 | 0.4989 | 0.4527 | 0.4978 |
| *hhsize3* | 0.1526 | 0.3597 | 0.143 | 0.3502 |
| *hhsize4* | 0.1343 | 0.3411 | 0.1341 | 0.3408 |
| *hhsize5_andmore* | 0.0675 | 0.251 | 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 | 0.333 | 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 | 0.481 | 0.4997 |
| *mar_stat_mar* | 0.741 | 0.4382 | 0.7253 | 0.4464 |
| *mar_stat_wid* | 0.0433 | 0.2036 | 0.0583 | 0.2343 |
| *mar_stat_div_sep* | 0.124 | 0.3297 | 0.1145 | 0.3184 |
| *mar_stat_none* | 0.0917 | 0.2887 | 0.102 | 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* | 0.036 | 0.1862 | 0.048 | 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 | 0.482 |
| *region_central* | 0.3059 | 0.461 | 0.4004 | 0.49 |
| *region_west* | 0.2612 | 0.4394 | 0.2329 | 0.4227 |

*Notes: a. Total number of observations for organic and conventional flour is 1,363 and 5,355, respectively. b. 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. c. Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at 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 likelihood 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 estimation results significant at the 1%, 5%, and 10% levels and obtained using STATA 12 software package are interpreted in this analysis. The p-values associated with the $\chi 2$ statistic for both models indicate 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. However, it needs to be noted that the probit model correctly predicted 64.05% and 54.56% of choices associated with organic flour and conventional flour, respectively.

According to the empirical results in Table 4, 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 the household head is an important factor in purchasing conventional flour. In comparison to households with heads aged 65 and above, for households with heads aged 25 to 44, the probability of purchasing conventional flour increases by 0.0095. Household employment is found to be important for purchasing decisions 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 decisions for both organic and conventional flour, with the likelihood of purchasing organic and conventional flour increasing with advances in educational levels.

**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 | 0.003 |
| *hhsize4* | 0.0858 | 0.0546 | 0.0044 | 0.0028 |
| *age_pres_child_atleast1* | -0.0382 | 0.0449 | -0.002 | 0.0023 |
| *head_age_und25* | 0.0096 | 0.1868 | 0.0005 | 0.0097 |
| *head_age_25_44* | 0.0469 | 0.043 | 0.0024 | 0.0022 |
| *head_age_45_64* | 0.0387 | 0.0318 | 0.002 | 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 | -0.002 | 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 > $\chi^2$ | 0.0001 | | | |

*Notes: a. *** p<0.01, ** p<0.05, * p<0.1. b. Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at 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 | 0.037 | -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*** | 0.018 | -0.0180*** | 0.0028 |
| *head_edu_lths* | -0.2474*** | 0.0535 | -0.0386*** | 0.0083 |
| *head_edu_hs* | -0.2161*** | 0.0194 | -0.0337*** | 0.003 |
| *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* | -0.029 | 0.0378 | -0.0045 | 0.0059 |
| *race_black* | -0.2092*** | 0.045 | -0.0326*** | 0.007 |
| *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 $\chi^2$ (22) | 562.37 | | | |
| p-value > $\chi^2$ | 0.0001 | | | |

*Notes: a. *** p<0.01, ** p<0.05, * p<0.1. b. Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.*

**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*** | 0.037 |
| *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* | 1.214 | 1.074 | 2.0343* | 1.0692 |
| *mar_stat_wid* | 0.8097 | 1.1251 | 0.157 | 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 |
| $R^2$ | 0.048 | $R^2$ | | 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 |

*Notes: a. *** p<0.01, ** p<0.05, * p<0.1. b. The regional dummy variables (region_east $_i$ and region_central $_i$) were dropped from the final estimation of the second-stage demand models in order to avoid the multicollinearity issue due to their use in the missing value imputation process for cross-price variables, pred__unitval_con and pred_unitval_org. c. Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.*

For household heads with less than a 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 a college degree. For household heads with a 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 a college degree. For household heads with an 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 a college degree. Marital status also emerges as an important factor influencing households' decisions 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 who are single. For divorced or separated household heads, the probability of purchasing organic flour increases by 0.0052, compared to household heads who are single.

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 East and Central regions, 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 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 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 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 $IMR_i$ variable in both the organic flour demand model and the 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 the $F$ 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 is 0.048, meaning that 4.8% of the variation in the quantity purchased of organic flour 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 purchased of conventional flour is explained by 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 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 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 possibly can be explained by the fact that wealthier household heads might prefer to eat out rather than purchase ingredients (for example, flour) to prepare meals at home. 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. The age of a household head has a positive impact on the demand for organic flour. Compared with household heads aged 65 and above, household heads 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 the 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.

The education level of a 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 a college degree. Married household heads purchase more 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.

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

*Notes: a. Elasticities are computed at the sample means. b. Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.*

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 the flour product category to be -1.01, suggestive of almost unitary elastic demand for that product category.

The 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 a 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 organic flour is -1.0597, indicating that both flour types are complements and that a 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 possibly can be 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 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 for the flour product category 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 and 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 unresponsiveness to flour price changes. As such, flour manufacturers can raise their prices in an attempt to maximize short-run revenues. As far as cross-price elasticities, an asymmetric pattern is observed. In particular, the cross-price elasticity of organic flour demand with respect to the price of conventional flour suggests a substitutability relationship between them. At the same time, the cross-price elasticity of 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 few 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. Finally, future research should focus on replicating the current analysis using the most recent data available from the Nielsen Homescan panel to provide the most up-to-date empirical findings related to the demand for conventional and organic flour.

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