An Analysis on Sustainable Food Consumption by Income Level:

The Case of Environment-Friendly Fresh Grains in Korea

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An Analysis on Sustainable Food Consumption by Income Level: The Case of Environment-Friendly Fresh Grains in Korea

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Research Background

The food industry has been steadily growing quantitatively. Furthermore, the recent food consumption pattern is changing from quantity to quality with the consideration of environment-friendly factors. For instance, the consumption of environment-friendly foods is in the trend of increasing in the sense that it takes into account qualitative factors such as human health and sustainability. For this reason, the concept of sustainable food consumption, which considers various qualitative factors such as cultural, social, environmental factors, is gaining attention.

Sustainable food consumption can be conceptualized as food consumption with sustainable values. With that concept, it minimizes environmental pollution and social problems and enhances consumers' life quality by developing the economy through food choices beneficial to individuals, society, and the earth (Levett and Therivel, 2005). The interest in sustainable food consumption is expected to have a large impact on global food consumption and production trends. As the importance of the food industry is growing, it would be timely to analyze issues concerning sustainable food consumption.

Research Object

The object of this study is to analyze whether there is a difference among environment-friendly food consumptions by income levels using the concept of sustainable food consumption. For this object, this study suggests environment-friendly food as an example of sustainable food as it shares natural environment and consumers' health with the sustainable food. Especially, this study analyzes the effect of income level on environment-friendly food consumption with the consideration that income level can be a criterion for assessing social equity. For example, if consumption patterns for environment-friendly food differ by income levels, it could show the existence of social inequality in terms of the concept of the sustainable food consumption.

Previous Literature

Previous literature has analyzed the determinants of sustainable food consumption through surveys and its impact on the environment and the economy (Duchin, 2005; Vermeir and Verbeke, 2006; 2008). The research on environment-friendly food consumption analyzed consumption factors according to consumers' perception with their individual characteristics (Jeong, 2012; Jun, 2014). Yim (2012) considered social equity by comparing the effects of food trust on the safety of agricultural products according to the income level of households, but it was not a detailed analysis of environment-friendly foods.

Model

This study uses a multilevel mixed-effects linear regression model, including both fixed and random effects under the existence of a hierarchical relationship. The reason for using this model is that it is the most suitable model for determining whether there is a difference in food purchase decision making by income levels. It has the following advantages (Bryk et al., 1996; Seok and Saghaian, 2016):
1) the effects of different levels of variables can be grasped, and data can be estimated even if they do not have the same intervals.
2) analysis can be performed even when the level of analysis is mixed.
3) the interaction between levels can be verified by handling level variables simultaneously.

Multilevel mixed-effects linear regression model can be divided into the random effect model, the random intercept model, and the random coefficient model depending on whether the slope and the intercept are included or not.

This study introduces the random coefficient model as the baseline model to analyze the difference between the random slope and the random intercept of consumption factors by income levels. Also, the random effect model and the random intercept model are used.

When i is individual consumer and j is high-level group, the model is as follows:

$$(1) \quad y_{ij} = \mu + \beta_{sj}x_{ij} + \alpha_j + \varepsilon_{ij}$$
$$\text{,where } \alpha_j \sim N(0, \delta_\alpha^2) \text{ and } \varepsilon_{ij} \sim N(0, \delta_\epsilon^2).$$

$$(2) \quad \alpha_j = \gamma_0 + \gamma_1 z_j + u_{1j}$$

$$(3) \quad \beta_{sj} = \rho_s + \rho_s z_j + w_{sj}$$

$$(4) \quad y_{ij} = (\mu + \rho_s + \gamma_0) + \rho_s(z_j x_{ij}) + \gamma_1 z_j + w_{sj}x_{ij} + \mu_{1j} + \varepsilon_{ij}$$

Dependent variable y is influenced by both the cross-level interaction variables and the level variables. Since the coefficients and random effects depend on level j, the slope and intercept of the model change into random slope and random intercept. Following equation (5), the random coefficient model is applied to this study:

$$(5) \quad y_{ij} = \beta_0 + \beta_{1ij}x_{1ij} + \beta_{2ij}x_{2ij} + \beta_{3ij}x_{3ij}$$
$$+ (\rho_0 + \rho_1 z_j + u_{2j})x_{4ij}$$
$$+ (\theta_0 + \theta_1 z_j + u_{3j})x_{5ij}$$
$$+ \gamma_0 + \gamma_1 z_j + u_{1j}$$
$$+ \varepsilon_{ij}$$

Data

As a target product, this study selects the fresh grain because grain is a major staple food in Korea with the largest share of environment-friendly food consumption. This study uses data from the fresh grain consumption panel of 667 consumers from January 2010 to December 2015 obtained from Korea Rural Development Administration. Data includes demographic variable such as the number of food purchases, food prices, and consumers' consideration for food purchases. These variables correspond to lower-level variables, and the income level is used as a higher-level variable to analyze how the higher-level variable affects the lower-level variables. The income level used in this study is assorted into three class according to Korean Statistical Information Service(KOSIS) income distribution index: high income, middle income, low income. Based on the middle income class, more than 150% of the class is classified as high income and less than 50% of the class is classified as low income.

	Variable	Name	Description
Dependent variable	y_{ij}	The number of environment-friendly food purchases	The sum of daily environment-friendly food purchases on a quarterly basis
Fixed independent variable	x_{1ij}	Average price	Total purchase values divided by purchase quantities and organized quarterly
	x_{2ij}	Average number of meals	The average daily number of meals is reconstituted quarterly
	x_{3ij}	Number of children (Exclude adults)	Sum of the number of children of infants, kindergarteners, elementary students, junior high school students, and high school students
Random independent variable	x_{4ij}	Weights for the consideration of prices	Weights for the consideration of prices when food purchase
	x_{5ij}	Weights for considerations of qualities	Weights for considerations of qualities when food purchase
Higher-level variable	z_j	Income-level	Classified as low income, middle income, and high income according to certain income standards

Results

The likelihood ratio (LR) test about the random effect model shows that there is the random effect. If the random effect exists, it means that multilevel model is better than the pooled ordinary least square (OLS) model. Next, the random intercept model is used to derive the random intercept by income levels using the Maximum Likelihood (MLE) method, and we compare the sign and the size of the random intercept. In contrast to the fact that the high income group has positive random intercept, the middle and low income groups have negative random intercepts. The ICC(intra-class correlation) estimates means the correlation between income levels and environment-friendly food purchases. Finally, the random coefficient model is used to estimate the random slope and the random intercept for each income level and to derive the covariance. Since the model includes random slope as well as random intercept, interaction variable ($x_{4ij}\&x_{5ij}$) is included in the results.

The fact that interaction variable has negative coefficient means that the lower income level, the greater the marginal effect on the number of environment-friendly food purchases. In other words, this indicates that income level variable has negative effects on the slope parameter of consumers' consideration for food purchases. In other words, this indicates that income level variable has negative effects on the slop parameter of consumers' consideration for food purchases. The random intercept can be estimated directly, while the random slope can not be estimated directly. Therefore, we analyze the random slope by using the covariance between random slope and the random intercept in random effect variable.

		Random effect model	Random intercept model	Random coefficient model
Fixed effect	constant	0.0908*** (0.036)	0.0512 (0.0115)	0.035* (0.019)
	x_{1ij}		0.0001*** (0.0000)	0.0001*** (0.0000)
	x_{2ij}		-0.0008 (0.0009)	-0.0008 (0.0009)
	x_{3ij}		0.0056** (0.0025)	0.0056** (0.0025)
	x_{4ij}		-0.0005*** (0.0001)	0.0004 (0.0004)
	x_{5ij}		0.0001*** (0.0002)	0.0002 (0.0006)
	$x_{4ij}\&x_{5ij}$			-0.00002** (0.0000)
Random effect	Higher-level constant	0.0037*** (0.0032)	0.0001*** (0.0001)	0.0007**
	Error-term variance	0.1657 (0.0022)	0.0518 (0.0007)	0.0517
	ICC(Intra-Class Correlation)	0.0217	0.002	0.0131
	High income Random intercept	0.0829*** (0.0171)	0.015* (0.0086)	0.0142* (0.0086)
	middle income Random intercept	-0.0229 (0.0034)	-0.0036* (0.002)	-0.0048** (0.002)
	low income Random intercept	-0.0669*** (0.0102)	-0.0223*** (0.0043)	-0.0244*** (0.0043)
	LR statistic	Prob >= chibar2 = 0.0000	Prob >= chibar2 = 0.0287	Prob > chi2 = 0.0180

It means that the random slope and the random intercept have different directions in the regression for each income level because both of the covariance have negative values. That is, the low income group responds sensitively to consumers' consideration for food purchases, while the high income group responds less sensitively.

Random effect parameter	Estimates
$cov(u_{2j}, u_{1j})$	-0.0000141
$cov(u_{3j}, u_{1j})$	-0.0000223

Summary and Conclusions

This study reveals that patterns of environment-friendly food consumptions are different by income levels. In addition, it provides policy implications for positioning by income levels in case that empirical analysis of environment-friendly food consumption with social equity is inadequate.

Furthermore, it suggests policy alternatives such as diversifying the quality and the price of goods when there are differences of consumptions for environment-friendly food by income levels.

Also, this study will make some contributions to bring the concept of environment-friendly food closer to sustainable food consumption.

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