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# An Analysis of Consumer Preferences for Information Sources on Food Safety by using Fuzzy Pair-wise Comparison

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**An Analysis of Consumer Preferences for Information Sources on Food Safety by using Fuzzy Pair-wise Comparison**

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**Abstract**

The main objective of this study is to measure consumer preferences for information sources on food safety along with the factors influencing the degree of consumer preferences in Turkey. The data were obtained from a survey of 385 consumers selected randomly in Izmir, Turkey. This study involves two-stage methodology. In the first stage, fuzzy pair-wise comparison was applied to calculate a measure of preferences. Five information sources on food safety, television programmes, doctors/experts, newspapers/journal articles, radio programmes and neighbors/friends were given to the consumers. The consumers were asked to make pair-wise comparisons among the information sources. The information source hierarchies of consumers were established and ranked from most to least importance. The results show that the most important information sources of consumers are "doctors/experts" and "television programmes". The consumer preferences from the first stage were regressed upon the consumer specific variables by using seemingly unrelated regression in the second stage. The preferences for information sources are mainly influenced by education and level of income.

Keywords: Consumer Preference, Food Safety, Fuzzy Pair-wise Comparison, Seemingly Unrelated Regression Model

## 1. Introduction

In Turkey, food safety scandals such as avian influenza and BSE have had negative effects on the economy. Akgüngör and Miran (1997) reported that consumers have been affected by the BSE scandal and they have lost their trust in foods. Consumers thought that foods have lost reliability in terms of their tastes and health compared to the past (Akgüngör et al., 1999). In recent years, news in the media about pesticide residues and hormone used in the production of fresh fruits and vegetables have made consumers more sensitive and more selective. Consumers have made certain changes in their food preferences against the increased loss of trust (Akgüngör et al., 2007).

Nevertheless, researches on food safety based on the consumer behaviour in Turkey are quite limited. So, the issues of food safety and consumer behaviour need to be further investigated. In this study, it is aimed to determine the priorities of information sources on food safety for consumers in Turkey. The study is expected to contribute to improve food policies that can use the information sources ranked from most to least important.

The main objectives of this study are to measure consumer preferences for information sources, television programmes, doctors / experts, newspapers / journal articles, radio programmes and neighbors / friends on food safety, and to determine the factors influencing the degree of consumer preferences in Turkey.

This study involves two-stage methodology. In the first stage, fuzzy pair-wise comparison (FPC) is applied to quantify the preferences. In the second stage, the quantified preferences obtained in the first stage are regressed upon the consumer characteristics by using seemingly unrelated regression model (SUR).

The next section discusses the basic theoretical background of FPC and the SUR model. Afterwards, the data collection method and consumer specific characteristics used in SUR model are described. Section 3 presents the findings of consumer preference measures obtained from FPC. It also covers the factors influencing consumer preferences determined by means of SUR model in which preference measures are the dependent variables and characteristics of the consumers are the independent variables. Finally, section 4 provides conclusions and implications drawn.

## 2. Methodology and data

### 2.1 Fuzzy Pair-Wise Comparison

Fuzzy theory began with a paper on "fuzzy sets" by Zadeh in 1965. Fuzzy set theory is an extension of crisp set theory (Tanaka, 1997). Fuzzy sets are sets with boundaries that are not precise. Thus, fuzzy sets describe ranges of vague and soft boundaries by degree of membership (Lai and Hwang, 1994). The membership in a fuzzy set is a matter of a degree (Klir and Yuan, 1995). Fuzzy set is characterized by a membership function, which is allowed to choose an arbitrary real value between zero and one.

FPC was first used by Van Kooten, Schoney and Hayward (1986) to study farmers' goal hierarchies for use in multiple-objective decision making. The first step of FPC approach is data collection by using a unit line segment as illustrated in Figure 1. Two information sources, *T* (television programmes) and *N* (newspapers/journal articles), are located at opposite ends of the unit line. Consumers are asked to place a mark on the line to indicate the degree of their preferred information source. A measure of the degree of preference for information source *T* over *N*, $r_{TN}$, is obtained by measuring the distance from the

consumer's mark to the *T* endpoint. The total distance from *T* to *N* equals 1. If $r_{TN}<0.5$, information source *N* is preferred to *T*; if $r_{TN}=0.5$, the consumer is indifferent between T and N; and if $r_{TN}>0.5$, then information source *T* is preferred to N. $r_{TN}=1$ or $r_{TN}=0$ indicates absolute preference for information source *T* or *N*. For example, if $r_{TN}=1$, then information source *T* is absolutely preferred to *N* (Van Kooten et al, 1986).

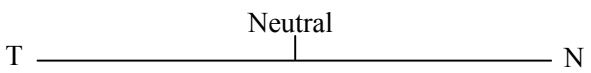


Figure 1. Fuzzy method for making pair-wise comparison between information sources (T)elevision and (N)ewspaper.

The present study employs five information source statements of the consumers. The number of pair-wise comparisons, λ, can be calculated as follows:

$$\lambda = n * (n-1)/2 \tag{1}$$

where *n* = the number of information sources. Thus, a consumer made ten pair-wise comparisons in a personal interview.

In the second step of FPC, for each paired comparison (i,j), $r_{ij}$ ($i \neq j$) is obtained. $r_{ij}$'s values is collected directly from consumer. Also $r_{ij}$ ($i \neq j$) is a measure of the degree by which the consumer prefers information source i to information source j and $r_{ji}=1- r_{ij}$ represents the degree by which j is preferred to i. Following Van Kooten at al (1986), the consumer's fuzzy preference matrix *R* with elements can be constructed as follows:

$$R_{ij} = \begin{cases} 0 & if\ i = j\ \forall i, j = 1,\ldots,n \\ r_{ij} & if\ i \neq j\ \forall i, j = 1,\ldots,n \end{cases} \tag{2}$$

Finally, a measure of preference, $\mu$, can be calculated for each information source by using consumer's preference matrix R. The intensity of each preference is measured separately by the following equation:

$$\mu_j = 1 - \left( \sum_{i=1}^{n} R_{ij}^2 / (n-1) \right)^{1/2} \tag{3}$$

$\mu_j$ has a range in the closed interval [0,1]. The larger value of $\mu_j$ indicates a greater intensity of preference for information source j. As a result, consumer's information sources are ranked from most to least preferable by evaluating the $\mu$ values.

To analyse the consumers' preferences derived from FPC, nonparametric statistical tests are used (Başarır and Gillespie, 2003). *Friedman test* is used to establish whether the information sources are equally important within a block which is a consumer's information source rankings according to his/her preferences. Since five information sources are presented to consumers, each row includes five values which are the degree of the preferences for the information sources exposed from a consumer. The null hypothesis is that there is no difference in preferences over the information sources among consumers. Alternatively, at least one information source is preferred over the others. *Kendall's W* is a normalization of the Friedman test. A concordance test is a test for agreement among more than two set of rankings (Bowen and Starr, 1982). Kendall's W is the coefficient of concordance, and ranges between 0 (no agreement) and 1 (complete agreement).

## 2.2 Seemingly Unrelated Regression Model

In the study, the quantified preferences obtained from FPC are analyzed by seemingly unrelated regression (SUR) that was investigated by Zellner (1962). A SUR system involves *n* observations on each of *g* dependent variables. In principle, these could be any set of variables measured at the same points in time or for the same cross-section. In practice, however, the dependent variables are often quite similar to each other. The seemingly unrelated regressions model is

$\mathbf{y}_i = \mathbf{X}_i\boldsymbol{\beta}_i + \boldsymbol{\varepsilon}_i$ , $i = 1, \ldots, M,$

where

$\boldsymbol{\varepsilon} = [\boldsymbol{\varepsilon}'_1, \boldsymbol{\varepsilon}'_2, \ldots, \boldsymbol{\varepsilon}'_M]'$

and

$E[\boldsymbol{\varepsilon} \,|\mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_M] = \mathbf{0},$

$$E[\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}' \mid \mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_M] = \Omega \tag{4}$$

It is assumed that a total of *T* observations are used in estimating the parameters of the *M* equations. Each equation involves *Km* regressors, for a total of $K = \sum_{i=1}^{n} K_i$ . $T > Ki$ is required . The data are assumed to be well behaved. It is also assumed that disturbances are uncorrelated across observations. Therefore,

$E[\varepsilon_{it}\varepsilon_{js} \,|\mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_M] = \boldsymbol{\sigma}_{\mathbf{ij}},$ if t=s and 0 otherwise.

The disturbance formulation is therefore

$E[\boldsymbol{\varepsilon}_i\boldsymbol{\varepsilon}'_j \,|\mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_M] = \boldsymbol{\sigma}_{\mathbf{ij}}\mathrm{I}_\mathrm{T}$

or

$$E[\boldsymbol{\varepsilon\varepsilon}' \mid \mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_M] = \Omega = \begin{bmatrix} \sigma_{11}\mathrm{I} & \sigma_{12}\mathrm{I} \ldots \sigma_{1M}\mathrm{I} \\ \sigma_{21}\mathrm{I} & \sigma_{22}\mathrm{I} \ldots \sigma_{2M}\mathrm{I} \\ \sigma_{M1}\mathrm{I} & \sigma_{M2}\mathrm{I} \ldots \sigma_{MM}\mathrm{I} \end{bmatrix}$$

The data matrices are group specific observations on the same variables. The covariance structures model is, therefore, a testable special case (Greene, 2003).

### 2.3 Data

The data obtained from a survey carried out in the period of April 2004-February 2005 in order to specify the attitudes and behaviors of consumers about food safety in Izmir, one of the third biggest province in Turkey, constitute the main material of this study. The population consists of the households residing within the borders of Izmir Metropolitan Municipality. Using the census data of the Turkish Statistical Institute and assuming that an average household size is 4, it is estimated that there are 558,066 households in total at the city center of Izmir. The number of consumers to participate in the survey is found out to be 385 by utilizing the population proportion through simple random sampling (Newbold, 1995). The questionnaire forms were filled by consumers through face-to-face interviews.

Table 1 shows the variable definitions used for determining the factors influencing consumer preferences in this study.

Table 1: Variable definitions on consumer specific characteristics

| Variables | Unit | Definition |
|---|---|---|
| Age | year | Age of consumer in years |
| Education | year | Consumer's years of schooling |
| Family size | persons | Number of household members |
| Income | Turkish Liras | Total household income |
| Anxiety about food safety | scale | 1: I am less anxious<br>2: I am same anxious<br>3: I am more anxious |
| Agree with food safety | scale | Five point scale; 1: Strongly disagree with food safety, ....., 5: Strongly agree with food safety |
| Gender | dummy | 1: Male<br>0: Female |
| Having knowledge about food safety | dummy | 1: Yes<br>0: No |

Table 2 presents basic descriptive statistics of consumer specific variables used in the second stage to examine the factors influencing consumer preferences. The consumers interviewed are of ages between 17 and 79. Average consumer age is approximately 40. Consumers are 8.16 years educated as average. Family size is approximately 4 persons on average. Average income is approximately 750[*] TRY. Consumers were asked "whether they are more anxious than they were previously" about "the general safety of foods" (1: I am less anxious than they were previously, 2: I am anxious at the same level with the past, 3: I am far more anxious about food safety than I was previously). The average anxiety level of consumers shows that they are more anxious about food safety than they were previously. Consumers were asked "Do you agree that foods are safe currently?" (five point scale;1: strongly disagree, …, 5: strongly agree) and the average level was found low which means they consider foods are rather unsafe. About 66 % are women and 84 % are married. A total of 62.4 % of the consumers expressed that they know what food safety is.

[*] 1 US$ = 1.16 TRY

Table 2: Basic descriptive statistics of consumer specific characteristics

| Variables | Mean | Standard deviation | Min | Max | No. Respondents* | % |
|---|---|---|---|---|---|---|
| Age (years) | 40.05 | 13.08 | 17.00 | 79.00 | | |
| Education (years) | 8.16 | 3.79 | 0.00 | 15.00 | | |
| Family size (persons) | 3.78 | 1.48 | 1.00 | 12.00 | | |
| Income (TL) | 749.56 | 407.56 | 100.00 | 4500.00 | | |
| Anxiety about food safety (scale) | 2.66 | 0.61 | 1.00 | 3.00 | | |
| Agree with food safety (scale) | 2.03 | 0.86 | 1.00 | 5.00 | | |
| Gender (dummy) | | | | | | |
| 1: Male | | | | | 129 | 33.95 |
| 0: Female | | | | | 251 | 66.05 |
| Marital status | | | | | | |
| Married | | | | | 320 | 84.21 |
| Single | | | | | 60 | 15.79 |
| Having knowledge about food safety (dummy) | | | | | | |
| 1: Yes | | | | | 237 | 62.37 |
| 0: No | | | | | 143 | 37.63 |

* Missing data excluded

## 3. Results and discussions

The present study employs the two stage method which involves calculating the degree of consumer preferences for each information source by using FPC and the consumer preferences from the first stage are regressed upon the consumer specific variables in the second stage.

### 3.1 Consumer Preference Measures

In this stage, the degrees of consumer preferences or the consumer priorities for information sources were determined. The consumers were asked to make comparisons among individuals and institutions. Therefore pair-wise comparisons of the information sources were obtained. Five information sources that notify consumers about food safety, purchasing or consuming safe food etc. were presented as follows:

1. Television Programmes
2. Doctors/Experts
3. Newspapers/Journal articles
4. Radio Programmes
5. Neighbors/Friends

Basic descriptive statistics of the results obtained from FPC model are presented in Table 3. The information sources on food safety are ranked from most to least preferable by using the degree of the consumer preferences. The results show that the most preferred information source for consumers is "doctors/experts" with a fuzzy pair-wise degree of 0.65. The following are "television programmes" and "newspaper/journal article" respectively. "Radio programmes" and "neighbors/friends" are the least important information sources for consumers.

Table 3: Descriptive statistics of consumer preferences for information sources on food safety

| ***Information Sources*** | ***Mean*** | ***Standard deviation*** | ***Minimum*** | ***Maximum*** |
|---|---|---|---|---|
| Doctors / Experts | 0.65 | 0.19 | 0.10 | 1.00 |
| Television Programmes | 0.60 | 0.18 | 0.10 | 1.00 |
| Newspapers / Journal articles | 0.43 | 0.13 | 0.00 | 0.85 |
| Radio Programmes | 0.31 | 0.11 | 0.07 | 0.65 |
| Neighbors / Friends | 0.28 | 0.14 | 0.00 | 0.83 |

*Significant by Friedman test for $p<0.01$*
*Kendall's W = 0.54*

Friedman test is used to see if there is a difference in the rankings of the information sources. Friedman test confirms some information sources being more preferred than the others. Kendall's W test is used to measure the degree of agreement. The value of Kendall's W is 0.54 and shows that the agreement for consumers in ranking the information sources is moderate.

According to the degrees of consumer preferences for the information sources on food safety, the consumers want to be informed by doctors and food engineers. This points out that consumer awareness for food safety should be provided by means of the organizations such as ministry of health and related faculties of universities which can educate the consumers by using brochures, meetings and seminars. Television programmes are in the second rank. Televisions might prepare programmes on specific days and advertisements related to food safety for informing the consumers by doctors and experts. Articles, serials and news on the importance of food safety can be published in newpapers and journals regularly. The degree of consumer preference for radio programmes was found low that means the radio programmes requires to be improved or promoted in a way that they are more attractive for the consumers.

### 3.2 Factors influencing the consumer preferences

In this stage, SUR model was used to elicit the factors influencing the consumer preferences. The degree of consumer preferences for information sources was regressed on consumer specific characteristics in order to identify the reasons of preferences. The summarized estimation results are presented in Table 4.

Education has significant positive impact on the consumer preferences for newspapers/journal articles and radio programmes whereas negative on television programmes and neighbors/friends. As the consumer's years of schooling increase, the degree of preference for television and neighbors/friends decrease. The more educated consumers don't prefer to be informed about food safety via television and surrounding people.

The significant positive influence of gender on radio programmes related to food safety implies that men prefer radio than women.

The consumers with a high level of income are more sensitive to food safety. In higher income levels, the degree of preferring doctors/experts and newspapers/journals on food safety increases. As income level increases, the preference for radio programmes and neighbors/friends decrease.

Family size has significant positive impact on television and neighbours/friends, but negative impact on doctors/experts and radio. More crowded families prefer to be informed of food safety from television and neighbors/friends. The fact that the crowded families may have low level per capita income decreases the degree of preference for doctors/experts.

Consumer awareness for food safety increases the degree of preferences for doctors and experts. Increasing awareness for food safety would direct consumers towards to the specialists that may give right comments on food safety.

The anxiety level of consumers about food safety has significant positive impact on television and negative impact on newspapers or journals. As consumers are affected more intensively from the food scandals, they prefer television more. When compared to the old times if the consumer is more anxious about food safety then s/he more prefers television programmes as an information source.

As the consumers more agree with the belief that foods are safe at present time, the degree of preference for radio increases. These consumers don't take their neighbours and friends into consideration as an information source on food safety.

The age of consumers has no significant impact on the consumer preferences for the information sources.

Table 4: SUR Model for Consumer Preferences

| Variables | Television Programmes | | Doctors/ Experts | | Newspapers/ Journal articles | | Radio Programmes | | Neighbours/ Friends | |
|---|---|---|---|---|---|---|---|---|---|---|
| constant | 0.2272976 | * | 0.2731905 | * | 0.1957355 | * | 0.1409458 | * | 0.1627881 | * |
| | (0.0347382) | | (0.036578) | | (0.0232646) | | (0.0186354) | | (0.0252244) | |
| Age | -0.0001825 | | 0.000106 | | 0.0000208 | | 0.0000494 | | 0.00000836 | |
| | (0.0003559) | | (0.0003747) | | (0.0002383) | | (0.0001909) | | (0.0002584) | |
| education | -0.003225 | ** | 0.0010139 | | 0.0031151 | * | 0.0012496 | *** | -0.0021556 | ** |
| | (0.0013352) | | (0.0014059) | | (0.0008942) | | (0.0007163) | | (0.0009695) | |
| Gender | -0.0035248 | | -0.0082742 | | -0.0009848 | | 0.0123004 | * | 0.0006744 | |
| | (0.0089523) | | (0.0094264) | | (0.0059954) | | (0.0048025) | | (0.0065005) | |
| Income | -0.0000139 | | 0.00004 | * | 0.0000149 | ** | -0.0000132 | ** | -0.0000279 | * |
| | (0.000011) | | (0.0000116) | | (0.00000737) | | (0.0000059) | | (0.00000799) | |
| family size | 0.0070965 | ** | -0.0063777 | ** | -0.0026741 | | -0.002622 | *** | 0.0045648 | ** |
| | (0.0029576) | | (0.0031142) | | (0.0019807) | | (0.0015866) | | (0.0021476) | |
| having knowledge about food safety | 0.0038721 | | 0.0198316 | ** | -0.0041713 | | -0.0088096 | *** | -0.0107753 | *** |
| | (0.0090232) | | (0.0095011) | | (0.006043) | | (0.0048405) | | (0.006552) | |
| anxiety about food Safety | 0.0216987 | * | -0.0078363 | | -0.0105743 | ** | -0.0046451 | | 0.0013679 | |
| | (0.0068668) | | (0.0072305) | | (0.0045988) | | (0.0036837) | | (0.0049862) | |
| Trusting food Safety | -0.0007465 | | 0.0037009 | | -0.0025418 | | 0.0068736 | * | -0.0072969 | ** |
| | (0.0049383) | | (0.0051998) | | (0.0033072) | | (0.0026491) | | (0.0035858) | |
| $\chi^2$ | 32.99 | * | 34.54 | * | 37.79 | * | 32.23 | * | 49.89 | * |
| R-sq | 0.0799 | | 0.0833 | | 0.0905 | | 0.0782 | | 0.1161 | |

*Significant at 1% level ** Significant at 5% level *** Significant at 10% level

## 4. Conclusions

This study applied fuzzy pair-wise comparison model to obtain the degrees of consumer preferences for the information sources on food safety using survey data collected from 380 randomly selected consumers in Izmir, Turkey. Besides, the degrees of consumer preferences were regressed upon the characteristics of consumers in order to identify the

reasons for why an information sources are preferred or not, by using seemingly unrelated regression model. The results indicate that the most preferred information source for consumers is “doctors/experts”. “Television programmes” and “newspaper/journal article” are the followings respectively. The least preferred information sources for consumers are “radio programmes” and “neighbors/friends”.

Well educated consumers prefer newspapers or journal articles and radio. Men prefer radio more and as income level increases, the preferences for doctors or experts increase too. More crowded families prefer to be informed of food safety from television and neighbors/friends. The consumers who are far more anxious about food safety today than before prefer television. The consumers who trust that foods are safe at present prefer radio more. The preferences for information sources are not influenced significantly by the age of consumers in any model.

In the increasing of consumer awareness for food safety, the organizations such as ministry of health and related faculties of universities should have responsibilities with the aim of educating the consumers by using brochures, meetings and seminars. Since televisions are reasonably preferable, they should prepare programmes directed and prepared by doctors and experts. Articles, serials and news on the importance of food safety can be published in newspapers and journals regularly as well.

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