

Analysis of Demand Determinants of High Quality Food Products through the Application of the Cumulative Proportional Odds Model

M. Lanfranchi, C. Giannetto and A. Zirilli

University of Messina, Department S.E.A.M.
Via dei Verdi, 75, 98122 - Messina, Italy

Copyright ©2014 M. Lanfranchi, C. Giannetto and A. Zirilli. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

The process of globalization that has characterized the new century has resulted in the change of the economic and political environment in the world. Agriculture has not been excluded from this global scenario, redesigned according to the principles of market liberalization. The agriculture and the agri-food system in particular, are subject to conditioning deriving from the evolution of the economic, political and legal international framework (Lanfranchi M., Giannetto C., Puglisi A., 2014). The agricultural field, increasingly, more and more perceives the urgency of more rigorous and demanding policies, careful to interpret, in addition to the demands of the consumer, also the protection of the man and his psycho-physical well-being in order to catch up easier an important goal, that of food security. The objective of this paper is to deepen study on the buying habits of consumers of food products and the degree of information asymmetry that characterizes the demand for foodstuffs. In the order to conduct the analysis of consumer behaviour a questionnaire was used to acquire the information needed for the purposes of the paper. Then a model for the binary variable relative to the habitual consumption of typical products was determined. In this paper, the research team has developed the Cumulative Proportional Odds Model.

Keywords: Cumulative Proportional Odds Model, Analysis of consumer preferences, typical products, asymmetric information.

1 Introduction

In this paper we focused our attention on the variable "quality judgment on typical products" which is expressed as an ordinal variable on three levels. Based on the 1290 subjects responding to the questionnaire, 2.2% express a low quality judgment (defining the quality of local products as worse than usual), 20.1% express an intermediate judgment considering the same quality of local products compared to conventional products) and, finally, 77.7% expressed a very positive quality judgment (supporting the higher quality of local products). The objective of this paper is, therefore, to protect the consumer in the era of globalization, to identify if the buyer is a victim of asymmetric information on the knowledge of *functional food* products and more specifically of the products forming part of the Mediterranean diet and typical products (Lanfranchi, 2010). Unfortunately, in the agri-food market situations of information asymmetry often occur due to the differentiation of products which look similar because they belong to the same category. The consumer finds it difficult to properly identify qualitative differences. On the basis of the analysis on the consumption of local products and the relative degree of consumer information that we carried out, it was concluded that, even today, it is necessary to implement and increase EU policies on safety and protection of consumers of food products (D'Amico, M. *et al.*, 2011). To this end, the main policies identified are: to improve the information on the labelling of the product, improve the standard of the product process and strengthen the process of HACCP and traceability. The purpose of this paper is to determine whether the quality judgment about typical products (expressed on an ordinal scale with three levels) depends on other variables, which may be potentially predictive. Subsequently, we estimated an ordinal logistic regression model, which represents the methodologically adequate solution to model a structure of dependence between variables, when the response variable is ordinal with more than two categories; in particular, we estimated a *Cumulative Proportional Odds Model*.

2 Materials and methods

The research team has decided to deepen the study on the buying habits of the consumer and on the degree of information asymmetry to the disadvantage of the same (Lanfranchi, *et al.*, 2014). In the research we conducted earlier, it made reference to an identification of factors that depend on the purchasing behavior and the evaluation of cause-effect relationships in a given population. The work of 2010 led to the construction of a model for the variable "habitual consumption of typical products" which presents itself as a binary variable in order to investigate the existence of a relationship of dependence between the variables under consideration. As is known in the statistical literature, for modelling the dependence of a dichotomy as predictors, using logistic regression, a special case

of generalized linear model having as function logit link function, known in the literature as a test statistic G. In this paper, the research team instead intends to develop the Cumulative Proportional Odds Model, it is an extension of the logistic regression model for dichotomous data and is of ordinal type is obtained by using a logit link for the cumulative probability.

3 Analysis of consumer preferences of typical products of the Mediterranean diet

The survey on the typical product's consumption was conducted, in 2010 on a sample of 1954 consumers of Messina (Sicily – Italy). The survey with the handing out of a questionnaire was done mostly in sales points of the large scale organized distribution (GDO), interviewing directly a sample of consumers, with the face to face method, and using an ad hoc card-questionnaire. The analysis was conducted made up of people with different social-economic-demographic characteristics, so as to have the most reliable survey possible. The survey, however, was conducted taking into consideration only the interviewed people that answered correctly to the question relating to the degree of knowledge of a typical or a traditional product (they had to give an example), for this consideration, of the 1954 which received questionnaires, only 1290 were interviewed that's to say 66% of the total. Therefore, the study focused exclusively, as already done in other surveys on agricultural and food products consumption in Sicily, on the share of consumers that asserted to habitually consume the products object of the survey. The products under investigation constitute the basket of the Mediterranean diet (Lanfranchi M., Giannetto C., 2013). It has recently become a "World Heritage" by UNESCO and protected. It is an example of that diet for its health effects deserves to be exported as a model around the world (Lanfranchi, M. 2012).

Of the 1290 consumers, on which the analysis has concentrated, 41.7% represented the number of males and 58.3% the females. Based on the demographic characteristics, the subjects are subdivided into 4 age-brackets; those between 19 and 29 years (A) constitute approximately 27%, those between 30 and 49 years (B) are 41%; of the remaining, 26% comprise ages between 50 and 69 years (C) and 5% are those that exceed 69 years of age (D) (Lanfranchi M., Giannetto C., Alibrandi A., 2011). From this one finds that the subjects that best answered with accuracy to the questions proposed, manifesting special interest and attention on the discussed issue, are the subjects of medium age, that, for family reasons, are dedicated to the management of the food basket of their family. The average composition of the sample family was 3,21 units. The majority of the interviewed people belonged to a family of 2 to 4 members (65.50%), followed by those with more than four members (20.46%); only 14.04% of the interviewed declared being single. In reference to qualifications, the findings are that 79% of the interviewed sample belonged to a high-middle cultural level, in particular 59% have a high school diploma and 20% are university graduates. Other social-demographic characteristic variable of the interviewed is their income.

Table no. 1: Main socio-economic characteristics of consumers surveyed

Directions	Characters	n°	%
Gender	male	538	41.70543
	female	752	58.29457
	total	1,290	100.00
Age classes	70 years and over	69	5.35
	50 - 69	335	25.97
	30 - 49	536	41.55
	19 - 29	350	27.13
	total	1,290	100.00
Household composition	1 component	181	14.04
	From 2 to 4 components	845	65.50
	Superior 4 members	264	20.46
	Total	1,290	100.00
Qualification	University degree	258	20
	Diploma	761	59
	Junior High	232	18
	Licence elementary	39	3
	Total	1,290	100.00
Income classes	10 - 25/000	516	40
	25 - 35/000	413	32
	35 - 45/000	271	21
	45.000 in su	90	7
	Total	1,290	100

Source: Our calculations based on data collected directly

Regarding the family income, the category of consumers represented most is that with a declared income between 10 and 25 thousand Euros per annum (A) (40%), followed by those with income between 25 and 35 thousand Euros (B) (32%), those with income between 35 and 45 thousand Euros (C) (21%); and finally only 7% declared to have an income of more than 45 thousand Euros per annum (D). To characterize the basic variables that condition the consumer in the moment of the purchase of a typical product, we have turned to the survey's main components, that has allowed us to synthesize the data collected through the questionnaire. The questionnaire was divided into three sections. The first regarded the acquisition of the inherent information regarding the associate-demographic and economic characteristics of the interviewed consumers (age, sex, total number of the members of their family, degree of education, total familiar income). The second one aimed at characterizing the reasons and the specific consumption of typical products (the types of products, of frequency consumption, place of purchase). The third dealt with the finding of the information on the perception of quality, food safety and the prices of typical products as opposed to the pre-packaged conventional ones, as well as the reasons

for the possible refusal of typical products consumption. The interviewed were given a questionnaire composed of nineteen questions on their knowledge of the “functional foods”, of the products of the “Mediterranean diet”, typical products characteristics, the frequency of consumption, the monthly amounts destined to the purchase, the motivations that push them to the purchase of typical products rather than pre-packed. More than 70% of the interviewed answered that they do not know the “functional foods”, and almost 65% of the interviewed declared that they do not know the products of the “Mediterranean diet”. From study it has emerged that almost the totality of the interviewed thought to know at least one Sicilian or Messinese typical product, while in reality only a minimal part succeeded in making correct examples. In the following, we have considered correct the answers relating to typical, traditional or local product listings, that have a link with the territory of Messina. To the question relating to the habitual consumption of typical products of Messina and the Mediterranean diet, from the given answers the majority of the interviewed (approximately 800) consumes typical products frequently. The data is confirmed by the answers supplied by the interviewed on the question regarding the weekly consumption of typical products (Gheorghe, G., et al., 2013); in fact, approximately 60% consumes a typical product more than two times a week. Only 9%, instead, declared that they never consume this type of product, almost 51% of the interviewed declared that their personal consumption of typical products during the last five years has remained unchanged. Through the survey, in particular with the question in which the interviewed was asked to explain the reasons why they preferred typical products to pre-packed. More than 70% of the interviewed answered that they buy “typical” products for organoleptic reasons. Precisely 33% buy it because the product has a better taste, while 39% buy it for its quality. Although, in general terms, important attention is given to hygiene and to safety, only a minimal part of the interviewed sample said that they acquire the product because it is safe. Moreover many of the interviewed consider the product not to be economical. The analysis shows, in fact, the data shows that more than half of the sample chosen, said that as far as they are concerned the pre-packed product is less safe than the typical one. On the subject of the purchase’s habits, it is asked if it is economically convenient to buy typical products. The more frequent answer (64%) has been negative, there is in fact a general conviction that, acquiring a typical product, does not lead to a saving. Such data is confirmed by the answer given to the question in which it asked which could be the reasons that prevent the consumer from acquiring a typical product. Well, the more frequent answer is motivated by the high price (33%). The consumers were asked if they paid attention to the information contained on the label; the resulting data evidences that there is always a greater control of the nutritional and caloric content of the acquired product. Only 16% of the interviewed never look at the label before buying a typical product. Always on the purchase’s habits, in the end the consumer was asked where he considers more convenient to buy a typical product. Many think that the more convenient place to purchase is the supermarket (30%) or direct selling by enterprise (29%). This is

completely in line with the National trend, in fact, in the previous paragraphs we noted how Italians prefer to buy food products, with the brand of quality, mainly in supermarkets or large shopping centres.

4 The Cumulative Proportional Odds Model

Methodology

The Cumulative Proportional Odds Model is a model for ordinal data; it is obtained by using a logit link for the cumulate probabilities (O'Connell, 2006). The model is an extension of the logistic regression model for dichotomous data at categorical ordinal data (Zelterman, D., 1988). The most interesting point of this model is the observation of a particular score or less; for an ordinal variable with three modalities it's possible to define the following odds:

$$\Theta_1 = \text{prob. (score of 1) / prob. (score greater than 1)} \quad (1)$$

$$\Theta_2 = \text{prob. (score of 1 or 2) / prob. (score greater than 2)} \quad (2)$$

$$\Theta_3 = \text{prob. (score of 1, 2 or 3) / prob. (score greater than 3)} \quad (3)$$

The last category doesn't have an odds that is associated with it since the probability of scoring up to and including the last score is 1.

All of the odds are of the form:

$$\Theta_j = \text{prob (score} \leq j) / \text{prob(score} > j) \quad (4)$$

We can also write the equation as:

$$\Theta_j = \text{prob (score} \leq j) / (1 - \text{prob (score} \leq j)) \quad (5)$$

since the probability of a score greater than j is 1 minus probability of a score is less than or equal to j . The ordinal logistic model for a single independent variable is :

$$\ln(\Theta_j) = \alpha_j - \beta X \quad (6)$$

where $j=1, \dots, j-1$, with j categories number. Larger coefficients indicate an association with larger scores. For a continuous variable, a positive coefficient indicates that since the values of the variable increase, the likelihood of higher scores increases. A negative coefficient indicates that lower scores are more similar and close each other. An association with higher scores shows smaller cumulative probabilities for lower scores, since they are less close to occur, Each logit has its own term α_j , but the same coefficient β . That means that the effect of the independent variable is the same for different logit function. The ordinal logistic model is based on the assumption that includes a continuous latent variable

and that the ordinal observed result derived from discretization of a underlying continuous variable (Fujikoshi, Y. & von Rosen, D. 2000). The estimation of the model was carried out using the Polytomous Universal Model (PLUM) procedure of SPSS (Norušis Marija, 2009) which provides estimates of models for ordinal data, in particularly for the Generalized Linear Models (Lanfranchi M., et. al 2014. Stoka M., 1991).

5 Result economic analysis

By means of the Cumulative Proportional Odds Model, we assessed if the quality judgment depends on some predictors, such as: the qualification and the income class of the respondents, the judgments expressed with reference to the factors “taste”, “security” and “convenience” of the typical products and, lastly, the consumer habit to read the label of products. In Table 1 we report the results of the model: the coefficients, the standard error (SE), the Wald test and the significance.

Table no. 2: Cumulative Proportional Odds Model for quality judgement

Predictors	B	S.E.	Wald	p
Constant 1	0,007	0,457	0,000	0,988
Constant 2	2,708	0,438	38,254	0,000
Qualification	0,130	0,098	1,763	0,184
Income class	0,230	0,081	8,018	0,005
Taste	0,476	0,106	20,118	0,000
Safety	0,678	0,100	46,352	0,000
Convenience	-0,155	0,107	2,092	0,148
Label reading	0,398	0,068	34,602	0,000

Source: Our calculations based on data collected directly

The model provided a likelihood value equal to 1148.1. Examining the estimation of the model, we can see that only some variables are significantly influential on the quality judgment of typical products; in particular, the judgment is significantly related to income class. While a high qualification (diploma or degree) would seem to dictate the choice of being a habitual consumer of typical products, the income class seems to influence the quality judgment. Satisfaction about the quality also seems to increase at positive comments on the wider "quality" and "safety" and is also linked to the habit of consumers to read the label, denoting that the more satisfied consumer is therefore careful and believes in making the decision to buy typical products.

6 Conclusions

From the research it was found that the Community trademark protection is still little known. In most cases, the consumer does't know the meaning of the designation of origin or the healthy effects of the Mediterranean Diet. A second result obtained from our survey is as follows. Consumers have two main criteria: the Italian origin of the product, clear and comprehensive and detailed label of the product. The concept of typicality is related to tangible and intangible characteristics of a product. A product that is unique and recognizable by the consumer. The characters are the typical food: territorial link, geographical origin, the raw materials used, production process, the process of transformation (Lanfranchi, M., Giannetto, C., 2013). The model proposed in this study shows that only certain variables affect the judgment on the food quality and hence the choice of purchase. Among these variables, the most significant is the level of per capita income. In conclusion, we can say that the purpose of enhancement of agricultural food production is achieved through the progressive reduction of the degree of "information asymmetry" that characterizes the current market.

Therefore, the food safety becomes a real "public good" that causes the intervention of Communitarian Commissions to protect social community. Instruments possessed by public authorities can deal with, not only the law, but also the information, to reduce more and more the problem of informative asymmetry.

Acknowledgements

This study is a result of the research project "Analysis on the buying behavior of the consumer of quality food products" coordinated by Maurizio Lanfranchi. The work is the result of a complete cooperation of the authors and it is, therefore, of responsibility of both the authors. However, are attributing to Maurizio Lanfranchi, in addition to coordination and setting of the study, the material drawing up of paragraphs 1 and 6, paragraph 2 to Carlo Giannetto, paragraphs 4 and 5 to Agata Zirilli; the paragraph 3 to Maurizio Lanfranchi and Carlo Giannetto

References

- [1] D'Amico, M., di Vita, G., La Via, G., Peri, I., Quality Agro-Food Production in Sicily, *Quality - Access to Success*, (2011), Volume 12, Issue 125, pp. 56-64.

- [2] Fujikoshi, Y. & von Rosen, D., LR tests for random-coefficient covariance structures in an extended growth curve model, *Journal of Multivariate Analysis*, (2000), 75(2), 245-268
- [3] Lanfranchi M., Giannetto C., Puglisi A., A cost-benefits analysis for risk management in a biological farm, *Applied mathematical sciences*, (2014), Vol. 8, no. 16, 775-787.
- [4] Lanfranchi M., Giannetto C., Zirilli A., Alibrandi A., Analysis of the demand of wine in Sicily through ordinal logistic regression model, *Quality - Access to Success*, (2014), Volume 15, No. 139, pp. 87-90.
- [5] Lanfranchi, M., Giannetto, C., Analysis of the economic evaluation of an Italian farm in response to the economic-financial crisis that the EU is going through, *Quality - Access to Success*, (2013), vol. 14, pp. 119 – 124.
- [6] Lanfranchi, M., Economic analysis on the enhancement of citrus waste for energy production, *Journal of Essential Oil Research*, (2012), vol. 5, pp. 1-9.
- [7] Lanfranchi, M., Giannetto, Sustainable Development In Rural Areas: The New Model of Social Farming, *Quality - Access to Success*, (2014), Vol. 15, Issue Suppl.1, 219-223.
- [8] Lanfranchi, M., Sustainable Technology as an Instrument of the Environmental Policy for the Attainment of a Level of Socially Acceptable Pollution. *World Futures*, (2010) Vol. 66 Issue 6, Pages 449- 458.
- [9] Norušis, Marija J., PASW Statistic 18. Statistical Procedures Companion, Pearson Education, 2009.
- [10] O'Connell, A.A., Logistic regression models for ordinal response variables. Thousand Oaks: Sage, 2006.
- [11] Stoka M., Calcolo delle probabilità e statistica matematica, Ed. Leprotto & Bella, Torino, 1991.
- [12] Zelterman, D., Likelihood ratio tests for central mixtures. *Statistics and Probability Letters*, 6(4), (1988), 275-279.

Received: April 15, 2014