

## **THE PAADEL PANEL: A PROBABILITY-BASED PANEL FOR CONSUMER STUDIES**

**Annamaria Bianchi<sup>1</sup>, Silvia Biffignandi**

*Department of Management, Economics and Quantitative Methods, University of Bergamo, Italy*

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**Abstract.** *This paper describes and discusses a new consumer probability-based panel. The panel has been used for conducting a survey on attitude and behaviour related to food and beverage consumption and to identify changes in purchasing behavior during the recent economic crisis. Findings from the survey are described in detail. From the methodological perspective, the paper underlines key issues characterising the construction of a probability panel. Moreover weighting aspects to ensure representativeness are detailed.*

**Keywords:** *Consumer attitudes, Mixed-mode panel, Probability panel, Weighting*

### **1. INTRODUCTION**

The crisis and the pervasive spread of technology are changing consumer attitudes and behaviours. At the same time these changes – in both mature and emerging economies – are expected to play a key role in setting the pace of economic recovery and generating new opportunities for markets growth. As a consequence, businesses need to monitor emerging needs and consumer attitudes towards various issues related to products consumption.

It is now widely recognised that business decision making is data driven. The term *data-driven marketing* refers to the marketing insights and decisions that arise from the analysis of data about or from consumers (Einay and Levin, 2013). The insights from data can help businesses identify opportunity areas to enhance the business growth.

Data can be classified as primary or secondary data. Primary data are collected by the investigator conducting the research, for example by means of a survey. Secondary data, by contrast, are collected by someone other than the user. Common

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<sup>1</sup> Silvia Biffignandi, email: [silvia.biffignandi@unibg.it](mailto:silvia.biffignandi@unibg.it)

sources of secondary data are official surveys as well as tracking online social interactions, web browsing behaviour, online search behaviour, and transaction records. In general, a lot of information is provided by web communities, i.e. web sites (or group of web sites) that create virtual exchange of information among people, like social network services, Internet forums, blogs, or other kinds of social software web application. In this context, Internet offers huge amounts of data often referring to a large number of units. With the advent of online consumer panels and resources such as Amazon Mechanical Turk, companies are able to collect input from hundreds or thousands of consumers within hours and with a very limited budget. Common emerging reference (Artur, 2013) is now to the so called *big data*. The debate about if and how big data will impact on the existence and role of surveys based on statistical sample is open.

Consider that: a) understanding the meaning, representativity and quality of big data is a relevant task and more research has to be done on this issue. Thus far, however, criteria for judging the performance of big data for statistical purposes are not fully set up yet and using them for decision making purposes is not risk free; b) survey sampling data are going to be complementary to big data; at this stage they still represent a valuable source of information. They are useful tools for supporting decision making and market or marketing studies. Moreover, using the www as a survey data collection tool represents an innovative approach and encompasses many advantages in terms of timeliness, costs and data quality.

This study focuses on the problems and performances of surveys based on probability panels with web component. The paper has the following objectives: a) to describe and discuss a new consumer panel; b) to underline key issues characterizing the construction of a probability panel and some innovative methodological aspects for improving data quality; c) to provide substantial findings on consumers behaviour related to food; to this purpose economic hypotheses on food consumption are formulated and results of the first panel survey wave are analysed to evaluate the stated hypotheses. The analysis provides evidence on the usefulness of the panel for business decision making.

The panel under study has been set up within the PAADEL (Agri-foof-Demographic Panel for Lombardy) project and it is called Consumer-PAADEL. It is a household panel. Even if the panel has originated within a project related to the agro-food sector, it could be used for studying consumer behaviour in other sectors as well. The Consumer-PAADEL has been used for a first survey wave. The objective of this survey has been to collect data on food-related consumer behaviour (buying, food security, etc.) and to provide insights into how consumers' attitudes have changed in recent years. Special attention was paid to consumption innovations.

Comments on the findings on the consumer behaviour sorted out from the first survey wave of the panel are presented, both from the substantial and the methodological point of view. As regards methodological issues, the paper focuses both on aspects related to panel construction and to weighting procedures. As is it well known, the advantage of a probability-based panel is that it is possible to apply statistical theory to obtain population estimates. In order to refer the data to the population (Lombardy population in this case), they need to be weighted. A set of alternative weights is analysed. Comparing different weights characteristics, a weights set is used to produce the final estimates.

The paper is organised as follows. Section 2 defines basic concepts of panels (definition, probability and non-probability based panels). Section 3 presents the PAADEL panel. Section 4 highlights the role of weighting for probability panels and how weighting has been performed for the Consumer-PAADEL panel. Section 4 describes the main results from the first survey wave administered to panel members. Section 5 offers some conclusions.

## **2. PANEL BASIC CONCEPTS**

A panel consists of a set of units (e.g., households, individuals, or companies) that are interviewed at different points in time (called panel waves). Panels can be classified according to the recruitment method (Sikkel and Hoogendoorn, 2008):

- a. *probabilistic panels*: a sample is selected from the population using some kind of probability sampling method. To this purpose a sampling frame must be available. In case of probability sampling, it is not possible to contact all selected units via the web as part of the population does not have Internet access. In some cases, people in the sample without access to the Internet are given a computer and an Internet connection on purpose for participation to the panel. In other cases, a mixed-mode approach is used. Probability panels are representative and so it is possible to draw conclusions concerning the population which the panel refers to (target population).
- b. *non-probabilistic panels*, also called *volunteer* or *access panels*: respondents voluntarily sign up for the panel. Particularly in market research, there are many non-probabilistic panels (Comley, 2007). In the European literature (European Federation of Associations of Market Research Organisations, 2004), the term access panel is frequently used for proprietary volunteer panels containing individuals who have agreed to participate regularly in surveys run by a specific organisation, generally a market research organisation. Non-probabilistic panels do not allow to draw conclusions concerning the target population, even if they

often include a large number of participants.

Panels can be used to collect data for two different types of studies: longitudinal and cross-sectional studies. In the case of longitudinal research, the same group of units is surveyed at different points in time. The group may consist of all panel members or just of a sample of panel members. In longitudinal studies, the aim is to study changes over time; therefore the same questionnaire is administered over successive survey waves. In the case of cross-sectional studies, the state of a population is examined at one point in time and, usually, the panel is used only once to collect data on a specific topic (*specific surveys*). Further details on the construction, management, and representativity of web panels can be found in Bethlehem and Biffignandi (2012).

The construction of a panel is based on a recruitment stage. In case of probability-based panels, a careful and accurate recruitment strategy is needed to obtain a proper random sample. The selected subjects are contacted (generally using a traditional data collection mode), asked to subscribe to the panel, and basic variables (called *background variables*) describing the recruited units are collected. These variables represent the permanent information of the panel. Selected units completing all these steps constitute the *active panel*. Once the active panel is formed, surveys can be administered to active panel members.

Panel members may drop out of the panel in the course of time for a variety of reasons. This phenomenon is called *panel attrition* and it determines a reduction of the size of the panel. In some panels, members are removed from the panel after a specific period of time. In this case the term *forced attrition* is used. A certain decrease in the participation in the panel, called *unforced or normal attrition*, is determined by non-response at a number of consecutive surveys, which in practice determines the drop-out from the panel. To mitigate the effects of attrition, *panel maintenance* is required. Panel maintenance includes the use of incentives and the inflow of new elements in the panel.

### 3. THE PAADEL PANEL

The PAADEL (Agri-food and Demographic Panel for Lombardy) project is managed by the Center for Statistical Analyses and Interviewing/surveying (CASI) at the University of Bergamo and it is supported by a grant from the Lombardy District in Italy. The PAADEL project is a system of panels and includes a business and a household panel. The aim was to build up panels mainly – if not exclusively – based on web. No incentive strategy has been adopted in the construction of the panels. In this paper the household panel is considered.

In the next section the recruitment of the household panel is shortly described. More details can be found in Biffignandi (2012).

### **3.1 RECRUITMENT OF THE PANEL**

The target population for the PAADEL panel is all households living in Lombardy (Italy) in 2012. The sampling frame is based on a proxy of the target population: the telephone directory. The decision has been supported by discussions with experts of the regional demographic databases and by checks both of the directory statistical structure and the target population structure. The only information available in this directory is the full address and the phone number. No other variables are included.

A two-stage stratified sample was selected from the frame. Municipalities are the primary sampling units and households are the secondary sampling units. First, the list of municipalities was partitioned into four strata defined by their population size. A proportionally stratified sample was drawn. Milan was a self-representing primary sampling unit. Next, a proportionally stratified sample of households was drawn from the primary sampling units included in the sample.

The theoretical sample consisted of 3000 households. The recruitment of the panel was conducted in 2012 and lasted approximately three months. Substitutions were made on the basis of similarity criteria by drawing from the reserve sample. The recruitment was based on a step by step procedure. A mixed-mode approach has been adopted in each step, since the partial diffusion of the Internet in the population did not hint using the web mode only for the construction of a representative panel. Modes are not the same for each step. They cover web, phone, and mail.

The theoretical initial sample was randomly divided into two subsamples: 1500 households were allocated to be initially contacted by phone and the other 1500 to be initially contacted by mail. Households allocated to the group to be contacted by phone were recruited in two-steps, while households allocated to the mail group proceeded in a single step.

As regards the phone-allocated households, during the *first step*, preliminary subscription to the panel, together with the chosen mode for the second step (web, mail, phone) and the necessary contact details were acquired. Contact details were especially crucial to proceed through the web mode because households' email addresses are not available at the population level in Italy. In the *second step*, the questionnaire asking for the confirmation of the participation to the panel and socio-demographic variables (background variables) of both the respondent and of the other members of the household was administered to the units registered in the first

recruitment step, using the chosen mode. The background variables included in the panel profile database are:

- a. at the household level: number of household members, number of members less than 16 years, family income, and number of income receivers;
- b. at the individual level: age, gender, educational qualification, occupational condition, and occupation.

As regards background variables, item non-responses have been analysed and they did not seem to be relevant. The panel was subsequently used for a first survey wave. For the survey, a mixed-mode approach (web, phone, and mail) was also adopted. Figure 1 synthesises the scheme of the adopted mixed-mode approach both at recruitment and at the data collection stage.

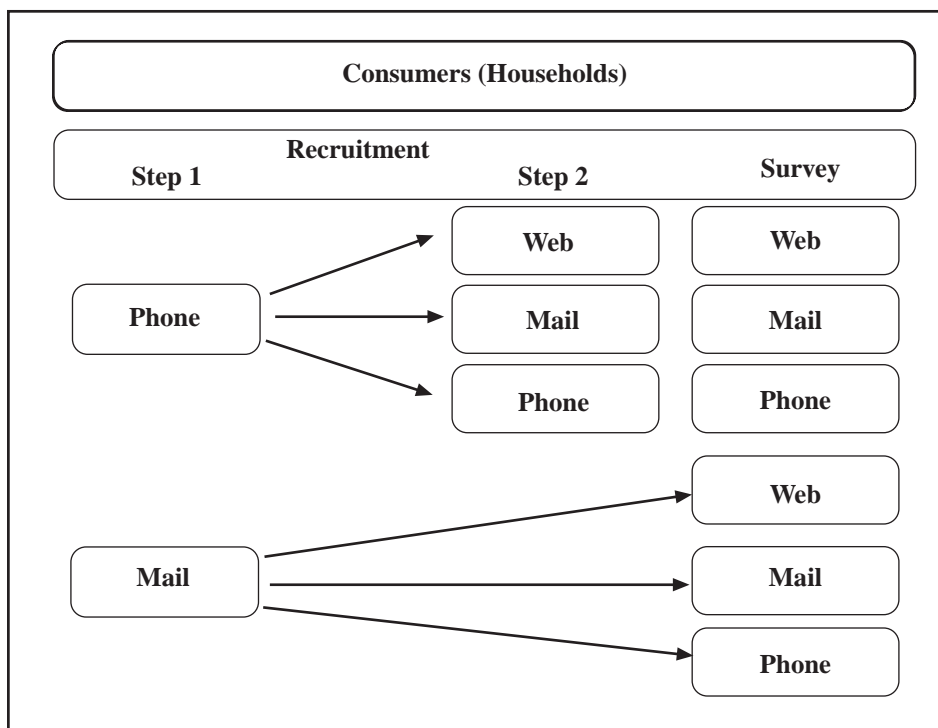
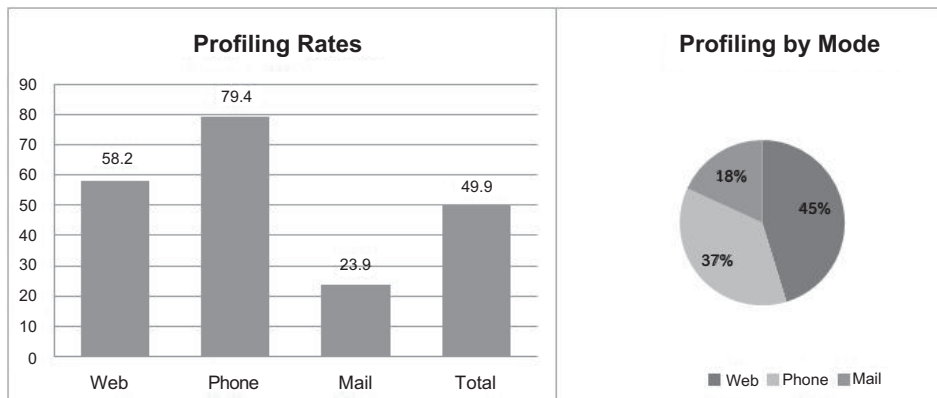


Figure 1: Consumers PAADEL: mixed-mode in the recruitment and in the survey (Biffignandi, 2012)

In the first recruitment step, the unweighted recruitment rate was equal to 55.1%. The explicit refusal rate was 44.9%. The second-step recruitment is quite diversified depending on the chosen mode. The term *profiling rate* refers to the effective subscription in the transition from first to second step, i.e. to final recruited households. Final recruited households are those who, by definitely accepting the participation to the panel, were filling in the questionnaire on the background variables. Profiling rates broken-down by mode are particularly high in the phone mode (79.4%), even if the web mode achieves a high rate too (58.2%). Mail profiling rate is lower (23.9%), even though not irrelevant. Due to the higher number of households choosing web as second-step recruitment mode, final participation to the panel is largely based on web mode (more than 45% of finally recruited). The phone participation mode (about 37%) is the second most important mode (Figure 2). Mail subscription gives a significant contribution to the final composition of the panel too. The mail subscriptions in the second step represent 18.2% of the panel.



**Figure 2: Profiling rates (a) and profiling percentage composition (b) for phone-allocated households**

As regards the mail-allocated households, socio-demographic questions for the reference person were administered together with the participation subscription request and the choice of the survey mode. The collection of socio-demographic information for the other members of the households was postponed to the first survey wave. As for the main survey, it was decided to adopt a mixed-mode approach (in the recruitment questionnaire it was asked to choose a mode to answer the survey).

The mail recruitment led to a households profiling rate subscription as an effective member of the panel equal to 14.8%, with an explicit refusal rate equal to almost 30% and a non-response a little higher than 40%<sup>2</sup>.

The net overall profiling rate (that is compared with the initial sample, considering both phone and mail recruitment) is equal to 21,3%.

#### **4. THE SURVEY**

Market research makes extensive use of web panels (Comley, 2007; Postoaca, 2006). For many years web panels have been used in the United States. Recent trends indicate a large-scale diffusion of this data collection mode in many European countries as well. Some panels are more social aspects oriented, like the LISS (Longitudinal Internet Studies for the Social Sciences), other more general like the Innovation panel. Now panel collection mode is being recognised as one of the most important market research survey tools; thus many commercial panels exist, mostly access panels based on non-probability approaches. Due to the lack of methodology adopted in many commercial panel, recently many organisations have provided guidelines on the use of web panels (among the others ESOMAR, 2005). An example that most web panels are non-representative, suffering from self-selection is given in Vonk et al. (2006). They investigate the representativity of 19 web panels used for market research in the Netherlands. Panel participated in the study were self-selected among the Dutch Market Research Association (see MOA website). The same survey has been administered to the 19 panels. The survey refers to variables on labour, transport, policy, judgment of the Prime Minister, religion, moving houses and satisfaction with house and neighborhood, spontaneous and aided awareness of bier and TV brands, advertising awareness, participation in online research (panels), Internet usage. Moreover, information on the panel incentives, invitation policy, age of panel, type of panel provider were collected. Finally, as regards panel members the following information were recorded: panel history, duration of panel membership, way of recruitment, number of invitation and individual response rates, socio-demographics.

It was found that these panels are representative only with respect to basic demographic variables (age and gender). They find lack of representativity with respect to other variables. Recent literature has proposed corrections to improve the

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<sup>2</sup> Note that the profiling rates concerning the mail recruitment are not comparable to those of the first step of phone recruitment; they are – approximately – comparable to the final ones of the recruitment with first phone step (net profiling rate of phone recruitment).



representativity of non-probability panels (among others, Steinmetz et al., 2014). However, representativity with respect to every key variable is not guaranteed.

It is important for marketing strategies to be based on reliable results, which can be referred to the target population of interest. The PAADEL panel is an example of a representative infrastructure which could be used to administer surveys to consumers and to obtain sound results.

In this framework, a questionnaire was administered to the PAADEL active panel members. Section 4.1 outlines the theoretical framework for the survey and the hypotheses tested using the survey. Section 4.2 is devoted to technicalities concerning weighting issues. Section 4.3 presents the main findings from the survey. Notice that results are reported with confidence intervals thanks to the probabilistic nature of the panel.

#### **4.1 OBJECTIVES AND SURVEY STRUCTURE**

Consumer behaviour has been attracting many researchers for a long time because of its importance to the industry. By understanding consumers' behaviour, a business can understand consumers' needs and can work on fulfilling the needs and meeting the expectations of its customers. This would eventually help businesses to maintain their performance on the market. Even if food plays a central role in the life of consumers, food consumption behaviour has not attracted systematic attention of consumer behaviour researchers, probably due to the fact that it mainly satisfies primary needs, and food consumption traditionally has been only partially affected by economic crises. Moreover, the problem of food consumer behaviour is rather complex and various elements are drivers of food choice and consumption, thus involving concepts and insights from a wide range of science and social science disciplines (food science, nutrition, health, psychology, sociology, economics, marketing, and anthropology), as Steenkamp (1993) stated. Complexity has been recognised since initial studies (Pilgrim, 1957). Literature overview (Shepherd, 1990) highlights that in general three types of factors are drivers of food consumption: 1) properties of the food, 2) factors related to the person engaged in the food consumption, and 3) environmental factors.

The recent socio-economic context reinforces the importance of food consumption behaviour research since the consumers' decision making process is more and more affected by a combination of customer's awareness and external motivators. Some external environmental driving factors, which are, at the time being, receiving increasing attention in the community, are quality perception, health nutrition security and related risk factors, storage problems, and changes in channel distribution.

All stakeholders play a role in determining the external environment: the government (pricing, policies promoting sustainable social norms, national/regional standards, legislation, information, leadership, regulating advertising, supporting civil society and industry initiatives), business and food retailers (pricing, availability, information and labeling, choice-editing), and civil society (campaigns, practical projects, information, standards and monitoring).

Last, but not least, in recent years, the global financial crisis has greatly affected household income availability and socio-economic values. Recent data on food consumption show that even the food sector, usually not highly sensible to economic cycles, has been affected by a decreasing pattern.

Taking the context described above into account, the panel can be a relevant tool for investigating and monitoring the multidisciplinary aspects of consumer behaviour and attitudes – during the crisis and toward new external values in the society. A first survey wave was administered to panel members. The focus of the study is on a few preliminary hypotheses related to factors motivating purchasing decisions, distribution channels, food risk perception, and changes due to the crisis.

Two hypotheses to be tested using results from the survey are proposed. First, the increasing amount of solicitation to consumers coming from media and other communication tools is switching consumers attention from marketing traditional factors based on status ephemeral values to new factors based on values related to the individual benefits in terms of basic quality of life (quality as basic value for the quality/price ratio evaluation, health, etc.). The *first hypothesis* under study aims at investigating whether there has been a trend in the factors influencing purchasing behaviour and their current role. Special attention is devoted to the importance of quality and the meaning attributed to quality. It is verified whether quality is mainly intended with respect to new factors (health, food security, etc.) driving consumption and purchase behavior.

The *second hypothesis* concerns the use of distribution channels. Large-scale distribution stands above every other distribution channel. Nevertheless if new values drive food consumption (first hypothesis), new forms of small scale distribution channels could better match customer needs. Choice factors related to the distribution are becoming tailored not only to factors typical of the large scale distribution, but also to factors typical of small scale distribution channels (health and lifestyle related factors) and traditional shops. If this hypothesis holds large scale distribution needs to gain insight into these factors and take them into account.

As regards the survey statistical aspects, hereunder the basic characteristics are described. The data collection was conducted towards the end of 2012 and it lasted three months. It was based on a mixed-mode design (telephone, web, and

mail) and ended up with a quite high (unweighted) response rate (63.5%<sup>3</sup>). The survey response rates are quite high for any mode. This confirms the good quality of the recruited panel and the efficacy of the adopted mixed-mode approach (Table 1).

**Table 1: Response rates by mode**

<i>Survey response rates by mode</i>		<i>Percentage composition of survey responses</i>	
<i>Mode</i>	<i>%</i>	<i>Mode</i>	<i>%</i>
Web	68.5	Web	45.5
Phone	71.2	Phone	30.2
Mail	53.2	Mail	24.3
<b>Total</b>	<b>63.5</b>	<b>Total</b>	<b>100.0</b>

#### 4.2 WEIGHTING ISSUES

Like other survey samples, representative panel samples need to be weighted in order to produce unbiased estimates of population quantities. Weights are applied for three reasons: (i) to account for differential units selection probabilities, (ii) to compensate for differences in response rates across subgroups, and (iii) to adjust for random or systematic departures from the composition of the population.

Before adjustment techniques can be implemented, it is important to have a look at the sample composition and compare it with available population information from the Italian National Statistical Institute (Istat). Tables 2 to 6 show the unweighted sample composition, the design-weighted sample composition (using base weights), the weighted sample composition (with final weights), and the population parameters for the variables Province, Number of members in the household, Gender, Age, and Education. The tables reveal that single households, people between 30 and 45 years of age, and lower educated people are under-represented in the survey (both unweighted and design-weighted sample). Households with two members, people between 46 and 65 years of age, and higher educated people are over-represented. The distribution of households by province and the distribution of household members by gender present little differences with respect to the population.

<sup>3</sup> Additional mail responses arrived outside the assigned survey time have not been counted in these rates, but they are an interesting indicator of efficacy and vivacity of the panel.

**Table 2: Unweighted, design weighted, and weighted (with final weights) sample composition, and population distribution by province**

	Sample			Population		
	Unweighted	Design-weighted	Weighted (final)	Unweighted	Design-weighted	Weighted (final)
Province	%	Std Err.	%	Std Err.	%	Std Err.
BG-BS	19.1	20.6	3.8	21.5	4.1	23.0
VA-CO	10.2	11.1	2.6	13.6	3.1	14.7
CR-MN	7.6	14.6	3.7	11.2	1.7	7.6
MB-LC-SO	13.0	17.5	2.9	16.7	2.2	13.6
MI-LO-PV	50.1	36.2	3.6	37.0	3.7	41.1
<b>Lombardy</b>	<b>100.0</b>	<b>100.0</b>		<b>100.0</b>		<b>100.0</b>

**Table 3: Unweighted, design weighted, and weighted (with final weights) sample composition, and population distribution by number of members in the household**

	Sample			Population		
	Unweighted	Design-weighted	Weighted (final)	Unweighted	Design-weighted	Weighted (final)
Members	%	Std Err.	%	Std Err.	%	Std Err.
1	17.6	11.3	2.1	23.9	4.6	26.5
2	38.0	37.5	4.1	27.4	4.3	28.9
3	22.2	26.5	3.3	28.0	3.7	23.0
4	17.3	18.1	3.7	16.3	4.5	16.9
5 or more	4.9	6.6	2.2	4.3	1.4	4.7
<b>Total</b>	<b>100.0</b>	<b>100.0</b>		<b>100.0</b>		<b>100.0</b>

**Table 4: Unweighted, design weighted, and weighted (with final weights) sample composition, and population distribution by Gender**

	Sample			Population		
	Unweighted	Design-weighted	Weighted (final)	Unweighted	Design-weighted	Weighted (final)
Gender	%	Std Err.	%	Std Err.	%	Std Err.
Male	47.9	48.8	2.5	49.5	2.7	48.6
Female	52.1	51.2	2.5	50.5	2.7	51.4
<b>Total</b>	<b>100.0</b>	<b>100.0</b>		<b>100.0</b>		<b>100.0</b>

**Table 5: Unweighted, design weighted, and weighted (with final weights) sample composition, and population distribution by Age**

	Sample			Population		
	Unweighted	Design-weighted	Weighted (final)	Unweighted	Design-weighted	Weighted (final)
Age	%	Std Err.	%	Std Err.	%	
<30	23.6	25.5	2.2	27.3	3.3	28.5
30-45	12.8	15.7	2.3	24.1	2.7	24.7
46-65	35.8	37.7	4.2	27.8	3.8	27.2
>65	27.8	21.1	4.8	20.9	3.7	19.6
<b>Total</b>	<b>100.0</b>	<b>100.0</b>		<b>100.0</b>		<b>100.0</b>

**Table 6: Unweighted, design weighted, and weighted (with final weights) sample composition, and population distribution by education level**

	Sample			Population		
	Unweighted	Design-weighted	Weighted (final)	Unweighted	Design-weighted	Weighted (final)
Education	%	Std Err.	%	Std Err.	%	
None	6.0	7.3	1.6	12.1	2.3	7.2
Primary	7.0	6.8	1.4	19.1	3.1	26.3
Lower secondary	22.2	24.1	4.0	32.2	3.6	31.8
Upper secondary	40.8	46.2	4.5	27.0	2.2	27.3
Bachelor/Master/PhD	24.0	15.7	1.9	9.7	1.8	7.4
<b>Total</b>	<b>100.0</b>	<b>100.0</b>		<b>100.0</b>		<b>100.0</b>

The weights for the survey were computed through a three-step approach. In the first step, each unit in the sample was assigned a design weight to compensate for differences in the selection probabilities of the individual units. These differences arise from the design of the sample (Lohr, 2010). The Consumer-PAADEL panel is a two-stage stratified sample and different probabilities are used within different strata.

The second step adjusts the weights for differences in subgroup participation rates. In general, certain groups of individuals tend to participate at lower rates than other groups. When the characteristics of those who respond are systematically different from those who do not respond, non-response introduces bias into the results. Due to the little information available about non-respondents, non-response adjustment cells have been formed only using strata. This corrects for different response rates across different strata.

The third step compensates for differences between the composition of the sample and the composition of the population. These differences may occur by chance or because of coverage problems of the sampling frame or because of non-

response. For this purpose, the weights are calibrated (Deville and Särndal, 1992), i.e. they are replaced by other weights which are as close as possible to the initial ones in a proper sense and whose sum over various domains corresponds to known population counts. There are essentially two reasons for calibrating. First, it is hoped that possible undercoverage and non-response bias are reduced. Second, the calibration enhances the comparability with data from official statistics. Variables to calibrate on are known from the national Italian censuses (2011, when data are available, or 2001). Their choice is based on a dual consideration. Variables included in the model should be related both to the response behaviour and to the target variables in the survey (Bethlehem et al., 2011; Särndal and Lundström, 2005). In order to identify auxiliary variables to be used in the calibration process, first the relationship between a number of auxiliary variables and the response behaviour is analysed by comparing the distribution of such variables in the responding set and in the population and by performing appropriate chi-squared tests. Next, the influence of variables showing a differential response is investigated on a number of target variables.

After calibration, the variability of the calibrated weights was studied. This is an important aspect to be considered, since the variability of the weights may increase the variance of the corresponding estimates (Kish, 1992). Since a large part of the observed variability of the calibrated weights was due to very few observations, the decision to winsorize the most extreme weights was taken, in order to reduce the variance of the weights and hopefully that of the estimators. The bias incurred should be compensated by the variance reduction.

In the process described above, different types of weights are compared. This comparison is an in-depth analysis of the one carried out in a preliminary analysis of the results reported in Biffignandi (2012). Different calibration methods, different variables for the weighting model, and different winsorizing strategies were compared. By means of example and to highlight the impact that the choice of weights may have on the final estimates, in the following the main steps of the comparison for just a few sets of weights are briefly reported.

Tables 7 and 8 contain some of the weights considered together with their description and basic characteristics. For example, WGT7 is computed using ratio raking based on the marginal values of the variables Province (in five categories), Gender, Number of members in the household (in five categories), Age (four categories), and Education (five categories). Weights are then winsorized at the 5<sup>th</sup> and 95<sup>th</sup> percentiles, that is values below the 5<sup>th</sup> percentile of the weights distribution are replaced by the 5<sup>th</sup> percentile and values above the 95<sup>th</sup> percentile of the weights distribution are replaced by the 95<sup>th</sup> percentile. The resulting set of weights

has coefficient of variation (CV) 1.7 and the max/min ratio is 1091.1. Further, the design effect ( $deff=1+ CV^2$ ) due to unequal weighting is computed to examine the effects of weighting adjustments on the precision of the survey estimates (Kish, 1992). For WGT7, the design effect is 3.9. By comparing the design effect for adjusted weights to the one computed for design weights, it is possible to understand whether weighting adjustments are causing a substantial loss of precision in the survey estimates. Kish’s rule states that if the calibration is worth nothing then a 20% increase of the deff of the weights would roughly mean a 20% loss in efficiency. We would then hope that also the max/min ratio in absolute terms would be less than 100, i.e. less than 4 times the max/min ratio for the design weights (26.2). However, it has to be noted that the deff approximation does not always yield a good approximation for the effect of calibration. When the weights are calibrated to known population totals, then the design effect is poorly approximated when the target variable is highly correlated with one or more of the control totals. In case of correlation, calibration to known population totals can appreciably improve the precision of the estimates, but this improvement will not be captured by deff. Therefore, this measure has to be considered with some cautions.

**Table 7: Description of some weights considered in the comparison**

Weights	Method	Winsorization	Weighting model
WGT1	Ratio raking	–	Prov.+Gender+N.members
WGT2	Ratio raking		Prov.+Gender+Age
WGT3	Ratio raking		Prov.+Gender+N.members+Age
WGT4	Ratio raking	–	Prov.+Gender+N.members+Age+Education
WGT5	Ratio raking	1–99	Prov.+Gender+N.members+Age+Education
WGT6	Ratio raking	2–98	Prov.+Gender+N.members+Age+Education
WGT7	Ratio raking	5–95	Prov.+Gender+N.members+Age+Education

**Table 8: Characteristics of the weights considered in the comparison**

Weights	CV	deff	MIN	MAX	MAX/MIN
Design weights	1.3	2.6	1784.0	46721.0	26.2
WGT1	1.3	2.8	1280.1	127514.9	99.6
WGT2	1.6	3.5	536.1	171318.8	319.6
WGT3	1.6	3.5	428.7	185632.8	433.0
WGT4	2.7	8.2	2.9	269145.0	93129.8
WGT5	2.4	7.0	7.6	176964.8	23400.0
WGT6	2.2	5.9	15.4	126821.3	8252.6
WGT7	1.7	3.9	65.5	71507.1	1091.1

If we look at the increase in the deff over the deff of the design weights, then WGT2, WGT3, and WGT4 are above a 20% increase. For this reason, weights are winsorized to see whether winsorizing brings the design effect and max/min ratio down to a reasonable level. Of course, winsorized weights are no longer exactly calibrated at the level of the variables. Therefore winsorized weights were subsequently calibrated to sum to the population size.

Next, the influence of the different weighting sets on a number of target variables was considered. The results are shown in Tables 9 and 10. Reported standard errors are computed using Jackknife replication estimators, which allows to explicitly account for all of the steps in estimation (non-response adjustment, calibration, and winsorization). See Valliant et al. (2013). The computation was performed using WesVar (Westat, 2007).

Looking at gender, the sample distribution is not very different from the population distribution (Table 4). Including gender in the calibrating equation is not expected to produce large differences in the estimates. Gender is generally included in order to allow comparability with data from official statistics. The influence of education seems rather large (see e.g. the jump in the hard discount estimate, or in the influence of the economic crisis when the variable Education is included in the weighting model – for example, from WGT3 to WGT4 the percentage of people using hard discounts as predominant place of purchase jumps from 4.3% to 5.4% and the percentage of people declaring that the economic crisis had an impact on purchasing behaviour jumps from 63.6% to 74.2%). Usually, the higher educated people tend to participate more and buy less in hard discounters. They are also less affected by the crisis. Therefore, the conclusion was that education should be taken into account. On the other hand, it seems that education also inflates standard errors quite a bit.

As regards the Number of members, it seems to be an influencer too. Indeed, a jump (from 61.9% to 63.6%) is observed from WGT2 to WGT3, for example in the effects of the crisis. Singles are under-represented (Table 3) and they are generally more affected by the crisis. It was concluded that the final set of weights should therefore include the variables Province, Number of members in the household, Gender, Age, and Education, in order not to under-represent important segments of the population. Different forms of winsorizing WGT4 were considered. Looking at the effects due to winsorizing WGT4 at different quantiles (Tables 8, 9, and 10), it was decided to adopt WGT7 as the final weighting set. Compared to WGT4, WGT7 modifies the weight of forty households. Twenty households are assigned a higher weight compared to WGT4. These households are characterised by high education and generally have three or more members. Households assigned



a lower weight correspond to lower educated people and generally have fewer members.

**Table 9: Impact of the weights on the estimates for the variable Predominant place of purchase**

Weights	<i>Hard discount Supermarket</i>		<i>Hypermarket/ shop</i>		<i>Traditional vendor</i>		<i>Market/Street</i>	
	Perc	Std. Err.	Perc	Std. Err.	Perc	Std. Err.	Perc	Std. Err.
Unweighted	5.2	1.1	87.5	1.7	4.4	1.0	2.9	0.9
Design weights	6.3	2.1	83.7	3.5	7.2	2.5	2.8	1.2
WGT1	3.6	1.1	85.0	4.5	6.7	2.4	4.8	3.4
WGT2	4.1	1.6	83.7	5.6	6.5	2.4	5.8	4.6
WGT3	4.3	1.8	83.3	5.3	6.3	2.3	6.2	4.9
WGT4	5.4	2.8	85.6	6.1	6.1	5.1	2.9	2.9
WGT5	5.7	3.0	85.7	5.5	5.6	4.3	3.1	3.1
WGT6	6.0	3.0	86.4	4.5	4.2	2.8	3.4	3.3
WGT7	5.5	2.1	88.6	3.0	3.3	1.7	2.6	1.8

**Table 10: Impact of the weights on the estimates for the variable Influence of the economic crisis on purchasing behaviour**

Weights	<i>Yes</i>		<i>No</i>		<i>Don't know</i>	
	Perc	Std. Err.	Perc	Std. Err.	Perc	Std. Err.
Unweighted	60.1	2.5	34.9	2.5	5.0	1.1
Design weights	62.3	4.2	31.6	3.4	6.1	2.8
WGT1	63.7	4.6	30.3	3.8	6.0	3.1
WGT2	61.9	5.6	32.2	5.0	6.0	2.9
WGT3	63.6	4.9	30.7	4.5	5.6	2.7
WGT4	74.2	5.2	19.0	6.0	6.8	5.0
WGT5	73.5	5.6	20.1	5.9	6.4	4.2
WGT6	72.8	6.1	22.2	6.3	5.1	2.9
WGT7	69.6	5.5	26.0	5.2	4.4	1.9

Notice that WGT7 is able to recover the population composition with respect to the variables Province, Number of members in the household, Gender, Age, and Education rather accurately (Tables 2 to 6). Even if WGT7 has been calibrated on these variables, the weighted sample distributions do not match exactly the population ones because of winsorization.

### 4.3 FINDINGS

This section reports the main findings from the survey, with specific reference to the formulated hypotheses (Section 4.1). Confidence intervals and hypothesis testing are based on replicate standard errors estimation (Westat, 2007).

A central theme which constantly emerges throughout the survey is the focus of consumers on the value for money factor. This last aspect is certainly strongly related to the global financial crisis, as it will be seen afterwards.

Going into details, a central question of the survey is about the factors that motivate the purchasing decision makers of the households in Lombardy. As Figure 3 reveals, the most important factor in 2012 is related to the *quality-price ratio* (43.7%). Also *quality* (17.9%) and aspects related to quality (*it's good for health*, 12.2%, and *biological product*, 3.4%) appear to play a central role in the purchasing process.

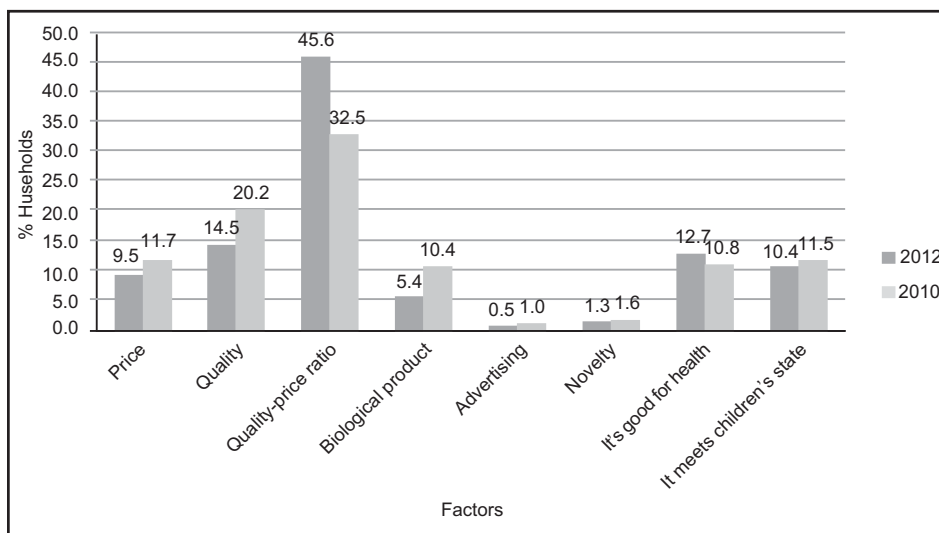


Figure 3: Factors motivating the purchasing decisions in 2010 and 2012

In order to understand changes between 2010 and 2012, the same question with reference to year 2010 was included in the survey. It turned out that, over the two-years period, there has been a statistically significant increase of the importance of the *quality-price ratio* ( $p\text{-value}=0.024$ , increase +6.3%), while the observed decrease for *quality* and *biological products* is not statistically significant. The importance of quality is confirmed despite the crisis. Attention to biological and health-related factors has remained unchanged (a negative change in the estimates is observed, but it is not statistically significant).

Turning to the changes in consumption behaviors (Table 11), 69.6% of the households declare that the purchase of food in the last two years has been affected by the general economic crisis (p-value<0.001). The main reasons are attributed to the price increase (39.3%, p-value<0.0001) and to the decrease in purchasing power of households (34.7%, p-value<0.0001). For the majority of the households (54.7%, p-value<0.0001), the behavior modified to the greatest extent concerns the search for promotional offers. However, the attention to quality is still evident: for over 96% of the households the quality of the purchased products has not changed in the last two years (p-value<0.0001). Around half of them pursue savings by reducing the quantity of the purchased products.

**Table 11: Changed behaviours (estimates and 95% confidence intervals. LB: lower bound. UB: upper bound)**

	%	LB	UB
<b>Influence of the economic crisis on purchasing behaviour</b>	69.6	58.9	80.38
<b>Main reasons for declining purchases</b>			
General economic trend	20.5	11.1	29.8
Price increase	39.3	30.5	48.0
Decrease in purchasing power of households	34.7	27.3	42.2
Mass media influence	0.5	0.0	1.9
Other	5.0	0.0	10.7
<b>Modified behaviours over the last two years</b>			
Purchasing habits (prepared food, frozen food, etc.)	8.2	3.2	13.3
Search for promotional offers	54.7	46.7	62.6
Search for low cost products	9.1	3.9	14.3
New consumption habits (eating outside, etc.)	6.6	1.9	11.3
No changes	16.1	8.8	23.4
Other	5.3	0.4	10.3
<b>Behaviour over the last two years</b>			
Unchanged quality of the purchased products	45.0	34.1	55.9
Unchanged quantity of the purchased products	2.0	0.0	4.1
Unchanged quality, reduced quantity	51.3	39.6	63.1
Reduced quality, unchanged quantity	0.5	0.0	1.3
Reduced quality and quantity	1.2	0.0	3.0

Further, the survey allows to detect other interesting aspects related to the consumer's attention to quality in 2012. A considerable interest in food security and food risks is observed with reference to 2012. Lombard families are pretty aware that the consumed products may affect health conditions. Almost 80% of the respondents believe that food consumption can highly/fairly affect health condi-

tions. Of those who are aware of food risks, around 45% consider not much adequate the available information, while 55.3% believe it is quite adequate. The concept of quality is not interpreted only by looking at the taste, but the consumer pays attention to other factors related to health (genuineness 37.3%, security 28.9%, naturalness 18.0%, and healthiness 9.4%).

**Table 12: Perception of food risks (estimates and 95% confidence intervals. LB: lower bound. UB: upper bound)**

	%	LB	UB
<b>Incidence of consumed food products on health</b>			
Not at all	4.6	0.0	9.8
A little	16.9	7.8	26.0
To a moderate extent	38.3	27.2	49.3
A lot	40.2	28.4	52.0
<b>Adequacy of the available information</b>			
Not at all	1.3	0.0	2.9
A little	43.4	31.0	55.9
To a moderate extent	43.4	30.1	56.7
A lot	11.9	2.8	21.0
<b>Meaning of quality of the food product</b>			
Genuineness	37.3	31.7	42.9
Security	28.9	22.8	35.0
Naturalness	18.0	12.5	23.5
Healthiness	9.4	4.9	13.9
Taste	6.4	2.4	10.5

Looking at purchasing behaviors in 2012 (Table 13), 81.9% of the households in Lombardy buy (or would buy) guaranteed and certified products (biological, PDO, CDO, PGI) even at higher cost. The percentage of households that buy fair trade products is 77.3, and the percentage of those that buy zero-mile food is 81.6. This is another signal towards quality, since such products allow to reduce factors related to pollution and to buy local, fresher and seasonal products. It is also noticeable that for almost 90% of the households the purchase decision is affected by the country of origin of the product.

Overall from the results, the first hypothesis under study can be confirmed. Consumers' attention is focused on values related to individual benefits related to the quality of life. The focus on quality is maintained, despite the economic crisis. An increasing attention to the value for money is observed. A significant change in purchasing behaviours is registered as well.

Turning to the second hypothesis, the survey does not allow to confirm it. Two questions asking the most frequently used distribution channel in 2010 and 2012, respectively, were included in the survey. Differences observed over the two years period are not statistically significant. It is however interesting to notice that forms of consumption denoting a consumer attentive to both quality and prices are observed in 2012. On the one hand, these channels allow to hold down prices. On the other hand, their use is a signal of attention to the quality of the products.

**Table 13: Purchasing behaviours in 2012 (estimates and 95% confidence intervals. LB: lower bound. UB: upper bound)**

	<b>%</b>	<b>LB</b>	<b>UB</b>
<b>Purchase of guaranteed and certified products (biological, PDO, CDO, PGI) even at higher cost</b>	81.9	73.8	90.0
<b>Purchase of fair trade products</b>	77.3	68.0	86.5
<b>Purchase of zero-mile products</b>	81.6	72.7	90.5
<b>Influence of the country of origin of the product on purchase</b>			
Never	10.7	4.6	16.9
Sometimes	43.7	31.2	56.3
Often	45.5	34.3	56.8

**Table 14: Distribution channels (estimates and 95% confidence intervals. LB: lower bound. UB: upper bound)**

	<b>%</b>	<b>LB</b>	<b>UB</b>
<b>Consumption of self-produced products</b>	51.2	38.3	64.2
<b>Frequency of direct purchases from producers</b>			
Never	43.5	32.8	54.2
Sometimes	54.6	44.2	65.1
Often	1.9	0.0	4.5
<b>Reason for purchasing from producers</b>			
Saving	5.8	0.0	13.4
Freshness and genuineness of the products	89.3	79.2	99.3
Other reasons	5.0	0.0	11.9
<b>Use of purchasing groups</b>	14.4	2.0	26.9
<b>Use of pre-packed food products vending machines</b>			
Never	88.8	82.5	95.0
Rarely	10.7	4.8	16.5
Regularly	0.6	0.0	2.1

As can be seen from Table 14, 51.2% of the households in Lombardy resort to the consumption of autonomously produced products (e.g., fruits and vegetables), and 56.5% buy products directly from producers. The main reason for buying directly from the producers is the freshness of the product (89.3% of the cases). The percentage of households that make use of purchasing groups for buying products directly from the producers is 14.4. Around 11% of the households make use of pre-packed food products vending machines, mainly for buying snacks and milk. These findings identify life styles attentive to quality and saving at the same time.

## **5. CONCLUSIONS**

The paper describes the construction of a new households probability-based panel. It was built in 2012 within the PAADEL project.

A survey to study consumers attitudes and behaviours toward some innovative issues related to food and beverage purchase, such as packaging, health, and distribution channels and to identify changes in purchasing behavior during the recent economic crisis was carried out. From the methodological point of view, the paper focuses both on issues related to panel construction and on issues related to weighting procedures. As regards the main results, it emerges that consumers pay much attention to quality, even in relation to the origin of the products. Some changes in the last two years are related to the persistence of the current recessive phase. Nearly 70% of the households states that their purchases were affected by the recent economic crisis. An increasing attention towards saving, which translates into the search for promotional offers is observed. Small scale distribution channels are also used in 2012, such as autonomous production and direct purchase from producers. These channels allow to curb spending, without sacrificing the quality of the purchased products. The first hypothesis formulated in Section 4.1 is verified, confirming a change in the factors influencing purchasing behaviour. The second hypothesis is not accepted. Differences observed for the predominant place of purchase in 2010 and 2012 turn out not to be statistically significant. Recall also that the crisis had already started before 2010 and that only a two-year period is considered here. Nevertheless, forms of consumption denoting a consumer attentive to both quality and prices are observed in 2012.

These findings are useful in many operational contexts. As food consumers become more aware of health problems related to food, and focus more on the price-quality relationship and on the quality of life, marketing operators and businesses seeking to grow must understand the elements that influence their customers purchase and switching behaviors and how marketing, sales, and customer service

practices should be adapted. Thus, the survey offers elements to anticipate future behaviours and to define marketing strategies.

The survey described in this paper shows how the panel prototype that has been built is a valid instrument for the collection of information and data. The panel provides an infrastructure suitable for investigations on various themes related to purchasing behaviours in Lombardy. The panel offers an infrastructure which guarantees representativeness. Innovative methodological approaches to improve representativeness of (web) probability panels are under study as well (see e.g. Bianchi and Biffignandi, 2013; 2014).

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## REFERENCES

- Arthur, L. (2013). *Big Data Marketing: Engage Your Customers More Effectively and Drive Value*. Wiley, Hoboken, NJ.
- Bethlehem, J., Cobben, F., and Schouten, B. (2011). *Handbook of Nonresponse in Household Surveys*. Wiley, Hoboken, NJ.
- Bethlehem, J., and Biffignandi, S. (2012). *Handbook of Web Surveys*. Wiley, Hoboken, NJ.
- Bianchi, A., and Biffignandi, S. (2013). Web panel representativeness. In P. Giudici, S. Ingrassia, and M. Vichi, editors, *Statistical Models for Data Analysis*, 37-44. Springer, Berlin.
- Bianchi, A. and Biffignandi, S. (2014). Responsive design for economic data in mixed-mode panels. In P.L. Conti, F. Mecatti, and M.G. Ranalli, editors, *Contribution to Sampling Statistics*. Springer Series *Contributions to Statistics*, Springer.
- Biffignandi, S. (2012). *Il Panel Agro-Alimentare e Demografico Lombardo (PAADEL): Un'infrastruttura di monitoraggio dell'innovazione nella produzione e nei consumi del settore agroalimentare*. Franco Angeli, Milano.
- Comley, P. (2007). Online Market Research. In ESOMAR, editors, *Market Research Handbook*, 401-420. John Wiley & Sons, Hoboken, NJ.
- De Leeuw, E.D., and De Heer, W. (2002). Trends in household survey nonresponse: A longitudinal and international comparison. In R.M. Groves, D.A. Dillman, J.L. Eltinge, and R.J.A. Little, editors, *Survey Nonresponse*, 41-54. Wiley, New York.
- Deville, J.C., and Särndal, C.E. (1992). Calibration estimators in survey sampling. In *Journal of the American Statistical Association*, 87: 376-382.
- Einav, L., and Levin, J.D. (2013). The Data Revolution and Economic Analysis, NBER Working Paper No. 19035, May.
- European Society for Opinion and Marketing Research, ESOMAR (2005). *Conducting Market and Opinion Research Using the Internet*. [www.esomar.org/uploads.pdf/](http://www.esomar.org/uploads.pdf/). Last access: 12/3/2014.

- European Federation of Associations of Market Research Organisations, EFAMRO (2004). *Quality Standards for Access Panel (QSAP)*. [www.efamro.com/shortprint2.html](http://www.efamro.com/shortprint2.html). Last access: 12/3/2014.
- Kish, L. (1992). Weighting for unequal Pi. In *Journal of Official Statistics*, 8: 183-200.
- Lohr, S. (2010). *Sampling: Design and Analysis*. Cengage Learning, Boston, MA.
- Marreiros, C., and Ness, M. (2009). A conceptual Framework of Consumer Food Choice Behaviour, CEFAGE-UE Working Paper 2009/06.
- Pilgrim, F.J. (1957). The Components of Food Acceptance and Their Measurement. *American Journal of Clinical Nutrition*, 5: 171-175.
- Postoaca, A. (2006). *The Anonymous Elect. Market Research through Online Access Panels*. Springer, Berlin.
- Särndal, C.E., and Lundström, S. (2005). *Estimation in Surveys with Nonresponse*. Wiley, Hoboken, NJ.
- Shepherd, R. (1990). Overview of Factors Influencing Food Choice. In M. Ashwell, editor, *Proceedings of the 12<sup>th</sup> British Nutrition Foundation Annual Conference*, BNF, London (UK): 12-30.
- Sikkel, D., and Hoogendoorn, A. (2008). Panel Surveys. In: E.D. DeLeeuw, J.J. Hox and D.A. Dillman, editors, *International Handbook of Survey Methodology*, 479-499. Lawrence Erlbaum Associates, New York.
- Steenkamp, J.-B.E.M. (1993). Food Consumption Behavior. In W. Fred Van Raaij and G.J. Bamossy, editors, *E – European Advances in Consumer Research*, Vol. 1., 401-409. Provo, UT, Association for Consumer Research.
- Steinmetz, S., Bianchi, A., Tijdens, K., and Biffignandi, S. (forthcoming). Improving web survey quality – Potentials and constraints of propensity score weighting. In M. Callegaro, R. Baker, P.J. Lavrakas, J.A. Krosnick, J. Bethlehem, and A. Göritz, editors, *Online Panel Research: A Data Quality Perspective*. Wiley,
- Valliant, R., Dever, J.A., and Kreuter, F. (2013). *Practical Tools for Designing and Weighting Survey Samples*. Springer, New York.
- Vonk, T., Van Ossenbruggen, R., and Willems, R. (2006). The effects of panel recruitment and management on research results. A study across 19 online panels. In *Panel Research 2006*. ESOMAR Publications Series, Amsterdam, The Netherlands.
- Westat (2007). *WesVar 4.3 User's Guide*. Westat, Rockville MD, URL [www.westat.com](http://www.westat.com). Last access: 12/3/2014.