Syst Pract Action Res (2013) 26:217–238
DOI 10.1007/s11213-012-9248-6

ORIGINAL PAPER

Enhancing Validity and Reliability Through Feedback-Driven Exploration: A Study in the Context of Conjoint Analysis

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Published online: 18 September 2012

Abstract This study proposes a research design for the enhancement of validity and reliability in conjoint analysis research. For this purpose, we are applying the concept of feedback-driven exploration to conjoint analysis and assess the proposed research design concerning its benefits and limitations in respect of validity and reliability of results. The article is of interest for the field of preference elicitation through stated preference methods, and for model validation in transdisciplinary research. By applying the principle of feedback-driven exploration, we allow for feedback loops between researchers, industry experts and survey participants in order to strengthen both validity and reliability. A multi-case study of the agricultural markets in Switzerland illustrates the functioning of the proposed research design. We find that feedback-driven exploration significantly increases validity and reliability by enhancing methodological rigor and implementing an error-correcting mechanism. Additionally, a better understanding of the underlying decision processes is supported by the design due to increased interaction between researchers, industry experts and market participants.

Keywords Conjoint analysis · Feedback-driven exploration · Exploratory research · Preferences

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Introduction

A growing number of companies rely on preference measurements in order to implement business strategies designed to streamline products according to customer preferences (Baier and Brusch 2009). Also, preference analysis is nowadays applied to a wide range of research questions including the analysis of product concepts, environmental policies, fairness issues or branding strategies (Teichert and Shehu 2009).

When trying to know one person's preference on any given issue, there are two main methods to do so. *Revealed preference methods* take actual purchases as indicators of preferences. In contrast, *stated preference methods* are theoretical as they ask how a person theoretically values a product or service. With stated preference methods, one can either *directly* ask for a product's value or ask *indirectly* by evaluating product attributes. Indirect approaches such as conjoint analysis compare different product attributes. It has been shown that indirect approaches are more successful in getting people to respond truthfully (Teichert and Shehu 2009).

Conjoint analysis (CA) is a multivariate decomposition technique used to understand how respondents build preferences for products and services. It is based on utility theory, deriving the utility values that people attach to varying levels of product attributes (North and de Vos 2002). It was developed by Luce and Tukey (1964) and brought into marketing by Green and Rao (1971) as well as Green and Srinivasan (1978) and McFadden (1974). CA has become the method of choice for quantitative preference measurement and is considered among the major contributions of marketing science to marketing practice (Netzer et al. 2008). Traditionally, CA has mainly been used to measure preferences in the choice of existing or new products (Teichert and Shehu 2009; Wind and Green 2002). Recent advances in conjoint analysis incorporate developments in research designs, estimation methods or methods to handle large numbers of attributes or small sample sizes (Rao 2008). These methods have led to a sharp increase in the application of conjoint analysis into new fields of applied research (for a general overview, see Teichert and Shehu 2009). Among others, new fields of applied conjoint analysis research include policy design (Luethi 2011), entrepreneurship research (Priem et al. 2011), or branding strategies and values (Sonnier and Ainslie 2011; Ferjani et al. 2009). These new applications of conjoint analysis represent a shift from a focus on prediction of market choices and consumer preferences to a focus on understanding the choice process (Rao 2008; Bradlow 2005; Louviere 2006). With this change of focus, the question of validity and reliability arises and needs to be addressed, especially in fields where literature and validation data are scarce (Bradlow 2005) and mixed methods are thus applied.

In Fig. 1, the main design steps of a CA are depicted. Product attributes (e.g. color and freshness of apples) and levels (e.g. green and red for the color of apples) play a crucial role in CA as they determine the possible range of preferences. The attributes and levels used in a study will primarily come from the objectives of the study and researchers generally apply the principle that both should be capable of being acted on and important to consumers (North and de Vos 2002; Weiber and Mühlhaus 2009). However, there seems to be no consensus on how to derive the "correct" attributes and levels that are to be used in a CA (Rao 2008; Weiber and Mühlhaus 2009). Bradlow (2005) also stresses that despite their importance in practice, little guidance is given on how to select appropriate attributes and levels. In general, qualitative methods (one-on-one interviews, focus groups, literature reviews) are used to ascertain which attributes and levels to choose, but these are rarely systematically reviewed with experts (for an overview of methods, see Weiber and Mühlhaus 2009). Selecting the survey design means selecting the form of presentation of

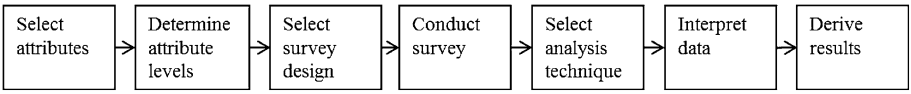

Fig. 1 Main steps of a conjoint analysis experiment (adapted from Baier and Brusch 2009)

stimuli (verbal, numerical or pictorial description) and the nature of judgements that must be obtained from the respondents. In the case studies discussed here, stimuli are presented in a paragraph and respondents are asked to indicate whether they would buy the presented attribute combination or not. Choice data is then analyzed using Hierarchical Bayes (HB) Estimation (Allenby and Rossi 2008; Rossi et al. 2005).

Within CA research, much research has been dedicated to criteria of validity and reliability from a statistical point of view, e.g. through comparison of results with hold-out choices or stated preference data. However, this recent research might benefit from improvement in three regards: First, little research has been carried out to assess the validity and reliability of a result from a qualitative and methodological aspect (Louviere et al. 2010). These aspects are particularly important in new fields of conjoint analysis that deal with problems for which market data to validate results are not available. Second, guidelines for conducting conjoint experiments generally suggest different procedures for the steps in the implementation of these experiments (e.g. generation of attributes to include in the survey, conducting the survey and analyzing data). However, these suggestions generally do not propose an overall framework to guide the research design and process. Third, experts from outside academia are generally not included other than as respondents of the survey. Thus results only reflect perspectives of researchers and respondents, leaving out other stakeholders of the investigations.

These three aspects in current CA research might greatly benefit from applying the concept of feedback-driven exploration (FDE), as developed by Schwaninger (1996). FDE refers to a research design that, in principle, increases the validity and reliability of exploratory research projects by implementing continuous feedback between researchers, the people concerned and experts as an integral part of the research process. We are choosing this framework for the following reasons: In the literature, the postulate for participative approaches to research, by which different stakeholders are included in the process, has often been brought forward (see e.g. Scholz 2011; Yin 1994). However a systematic treatment of feedback as a device, by which validity and reliability can be enhanced, has not yet been provided. Finally, the only systematic design for the instantiation of feedback mechanisms in a participative research setting, we have found, is the framework of FDE.

The purpose of this study is to assess the claimed benefits to validity and reliability of implementing the methodological concept of FDE as developed by Schwaninger (1996) into conjoint analysis. The research objectives are twofold:

(i) Proposal of a methodology to enhance the strengths of conjoint analysis by introducing FDE in order to increase validity and reliability of results.
(ii) A first assessment of implementing FDE into a CA research design is done by means of a multiple-case study at the business-to-business (B2B) interface of food value chains in Switzerland.

The case study is an analysis of Swiss milk, wheat and industrial potato processors' preferences for attributes and levels of these primary products. Results are relevant for theoretical reasons as they outline strengths and weaknesses of the chosen methodological

approach. They are also relevant for practical reasons as this is one of the first studies looking at industrial preferences in the markets for primary agricultural commodities of a developed country.

The study is divided into six parts. After this introduction to the topic, the concepts of validity and reliability are clarified in part two. Part three outlines the concept of FDE. In part four, a multi-case study is introduced. Part five explains the details of a procedure using an FDE research design in a CA. Results with regards to validity and reliability are described in part six. In part seven we provide a discussion of the main conclusions and directions for further research.

Validity and Reliability

The goal of social science is to reveal the processes that underlie observed social phenomena. Social phenomena are contextualized events that unfold and recur in the flow of time and are only meaningful when understood in context. They are multi-layered events that are present within a society independent of our mind (Scholz 2011). However, social phenomena are constructed through interaction of people in a social setting (von Förster et al. 2003) in the sense that people are not only the products, but also the producers of the social and cultural contexts in which they live. Their perceptions of and capabilities to access reality influence social phenomena (Scholz 2011). These are difficult to observe because they involve the application of judgment. We thus argue for *constructivist realism* as the set of ontological and epistemological principles that underlie our analysis and guide how methods used in the process of inquiry are deployed and interpreted.

Social phenomena are often researched using qualitative and/or quantitative research methods. Qualitative methods use verbal and textual data, while quantitative methods work with numerical data. Both methods are deconstructive in the sense that they select an episode in the social world, break it into data and selectively focus on certain aspects of the phenomenon. Thus the data is always shaped by the researcher (Cupchik 2001). At the same time, the two methods bring distinct features to the research. The qualitative method treats the phenomenon as a system and searches for patterns within its boundaries, incorporating as many episodes as possible in order to represent a coherent account of the underlying processes. Contrary, the quantitative method is analytical in orientation and fractionates phenomena to simpler models, resulting in great precision and internally consistent results. So while qualitative research is a rich source of data and provides thickness, quantitative research involves precision and can yield statistically significant effects, but their meaning remains to question.

Often, it is assumed that natural history precedes experimental science. This implies that qualitative research precedes a quantitative hypothesis testing phase. We argue that with the framework proposed in this study, this sequential view should be replaced by an iterative view and a complementarity of qualitative and quantitative research, instead of mutual exclusiveness. The sequence does not matter because the process is iterative and one approach feeds back into the other. This implies that through an approach guided by *constructivist realism*, richness can enhance precision. The interactions with the industry field and the working group within the first feedback loop shape the choice of attributes and levels for the CA. Reciprocally, the results derived from the CA then help to reframe the problem and provide a clear focus for the discussion in the second feedback loop. This iterative process allows for an arrival at firm conclusions. The interplay of the two approaches implies that they in fact share many qualities as part of research and are both

constructive because they create data, and mutually constitutive, reflecting the interplay between words and variables (Cupchik 2001).

Thus *constructivist realism* is a stance that recognizes that social phenomena exist independently of researchers even though we cannot ever claim to have unmediated access to such a reality. When researching the phenomenon, qualitative methods provide a basis for thick descriptions (Geertz 1973). Quantitative methods, in this case CA, yield insights through presenting stimuli to relevant groups. The resulting statistics provide further facts on the underlying processes. Statistically significant effects then lead to socially meaningful events that are re-examined in depth. So the combination of descriptive richness and experimental precision can bring research of social phenomena to higher levels of clarity.

The paradigms also influence how tests for establishing validity and reliability are conducted (see Table 1). An in-depth and rigorous analysis rooted in constructivist realism needs to apply tests from both realism and constructivism (see Table 1). In the realism-oriented, generally more quantitative aspects of research, we apply the concepts of construct, internal and external as well as reliability in order to assess the research outcome. Similary, we use tests for confirmability credibility, transferability and dependability to gauge the level of confidence we may apply to the more constructivist-oriented parts of the research project. Different techniques apply to the different loops of the research. However, tests that are "confirmatory" are final in neither the realist nor the constructivist paradigm as they may always be falsified at a later stage, they are thus tentatively corroborated hypotheses.

CA experiments are generally single or multiple case studies of the mixed method research type: attributes and levels are obtained by qualitative methods while the preference data elicitation survey is quantitative. In the past, a strong focus has been given to the statistical analysis of the choice data (Backhaus et al. 2003). Due to this focus, CA is seen as quantitative method and validity and reliability have been tested with tests originating in realism (see Table 1). However, as we have outlined in the introduction, CA has recently been applied to a broad field of research questions, and qualitative methods are introduced into research designs working with CA (e.g. for the generation of attributes and levels or for discussion of results). In light of this recent development, Gallardo and Chang (2010) argue that controlling for context and dataset structure are essential and both internal and external validity criteria need to be incorporated into any conjoint analysis in order to establish validity of results. There are different methods for in-sample criteria that measure internal validity. The most common variants are aggregate-level market share predictions, individual-level predictions of purchase intentions or individual-level predictions of actual behavior (Ding et al. 2005; Gallardo and Chang 2010; MacLachlan et al. (1988); Orme et al. 1997). Wind and Green (2002) as well as Rao (2008) note that these methods generally represent cross-validation tests. Louviere et al. (2010) also argue that these tests merely measure test–retest reliability and prediction shrinkage. Thus only the tests from the right-hand side of Table 1 are applied.

In the research design phase of any conjoint study, the selection of attributes and levels plays a key role. Louviere et al. (2010) therefore argue that especially external validity encompasses the selection of attributes and levels as well as the preference elicitation technique in the survey. The identification of attributes and levels ranges from different types of direct questions (Weiber and Mühlhaus 2009) to comparably sophisticated methods such as the Repertory Grid Method (Kelly 1955). However, none of the methods require multiple loops, incorporating feedback between the research stakeholders that allow the application of replication logic. Thus external validity cannot be generally assumed (Louviere 2006; Louviere et al. 2010).

Table 1 Predominant criteria for evaluating validity and reliability in realism and constructivism (Yin 1994; Easterby-Smith et al. 2002; Riege 2003; Denzin and Lincoln 2005)

Realism (Lincoln and Guba 1985; Scholz and Tietje 2002)			Constructivism (Berger and Luckmann 1966; Riege 2003) (Stake 1995; Yin 1994; Eisenhardt 1989)		
Concept	Definition	Possible questions for assessment	Concept	Goal	Possible questions for assessment
Construct validity	Refers to the extent to which an instrument or method measures the theoretical entity that it was designed to measure	Can we build hypotheses from theories that may be falsified or tentatively corrobated through the test results? How do the relevant measures empirically correlate with theoretically irrelevant measures?	Confirmability	Assesses the extent to which the conclusions are the most reasonable ones obtainable from the data	Are the study's general methods and procedures described explicitly and in detail? Has an adequate integration of views taken place? Are study data retained and available for reanalysis by others?
Internal validity	Is assumed if a causal statement can be made about the effects of experimental conditions manipulated or altered on dependent variables or other conditions	Do the results clearly speak for or against the hypothesis? Are alternative explanations inplausible? Are samples truly randomized selections?	Credibility	Demonstrates that the inquiry was carried out in a way which enhances credibility	How rich and meaningful are the descriptions? Are the findings internally coherent? Are concepts systematically related?
External validity	Refers to the generality of a finding, such as an effect of a cause-impact relationship and to what degree this finding or effect can be generalized to other populations, settings, situations, cases, etc	Does the operational measure the right thing? Is our sample representative to the ground population? Do participants behave as they normally do?	Transferability	Is achieved when the research shows similar or different findings of a phenomenon amongst similar or different respondents (thus achieving analytical generalization)	Do the findings include enough thick descriptions for readers to assess the potential transferability appropriateness for their own settings? Are the findings congruent with, connected to, or confirmatory of prior theory?

Table 1 continued

Realism (Lincoln and Guba 1985; Scholz and Tietje 2002)			Constructivism (Berger and Luckmann 1966; Riege 2003) (Stake 1995; Yin 1994; Eisenhardt 1989)		
Concept	Definition	Possible questions for assessment	Concept	Goal	Possible questions for assessment
Reliability	Defined by the degree to which a finding is independent from accidental characteristics of the research	Are the results independent of the sample selection? Do we have systematic drop-outs from the sample? If we randomly split the sample, do we get the same results for each subsample?	Dependability	Assess stability and consistency in the process of inquiry	Are the research questions clear and are the features of the study design congruent with them? Have things been done with reasonable care?

We have outlined the definitions of validity and reliability within constructivist realism. In the next section, we will see that constructivism is also a cornerstone of feedback-driven exploration.

Feedback-Driven Exploration

Definition

The concept of FDE as defined by Schwaninger (1996) denotes a research design by which continual feedback "mechanisms" between researchers and any other party involved into the research process (e.g. industry representatives, respondents, clients) are installed as integral parts of exploratory research projects, thus knowledge systems are put into relation (Scholz 2011). The purpose of this architecture is to increase the general quality of the research, namely its validity and reliability. It is thus an explorative and pragmatic approach to explore the broad fields of theories and to gain insights that valuably contribute to practical applications (Türke 2008).

FDE entails a circular structure of the process of inquiry in the sense of an evolution of collective interpretations and the emergence of shared meanings. This can entail a successive increase of mutual understanding and mutual learning, e.g., about the aims of the research and the interpretation of its results. In addition, it can lead to an evolution of concepts in the process of exploration. At the same time this process structure, via interaction and synergy, leads to a maximization of the knowledge available in the research process.

The integration and analysis of research, expert and respondent views overcomes the limitations of unilateral perspectives. It leads to a productive interaction that fosters a better understanding and therefore a more in-depth modeling of the relevant reality related to the research questions. Going further, feedback-driven exploration reframes certain epistemological principles. The traditional view considers researchers' subjectivity, and

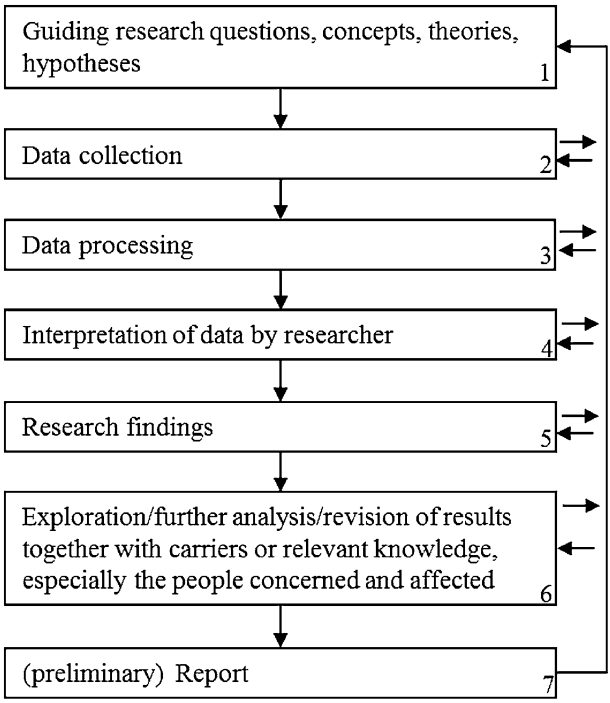

Fig. 2 Overview on FDE (Schwaninger 1996)

reactivity (the effect of the research setting on the respondents) severe drawbacks, to be avoided at (almost) any price. In the constructivist framework adopted here, subjectivity becomes a productive element, leading to a richer model through a discourse that is nourished by different perspectives, values and concerns.

Applying feedback-driven exploration to a research design includes the following steps:

(i) Shape guiding research questions, concepts, theories, hypotheses.
(ii) Collect and process data.
(iii) Interpret and reflect on data (researcher, possibly with data providers).
(iv) Report tentative research findings to data providers (e.g. survey respondents, interview participants) and broadly review, discuss and explore results with research stakeholders to arrive at overall conclusions,
(v) Intermediate or preliminary results may indicate a need of getting back to earlier phases of the research process, or even of adjusting concepts, theories, hypotheses, and starting the process anew.

Steps (i) through (v) may be carried out through several iterations ("loops"), depending on the research questions (see Fig. 1). It is of great importance to clearly follow through with all steps in order to minimize both ambiguity and ambivalence (Scholz 2011) (Fig. 2).

Underlying Assumptions

FDE is based upon three building blocks,—the concepts of feedback, construction and exploration. The first is the concept of *feedback* as developed by Rosenblueth et al. (1943).

Wiener (1954) defines feedback as the control of a system (e.g., a machine, an organism, a social system or process) on the basis of its actual performance rather than its expected performance. Feedback is thus a mechanism, process or signal that is looped back unto itself. The feedback processes in FDE allows to construct a shared reality between researchers and the people researched/observed (von Förster et al. 2003). Human beings are susceptible to feedback because we are able to sense feedback from the environment and adapt our behavior accordingly in order to function within systems. We constantly send and accept messages from the environment and alter our behavior in order to remain socially accepted. Wiener (1954) identifies a structural invariance in that people are capable of processing and interpreting feedback the same way as other kinds of systems. For complex relationships, Watzlawick et al. (1967) state that interpersonal systems may be viewed as feedback loops, since the behavior of each person affects and is affected by the behavior of each other person.

This corresponds to the *constructivist view*,—the second building block of FDE. In realist constructivism, a reality is constructed through an individual or social process. In the social context, constructivism entails processes of the joint construction of shared models and realities, generated by the interaction of different perspectives (von Förster et al. 2003). The constructivist base of FDE is the key difference to the traditional approach to triangulation, which is rooted in realism given its premise of an objective reality (Denzin and Lincoln 2005). Triangulation integrates methods, while FDE goes further, integrating perspectives through iterative discussions and interviews, revisiting issues several times with different research stakeholders at different research stages. Additionally, FDE builds a general framework which encompasses all steps of a research project, whereas triangulation is generally limited to the data collection and interpretation phases.

The third building block of FDE is the aspect of *exploration*. Thus the key focus is not on hypothesis testing, but on the development of new hypothesis and thus FDE is not grounded in the principle of hypothetico-deductivism (Musgrave 2011). In many of the new fields to which conjoint analysis is applied, as discussed in "Introduction" section of this study, decision processes are explored and new propositions are evaluated. This shift from the prediction of products to a focus on understanding human and societal choice processes implies a lessened emphasis on the testing of hypotheses and a stronger emphasis on broadening the understanding of processes through exploration.

Limitations

FDE has two main limitations. As FDE demands continual participation of several stakeholders, stakeholders might try to dominate the research process. The communication established through a research design implementing FDE might be misused by participants in order to impose their version of the research object. However, as FDE is consistent with the foundations of transdisciplinary research, thus mutual influence and learning is part of the process. A second limitation to FDE is time. Compared with traditional CA, more time is required to operate the feedback loops in interviews and discussions.

Applications

Based on the concept developed by Schwaninger (1996), several authors have published research applying feedback exploration to a broad field of academic research ranging from governmental issues to the analysis of dilemmas in management. Fontin (1997) explores multi-personal decisions when faced with dilemmas and paradoxes that often occur in

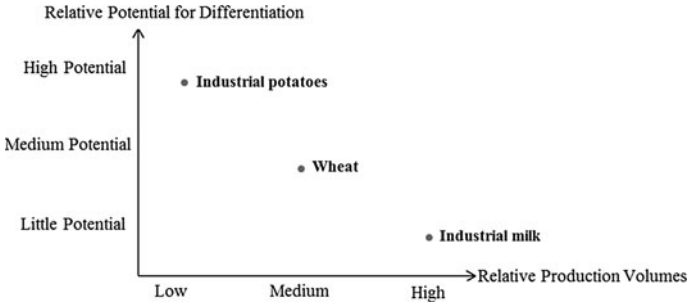

Fig. 3 Potential for differentiation and production volumes of markets for primary agricultural products

management positions, but at first appear to be irresolvable. Applying FDE to these questions allowed for a broad discussion between managers and researchers, revisiting issues several time for an in-depth analysis. Without the several loops, both researchers and managers felt that results would not be of the same quality, mainly due to the fact that closer relationships and trust has been built between the various stakeholders in this research project (Schwaninger 1996; Fontin 1997). The same holds true for the research conducted by Oesze (2000) as well as Schedler and Oesze (2000) on the performance management of public administration departments. In order to sustain practicability and applicability of research results, several loops between researchers, experts and respondents have been built into the process, thus implementing FDE. Koerner (2002) uses FDE to investigate transformation processes triggered by e-service in after-sales-management and possible gains and risks of transformation processes for both supplier and customers.

In the past, CA—the domain of social research methodology which is in the focus of this contribution—has not made use of research designs based on FDE. In the following case studies, we discuss benefits and limitations of FDE in the context of CA. This is done by conducting a multi-case study of three CA experiments in the Swiss markets for the primary agricultural products industrial milk, industrial potatoes and wheat. We thus look at preferences of processing companies for attributes of primary agricultural products such as milk, potatoes and wheat and aim at assessing the value of FDE.

Case Studies

Three case studies have been selected for this multi-case study as to represent *maximum variation* within *purposeful sampling* (Eisenhardt 1989; Scholz and Tietje 2002). So the choice for each case (see Fig. 3) has been made such that it either predicts similar results for predictable reasons or produces contrary results for predictable reasons (Yin 1994; Eisenhardt 1989).

The primary practical concern of the case studies was to evaluate processors' preferences in order to possibly assess differentiation potential based on product attributes for primary products within the Swiss food chains. As the second intention of the study was to address standard markets rather than niche markets, case studies have been as to represent different standard markets within agricultural production in Switzerland.

We choose three markets for the case studies: Industrial potatoes, industrial milk and wheat. In 2011, the production of milk accounted for 21 % of the total agricultural

production, thus being the largest production sector in Swiss agriculture. Of these 21 and 58 % is industrial milk, i.e. milk that is processed into products other than cheese, e.g. yoghourt, fresh milk or milk powder (SMP 2009). Industrial potatoes accounted for 2 % and wheat for 4 % (BLW 2011). All case studies have been conducted between May 2011 and May 2012. Switzerland has a total of 59,959 farms, of which almost half (totaling 27,131) relies on milk production as the main source of income (SMP 2009). 6,100 farms grow potatoes (Swisspatat 2010) and approximately 20,000 produce grains (Peter et al. 2009).

In the following, the three case study markets are briefly discussed.

Case A: The Swiss Market for Industrial Milk

In 2009, 27,131 milk producing farmers sold 3.4 mio tons of milk (SMP 2009), that are then turned into cheese (41.9 %), butter (16.7 %), fresh milk (12.5 %), yoghurt (3.4 %) and other dairy products. Prices for industrial milk range between 0.68 Swiss Francs and a guaranteed minimum price of 0.23 Swiss Francs (BO-Milch 2011). The market shows oligopsonic structures, and supply exceeds demand. The sector of industrialized milk products (tariffs and technical barriers) is still closed, but expected to be opened during the next years as free-trade negotiations have started between Switzerland and the European Union. Due to the lower price level in the neighboring countries, further market pressure for price decreases is expected and farm incomes are threatened. Differentiation based on milk attributes is thus currently widely debated as a possible source of income increase. With just five processing companies sharing 87 % of the Swiss industrial milk market, knowing consumers' preferences is essential for producers aiming at differentiation based on product attributes.

Case B: The Swiss Market for Industrial Potatoes

The Swiss market for industrial potatoes (production of fries, flakes and chips) comprises 6,100 producers. The five processing companies in this market buy a total of 148,066 tons of domestic potatoes (Swisspatat 2011b). 61 % of these are processed into frozen products, 22 % into canned products, 15 % into dried products and the remaining 2 % are fresh products (Swisspatat 2011a). Trade tariffs and price differentials to other countries limit imports to 22,250 tons and exports to 1,656 tons (EZV 2010). Market activities such as choices of variety, quantities or prices at the farm gates are coordinated by all members of the value chain in close collaboration. As a consequence, contrary to the milk market, the market for industrial potatoes is generally characterized by an equilibrium of supply and demand.

Case C: The Swiss Market for Wheat

The market for wheat consists of 20,000 producers and 48 milling companies with capacities higher than 500 tons per year. The four largest companies (milling capacities of over 300,000 tons per year) have a market share of 67 %. In 2009, a total of 482,798 tons of wheat has been processed into 382,583 tons of flour. Additionally, 70,000 tons are imported through quotas (Bergmann et al. 2009). Prices for Swiss wheat are, at the farmgate, approximately 2.5 times higher than prices for comparable wheat qualities in Germany (BLW 2010) so pressure for decreasing prices are high. The value chain is

Table 2 Comparison of case studies (SMP 2009; Swisspatat 2011a; Swissgranum 2011)

Dimension	Case A: industrial milk	Case B: industrial potatoes	Case C: wheat
Number of processing companies in the market	12	5	48
Coordination system	Newly founded joint association of producers and processors, traditional producers association	Traditional joint association of producers, processors and retail	Joint association of processors and producers, individual contracts between producers and processors
Degree of collaboration between market participants	Low	High	Medium
Numbers of processing levels until good is sold to final consumer	One: Milk → yoghurt, butter, fresh milk, specialties	One: Potatoes → chips, fries, flakes	Two: Wheat → flour → cereals, bread, frozen, durable products
Online survey recipients	10 Companies processing industrial milk	5 Companies processing industrial potatoes	40 Companies processing wheat
Survey response rate	50 %	100 %	32 %
Availability of literature on buying decision of processors	Plenty of literature available	Little literature available	Average amount of literature available

Table 3 Overview of stakeholders

Name	Definition	Role
Research group	Group of four academic researchers leading the research study	Definition of research design, conduct of study
Field group	Group of eight field representatives working for companies sponsoring the research project	Members of the working group and contacts to industry
Working group	Researchers and field group	Discussion of steps and results in pre-defined loops
Industry experts	People working in the industry; neither members of the working group nor respondents	Qualitative interviews for the assessment of attributes and levels as well as discussion of results
Respondents	Respondents of the survey: Representatives of case study companies; neither members of the working group nor industry experts	Survey participants
Company	A company in the context of this study is a processing business active in one of the case study industries	Framework of case studies, relevant sample size

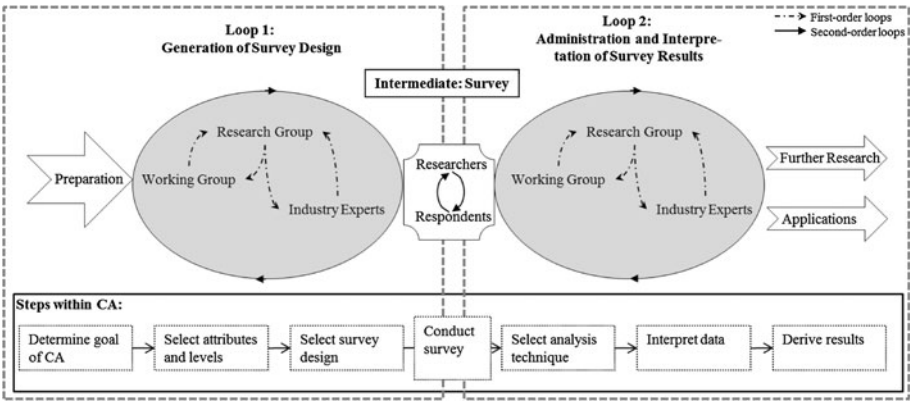

Fig. 4 FDE at the stages of a CA as applied in the case studies

organized in a similar fashion as the potato value chain. Wheat production quantities and prices are worked out in close collaboration of all members of the value chain.

Table 2 compares and contrasts the three case studies. We focused on differences that influence the procedures and results of FDE within the respective CA.

Methodology

We first discuss the general methodology. We then proceed to illustrate the method by discussing the case studies.

We conducted the case studies using the adaptive choice-based conjoint approach and parameters are modeled using Hierarchical Bayes Estimation (for further information on the modeling and discussion, see Boesch 2012). The survey was administered online and distributed to all companies processing industrial milk, potatoes or wheat (see Table 2 for an overview of the case studies). The main questions in the survey relate to how processors value attributes such as country of origin, quality or business relationships to producers within their supply chain management (Boesch 2012).

As described in "Validity and reliability" section, FDE requires participation of different people, both in- and outside academia. Table 3 broadly defines the relevant stakeholders and their role in the research process. Within all groups, participants are defined as people investing more than 1 day into the research studies. Other than the working group (which consists of the researchers and the field group), groups are disjunctive.

The relationship between the main stakeholders, the field group and the research group is characterized as *cogenerative style of action research* within transdisciplinary research (Scholz 2011). Thus both groups are responsible for problem definition and give mutual feedback. The working group members have participated in all three case studies. Industry experts have varied as they have participated only in the case study within their respective industry. It is important to note that all interviews are conducted through members of the research group.

A stylized version of the procedure, which is conceptualized following the logic of FDE, is shown in Fig. 4. Two second-order loops are implemented in the research process. The first loop has a qualitative character with the purpose of defining appropriate attributes

Table 4 Phases of the CA

Loop	Phase of CA	Procedures	Participants
1	Determine goal of CA (leading research question)	Discussion within the working group	Working group
	Select attributes and levels	For each case study, three qualitative interviews with industry experts were conducted; results are then discussed within the working group	Working group, industry experts
	Select survey design and prepare survey	The survey is selected to be administered online, with verbal description of choice tasks. Pre-tests are carried out	Research group
2	Select analysis technique	Adaptive choice-based conjoint analysis with Hierarchical Bayes estimation is selected	Research group
	Interpret data	Preliminary results are compiled in a report by the research group, three qualitative interviews with industry experts are conducted for each case study, and final results are discussed within the working group	Working group, industry experts
	Derive results	Possible differentiation strategies for each product and recommendations for market participants are discussed and evaluated based on the results of the CA	Working group, industry experts

and levels for the survey as well as choosing the survey design. The survey itself is considered an intermediate stage of the research. In the second loop, which is more quantitative, the survey data is collected and evaluated. Within each of these two higher-order loops, first-order loops between the research group, the field group and the industry experts are implemented.

In the first loop, steps 1 through 7 are implemented according to Fig. 2 and Table 4. The leading research questions are defined by the research group and then discussed with the working group. Data collection, meaning the collection of attributes and levels influencing the buying decision of processors, is followed by qualitative interviews with industry experts. The interviews are transcribed and evaluated by the research group. The findings, attributes and levels, are detailed in a report and discussed within the working group. These discussions focus on debating different interpretations and on arriving at a consensus that allows to create the survey. Points of dissent are carried forward to loop two and are discussed in the final report. The last step of the first loop consists of the compilation of the survey, thus preparing for loop two.

The intermediate stage is mainly composed by the administration of the survey, thus interaction between respondents and the research group occurs. Data processing in the second loop consists of preparing survey data for analysis. After interpretation of the results through the research group, the findings are gathered and discussed with industry experts. A preliminary report is then prepared and discussed with the working group.

Procedure in Loop One

The initial phase of the research project has included several meetings of the working group with the goal of establishing the leading research question so as to maximize both

academic and practical value of the research in focus. For the industrial milk case study, much information on the buying decisions of processors is available in the literature. Therefore, the interviews with industry experts have largely been used to discuss the literature review and to evaluate the attributes and levels for the survey. The discussion within the working group has not yielded considerable new evidence so the first loop has been relatively predictable. This was different in the industrial potato case study. Little literature is available on the key drivers of the buying decisions of Swiss potato processors. The interviews with the industry experts have therefore been the main source of information for attributes and levels. The interviews have been transcribed and the research group compiled a report with the attributes and levels going into the survey. When discussing the attributes with the field group, they strongly expressed their opinion of the attributes focusing too much on technical aspects such as starch content or starch distribution within the potato. Additionally, the field group felt that environmental and social aspects of the buying decision were under-represented. As a result from the discussion, the research group has re-visited the transcriptions of the expert interviews and conducted additional interviews. In the opinion of the working group, the list of attributes and levels has then been significantly improved. The third case study, the wheat market, has benefited from being the last in the line. Thus, many insights have been transferred from the first two case studies. Additionally, the expert interviews and the discussion with the working group have shown that processing within the wheat industry comprises two levels, thus expert interviews have to be arranged for at both levels in order to adequately discuss the results.

Procedure in Intermediate Stage: Survey

The administration of the survey has been conducted in close collaboration with the respective industry organizations which have supplied addresses and contact persons. All the survey participants have also been asked whether the survey is focusing on the question at hand or whether there is additional information that needs to be taken into account when looking at differentiability of primary products. This information was used to structure the qualitative interviews in the second loop.

Procedure in Loop Two

Data processing in the second loop primarily means statistical analysis of the choice data obtained by the survey using HB estimation (for theoretical details and application, see Allenby and Rossi 2008; Boesch 2012). The preliminary results are then discussed with industry experts to closely evaluate the underlying decision mechanisms. These interviews have proved to be of great value to the interpretation of the survey results, especially in the wheat case study with its complex two-stage processing. After transcribing these interviews and integrating the results into a preliminary draft of final report, a discussion with the working group takes place. In all three case studies, the discussion of the results with industry experts has allowed insights into the decision process, incorporating soft factors such as the influence of communication or interaction between market participants. This is especially true for the relatively large market of wheat. For the potato case study, these discussions have shown the importance of the sales channels on the buying process. Contrary to the final meeting of the working group in the first loop, the meeting in the second loop primarily serves information purposes and further clarifies research results. As the working group oversees all case studies, they play a crucial role in comparing and contrasting results between case studies.

Table 5 Techniques of FDE that benefit CA validity and reliability, based on phase of research

Benefit of FDE to	Phase of Research			
	Research design	Data collection	Data analysis	Report writing
Construct validity and Confirmability	Use of multiple sources of evidence Establishment of chain of evidence		Confirmability audit	Stakeholders review draft reports
Internal validity and credibility		Triangulation Researcher self-monitoring	Assurance of internal coherence of findings and concepts being systematically related Triangulation Explanation-building Peer-debriefing Researcher self-monitoring	Member check
External validity and transferability	Definition of scope and boundaries of reasonable analytical generalisation for the research		Comparison of evidence with literature Cross-case analysis	
Reliability and dependability	Dependability audit	Recording of observations and actions Use of case study protocol	Use of peer review/ examination	Development and refinition of case study protocol

Differences Between the Case Studies

In Table 2, differences between case studies are shown. As expected, these aspects played a significant role in the proceedings and results when using FDE. In the case study for industrial milk, the first loop went exceptionally well, so we expected survey response rate to be high. When it turned out to be rather low, the feedback given by the respondents as to why they did not want to participate, helped understand the decision mechanisms. The Swiss milk market is currently strongly exposed to market and regulatory pressure, so companies were more wary of participating in scientific studies that are published than expected. When compiling the list with attributes and levels for the survey in the potato market, we felt confident to have grasped and adequately pictured the complexity of the buying decisions made by processors. As the literature on the Swiss potato processing industry is scarce, the three qualitative interviews have been crucial and industry experts have been heavily drawn on for their knowledge. However, the working group strongly felt that technical attributes were over-represented. This would have led to an over-statement in the final results. So we re-visited this issue with industry and academic experts and significantly changed the list of attributes and levels. Contrary to the results in the milk market, the survey response rate in the potato study reached a 100 %. We feel that this is due to the close collaboration and significant trust between market participants. When conducting the wheat case study, loop one proved to be less challenging than loop two. As the wheat industry consists of two levels of processing, the number of views expressed by

the stakeholders is more diverse than in the other case studies. Not all points of dissent could be resolved in the iterative discussions, so the working group has eventually decided which attributes to take into account for the survey. However, the issues were revisited with the industry experts in the second loop and survey results were discussed also in light of the attributes not chosen for the survey. In a situation with dissent, it proved to be of great value to have implemented loops with industry experts from both levels.

Results

In this section, we will highlight results from applying the FDE research design to CA with regard to validity and reliability. Yin (1994), Easterby-Smith et al. (2002), Riege (2003) and Denzin and Lincoln (2005) define a framework for an investigation of the methodological rigor of case studies leading to enhancing validity and reliability as defined in Table 1. In this section, we discuss results of applying FDE to CA in the context of this framework and illustrate the benefits of FDE to validity and reliability of CA. *Error! Reference source not found* presents a summary of the key arguments, structured according to type of validity and research phase within the CA (Table 5).

Construct Validity/Confirmability

We aimed at measuring preferences of processing companies for attributes of the primary products industrial milk, industrial potatoes and wheat. The logic of FDE was used in several respects. By bringing together the working group to broadly discuss the research goal, the existing literature and methods as well as procedures, we were able to define a guiding research question in a balanced collaborative process and to confirm that the results of the preference analysis are functional with respect to the research question from both an academic and an industry perspective. Additionally, the qualitative interviews with industry experts, in the first loop, gave valuable insights in what attributes and levels need to be considered for preference measurement. In the second loop, feedback from industry experts and the field group gave valuable insights and affirmation that the complete picture with regards to the main attributes and its importance for the buying decision has been obtained. Especially the interviews with the industry experts allowed for a deeper understanding of the choice processes of the market participants. Applying FDE also requires thorough note-taking on behalf of the research group, thus study data are retained in chain of evidence and available for reanalysis by others.

Internal Validity/Credibility

Our research design goes beyond triangulation as suggested by Riege (2003). Views rather than data or methods are triangulated, thus improving internal validity as compared to working with traditional approaches to triangulation. In the case studies, this has been done through joint discussions with all research stakeholders after loops 1 and 2 and again at the end of the research. Also, recurring issues have been re-visited through interviews with available survey respondents. For example, one such issue has been the role of prices and origin as these may seem to be "umbrella attributes" that contain expectations and assumptions of buyers about the exact qualities of the primary products. Additionally, FDE includes member check techniques and peer debriefing techniques as defined by Riege (2003). This is done by presenting the steps of data analysis to the working group and

presenting findings and conclusions to the industry experts and the working group and taking their reaction into account. Thus findings are internally coherent and causal statements can be made about the effects of altered conditions manipulated on the dependent variables.

External Validity/Transferability

Both the first and the second loop contain a thorough discussion within the working group and thus benefit external validity. In these discussions, the aims and scopes of the respective research phase are debated so that reasonable analytical generalization is established through FDE. Additionally, the three interviews with industry experts in both the first and the second loop allow for comparison of evidence with the extant opinions and knowledge. So findings may be cautiously transferred to other markets for primary products within Switzerland and to foreign markets that exhibit similar purchasing behavior and preferences within the food chain.

Reliability/Dependability

The adoption of FDE can be seen as a way of safeguarding against researcher's theoretical position and of being consistent with a constructivist realism position through the participation of other stakeholders in the research process. Additionally, the three qualitative interviews in both loops serve as tests for the structure and logic of the research and the resulting interpretation. The use of a research group of four people further encourages communication and discussion about methodological issues. The working group also serves as a review and examination body for the research. Reliability is thus enhanced by our FDE research design.

The multi-case study approach has proven to be of value in several regards as it has shown that insights from using FDE occur at different stages of the research. In case studies with limited availability of literature, the first loop yields significant information necessary for the generation of the survey. So FDE is well suited for projects in other research fields of interest. In highly complex case studies with many different groups of stakeholders, the feedback from the interviews with field experts in both the first and the second loop allow that their insights become an integral part of the subject. Thus the shared reality is constructed working with more of the relevant perspectives.

In this section, we discussed results of a FDE research design on validity and reliability. We will conclude our study with an overview on the key findings, limitations of our study and an outlook on suggested further research.

Conclusion

A crucial aspect of enhancing validity and reliability in conjoint analysis is to recognize that interpretations and results will be viewed differently from the multiple perspectives of the different stakeholders involved. In the proposed framework, perspectives and opinions are iteratively discussed through interviews and meetings among the different research stakeholders in order to reach a consensus. Re-visiting issues at a later stage has often proved very useful in resolving differing perspectives. If consents cannot be achieved, the dissent in perspectives has to be described in detail in the final report of any research. Validity thus requires all of these perspectives to be taken into account while accepting that

any single perspective has its limitations. In this study, we suggest applying FDE, a concept developed by Schwaninger (1996), for use in organizational and sociological research. FDE leverages the interaction between a working group, researchers and industry experts throughout the research process. It enables error-correcting "mechanisms" and therewith an improved quality of the research results. The emphasis of the research design is on the process of knowledge growth and knowledge integration rather than on a discrete end result to be achieved at a single point in time. The joint construction of knowledge leads to an iterative process in which interpretations are scrutinized and shared meanings, as well as a joint understanding, evolve. The triangulation of research, expert and respondent views not only transcends unilateral perspectives, but is at the core of a validation process which converges toward better concepts, clearer interpretations and ultimately more valid results: all three discussed aspects of validity as well as reliability grow, as has been shown in respect of the context of conjoint analysis.

The suggested procedure yields results that are widely accepted and possess a high degree of validity and reliability. Additionally, it also yields a considerable amount of information not generally obtained by rigid quantitative exploratory analysis. The knowledge of soft factors influencing a buying decision or interaction effects on product or company levels is greatly enhanced. Especially insights about market interactions with their various determinants can be integrated into the final results, through a qualitative discussion with industry experts and the working group, after compiling CA results. The research design proposed here opens new vistas beyond an immediate decision outcome, namely on the whole decision building process. The implication is a richer outcome of the studies, showing both higher validity and reliability as well as deeper insights.

In response to the research questions, we conclude that FDE can establish a guideline for conducting methodologically rigid conjoint analysis experiments. FDE provides a rigorous methodology in order to increase validity and reliability of results. It especially contributes as it suggests a general framework and traceability at all stages of the research. Additionally, the feedback loops in the participative process as well as the cogenerative relationship of the working group members enhance acceptance of the research within the industry, leading to a more thorough discussion of results.

Based on constructivist realism and transdisciplinarity, different stakeholders participate in all stages of the research, offering not only different views on results and interpretations, but also on research design and methods. This leads to results that are more closely related to industrial practice. Transdisciplinarity goes beyond science in the sense that it allows to deal with complex societal problems and processes that relate knowledge and values of people from the scientific and the non-scientific world. Two issues inherent to transdisciplinary approaches are power sharing and the direction of involvement. Thus transdisciplinarity has been invoked e.g. through the fact the research questions have been defined not within the research group, but within the working group and that the research process works iteratively, i.e. going back and forth between research stakeholders, discussing and resolving issues.

Limitations of the study derive from the low number of cases. Eisenhardt (1989) and Yin (1994) propose a multi-case study with four or more cases. Due to time and resource requirements, this could not be entirely fulfilled. Additionally, our study is a first exploration of a FDE research design within conjoint analysis. Further studies are necessary to establish the merits of this approach to other settings of CA studies. As discussed in "Validity and reliability" section, statistical measures for internal validity and reliability exist (Louviere et al. 2010; Gallardo and Chang 2010; Rao 2008). The impact of FDE on such measures has not yet been studied, but is suggested for further research. However, as

FDE encompasses all stages of a CA, including data collection and data analysis, we feel that statistical measures are improved through the research design proposed here.

While we have demonstrated the benefits for conjoint analysis, FDE may be applied to a broader field of research. However, especially fields with scant literature or prior knowledge regarding the key drivers of human decisions, benefit from the feedback in the two loops. This holds especially true for all kinds of decision analysis processes in business-to-business or business-to-consumer environments: data on the decision making processes of companies tend to be scarce, and this gap may be closed by means of interviews as proposed in our framework. Additionally, we expect the benefits of FDE to also prevail in other methodological settings using mixed research methods.

The thorough qualitative discussion resulting from FDE possibly allows for smaller sample sizes due to wide array of qualitative information that is captured through the research process. However, statistical generalization might then not be concluded. This should be studied further. The measures of validity and reliability discussed here are applicable in contexts of both the realism and the constructivism research paradigm. However, we feel that a further discussion of the two paradigms in the context with regard to CA would yield considerable insights. Additionally, we propose discussing the application of FDE to other methods within preference analysis, such as contingent valuation or cluster analysis.

Finally, we conclude that while the implementation of FDE might be more time-intense than traditional triangulation methods, the benefits to validity and reliability prevail in both the preparation and the interpretation of a CA experiment.

Acknowledgments This study was supported by fenaco, the Swiss Milk Producer's Association and the Swiss Farmers Association. The usual disclaimer applies.

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