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Preferences for Attributes of Industrial Potatoes: An Empirical Investigation of the Swiss Market

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Abstract Managing the transition from a commodity to a differentiated good in an increasingly liberalized, price-driven world is a challenge for Swiss producers of potatoes. To facilitate this process at the production level, knowledge about preferences in terms of product attributes is needed. We evaluate processor preferences regarding potato product attributes such as price and country of origin. Attributes are selected according to their influence on the buying decision of the processors. Additionally, we quantify the relative importance of product attributes for the main market segments chips, fries, and flakes. By applying a discreet-choice experiment with Bayesian estimation of individual part-worth utilities and randomized first-choice models for scenario analysis, we find that color, size and producer price determine 46 % of the buying decision. However, while price is an important decision criterion, product and supplier criteria can be used to segment the market if the price premium is held within limits and size and color requirements are met.

Resumen El manejo de la transición de un producto básico a un bien diferenciado en un mundo liberalizado en aumento, orientado hacia precios, es un reto para los productores Suizos de papa. Para facilitar este proceso a nivel de producción, es necesario el conocimiento acerca de las preferencias en términos de los atributos del producto. Evaluamos preferencias de procesamiento relacionadas a los atributos del producto papa, tales como precio y país de origen. Los atributos se seleccionan de acuerdo con su influencia en la decisión de compra de los procesadores. Adicionalmente, cuantificamos la importancia relativa de los atributos del producto para los principales segmentos del mercado, papas fritas, a la francesa y hojuelas. Mediante la aplicación de un experimento de selección a discreción, con estimación Bayesiana de utilidades de partes individuales valiosas y de modelos al azar de primera selección para análisis del escenario, encontramos que el color, tamaño y precio del productor, determinan el 46 % de la decisión de compra. No obstante, mientras que el precio es un criterio importante de decisión, los criterios del producto y de su proveedor pueden usarse para segmentar el mercado si se mantiene el precio de cotización dentro de los límites y se cubren los requerimientos de tamaño y color.

Keywords Potato · Conjoint analysis · Hierarchical Bayes estimation · Switzerland · Food processing

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Introduction

Potatoes have traditionally held an important role in Swiss crop production due to their position in the crop-rotation system and their foothold in consumer preferences. However, potato production has decreased from roughly 900,000 t in the 1980s to around 450,000 t in the late 1990s and has remained stable since (swisspatat 2010). The historic decrease is mainly due to higher quality requirements by processors and lower demand for table potatoes, resulting in lower producer revenues. Thus producers have decided to discontinue potato farming. Further pressure is recently placed upon Swiss potato producers by the prospect of an agricultural free-trade agreement between Switzerland and the European Union that would liberalize the highly protected potato markets. Imports are currently restricted to 22,250 t per year following the WTO trade agreements that

specify an import quota of 5 % of average domestic consumption in the years 1995/1996 (swisspatat 2011a, b).

Swiss potato consumption per capita amounts to 45.5 kg (swisspatat 2010), which is less than half of the European average of 96.1 kg. With 45 % of potatoes being consumed as processed products, Switzerland is within the average European range of one to two thirds of potatoes being consumed in a processed state (Keijbets 2008; swisspatat 2011b; CEC 2007; Haase and Haverkort 2006).

On average, producer prices for Swiss potatoes are twice the amount of their counterparts from the European Union. So in order to remain in the market and keep both sales and margins at a reasonable level, producers need to know which attributes of potatoes are most relevant to both processors and consumers and, thus, what drives their buying decisions. In this paper we aim to provide an insight into the preferences and buying decisions of processors. This knowledge is relevant to producers and producer associations when designing strategies to ensure future market shares and to perhaps differentiate in order to develop a price mark-up strategy.

The main research objectives are threefold: (a) product attributes that drive the buying decisions of processors are collected through literature reviews and interviews; (b) the relative importance of these product attributes to processors is quantified through a survey using conjoint analysis; and (c) market segments (chips, fries, flakes) are explored for their potential for differentiation based on segmentation along product category lines.

The research is carried out through a triangulation of literature reviews, qualitative interviews, and a quantitative survey, following Schwaninger (1996). Preferences are evaluated through the use of adaptive choice-based conjoint analysis (Orme 2009a) based on the work of Train (2009), McFadden (1974), and Louviere and Woodworth (1983). In combination with Hierarchical Bayes (HB) estimation, Adaptive choice-based conjoint analysis delivers valid and reliable results in cases with small sample sizes due to small markets (Orme 2009c; Allenby and Rossi 2008).

The Swiss Market for Industrial Potatoes

In 2010, 5700 farmers produced a total of 148,066 t of industrial potatoes (potatoes used for processing, as opposed to table potatoes), 29 % of the total potato harvest (swisspatat 2011a). The Swiss market for industrial potatoes (production of fries, flakes, and chips) comprises 5 companies (swisspatat 2011b). All of these companies are independent swiss companies. Sixty-one percent of the potatoes 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 t and exports to 1,656 t (EZV 2010).

The activities of the market participants (farmers, processors, and retailers) are coordinated through a joint association that works closely with all parties involved to ensure market clearance through planting recommendations to producers, intermediation of any possible surplus, and clearance funds for actual surpluses. Price ranges and conditions of acceptance regarding quality are determined yearly by all members of the joint association. Producers will then either directly deliver their potatoes to a factory or to a collection agency, who will then distribute the potatoes to the processors. In years when supply exceeds demand, surplus potatoes are sold as animal feed but producers receive regular payments in order to keep prices from falling below the pre-agreed price-range minimum.

Literature

Industrial research within agricultural economics largely focuses on the optimization of value chains (Belasco and Horowitz 2009; Bourlakis and Weightman 2004) and buying processes within single industrial organizations (based on the theoretical groundworks of Webster and Wind 1972; Sheth 1973; Sheth 1996). Generally, primary agricultural products are considered as commodities and price is seen as the key factor for buying decisions. Therefore, no differentiation may be achieved. One main exception is the country-of-origin debate, where differentiation based on the country of origin is seen as a differentiation strategy (Loureiro and Umberger 2003).

The preferences of processors for certain attributes of agricultural products have been collected in the markets for milk (Lopez and Lopez 2009; Fearne and Ray 1996), meat (for a meta analysis, see Cicia and Colantuoni 2010), and rapeseed (Bech-Larsen 2001). All authors show that price is high on the list of the most important attributes. Bech-Larsen (2001) shows, in a traditional conjoint analysis of vegetable-oil purchasing, that the average relative importance of price is 40 %, while supplier origin is around 9%. However, the studies also show that there are other attributes determining the buying decision at the business-to-business (B2B) interface. These attributes relate to the characteristics of the buyers, the suppliers, or the products sold. Eales and Binkley (2003) and Cicia and Colantuoni (2010) particularly stress the importance of attributes related to characteristics of the buyers and suppliers; for example, the quality of their relationship and the information available.

However, to the best of our knowledge, little is known about preferences of potato processors in industrial countries with a market structure that is characterized by close collaboration of market participants rather than direct production-contract management and vertical integration, as is the case in larger industries such as those in the United States (Bolotova and Patterson 2009).

Materials and Method

Investigating preferences is done through either revealed- or stated-preference methods. Revealed-preference approaches are based on an ex-post analysis of actual buying decisions. However, such data is hard to obtain in industrial markets. Stated-preference approaches overcome this shortcoming by confronting respondents with hypothetical, but realistic choice situations in order to elicit preferences. Stated-preference data also allows for the researching of generic products that do not (yet) exist in the market through simulation.

Conjoint analysis as a stated-preference method has been developed by Luce and Tukey (1964), and was brought into marketing by Green and Rao (1971), as well as by Green and Srinivasan (1978) and McFadden (1974). There are a number of different approaches. The present study is conducted using adaptive choice based conjoint analysis (ACBC), where respondents make trade-offs between all attributes of the choice alternatives simultaneously. ACBC is preferred because of its realistic approach and its short questionnaire length, when compared to other conjoint methods, which results in a larger return of questionnaires (Orme 2009c). The obtained data is then analyzed using HB estimation to overcome the shortcomings of a small sample size, as shown by Allenby and Rossi (2008). Attribute range and number-of-level issues are treated according to Backhaus et al. (2003) in order to minimize possible biases.

Model Specification

ACBC is part of the discrete-choice experiment family, as described by Carson and Louviere (2011), and Louviere et al. (2010), as well as by Allenby and Rossi (2008). The utility of a product can be described as follows:

$$U = \sum_{i=1}^{m} u_i + e \tag{1}$$

Where m is an attribute, u_i the part-worth utilities of the different attributes and e is the stochastic component. The probability that an industrial buying organization i buys product j from a given choice set C_t can therefore be given by the following formula:

$$P_{ij} = \Pr\left(U_{ij} \geq U_{in}; \forall j \neq n; j, n \in C_t\right) \tag{2}$$

Where U is the utility of the specific product and n are the alternatives.

Individual part-worth utilities are estimated using HB estimation models. Average part-worth utilities are calculated based on these individual part-worth utilities using randomized, first-choice models, which allow the incorporation of heterogeneity among customer segments. Gensler (2003) demonstrates that ACBC in combination with HB results in the best estimations of parameters when using validity and reliability as criteria of goodness.

Individual parameters are assumed to be distributed multinormally and HB then estimates the mean vector and covariance matrix for that distribution. HB models consist of two levels (Orme 2009a). At the upper level, respondents are considered to come from a group of similar individuals and their part-worth utilities are assumed to have multivariate normal distribution. At the lower level, a linear-regression model calculates each individual's part-worth utility according to the respondent's choices. Discrepancies between actual and predicted ratings are assumed to be distributed normally and independently of each other (Orme 2009b). The utilities are zero-centered; therefore, a negative part-worth value for a certain level does not generally indicate a negative preference, but it indicates that this level is generally less attractive than other levels relating to the same attribute (Gensler 2003).

The relative importance of an attribute indicates how much difference each attribute could make in the overall utility of a product. It therefore shows the range of an attribute's utility values. The bigger the range, the more important the attribute (Backhaus et al. 2003). The relative importance of each attribute is computed as follows:

$$RI_i = \frac{\max\ U_i - \min\ U_i}{\sum_i \left(Max_i - Min_i\right)} \tag{3}$$

Where RI is the relative importance of attribute i of any respondent. It is important to note that the average relative importance for samples or sub-samples is computed additionally from the individual relative importance per respondent.

The standard deviations for estimates are a measure of heterogeneity. High standard deviations usually reflect high heterogeneity of preferences (Gensler 2003). It is important to note that the standard deviation can only be compared within one attribute, not between attributes.

Percent certainty (PCC), as defined by Hauser (1978), indicates the goodness of fit of the model (internal validity). Varying between zero and one, it indicates how "far from chance" the model is. It is calculated as the difference between the null log likelihood and the model log likelihood divided by the null log likelihood. PCC values between 0.2 and 0.4 are interpreted as a good fit (Pullman et al. 1999). For ACBC, PCC can be improved by applying additional covariates, therefore a cut-off of PCC=0.5 is usually implemented. This value is interpreted as the model having an explanative power of more than 50 %.

Questionnaire Design

A qualitative pre-study with a literature review and qualitative interviews has been carried out in order to obtain the

Table 1 Attributes and levels used in the ACBC experiment

Attribute	Description	Levels					
Size (mm)	Standardized measure	35–42.49	42.5–47.99	48–59.99	60–74.99	75–84.99	More than 85
Country of origin	Geographical indication	Switzerland	Non-surrounding of EU Surrounding countries	Rest of EU	Non-EU		
Color	Standardized measure	White	Light yellow	Yellow	Dark yellow	Blue	Red
Storage stability (months)	Standardized measure	max. 2	2–4	4–8	8–12		
Producer price (CHF/100 kg)	Price paid to producers	24–25.99	26–28.99	36–37.99	38–39.99	40–41.99	More than 42
Distance of transport (km)	Distance producer/factory	0–50	50–100	100–150	150–200	200–250	>250
Supplier relationship	Qualitative measure according to B2B standards	Single transaction without prior knowledge about supplier	Repeated transaction using single contracts	Long-term and stable business relationship	Vertically integrated supplier		
Environmental effects	Measured at farm gate	"unknown"	"GM-free"	"positive effects on biodiversity"	"low CO_2 output"	"low use of water"	
Societal effects	Measured at farm gate	"unknown"	"secure food provision"	"secure agricultural incomes"	"preservation of natural resources"		

attributes and the associated levels that determine the buying decisions in the Swiss processing potato market. The results of both the literature review and the interviews were then integrated into the ACBC questionnaire that also contained a section with demographic background information.

The interviews confirmed the prominent role that prices and technical aspects such as size or color play in the buying decisions. Besides these, factors involving transportation cost and supplier–buyer relationships are also mentioned often. Less mentioned, but nonetheless important, are environmental and societal issues, as well as the country of origin. To keep the number of attributes at a reasonable level, we have decided not to include attributes that act as a cut-off—for example, the starch content of potatoes or the internal quality of the potato—as these qualities are considered as basic requirements.

Based on the preliminary studies, nine attributes (see Table 1) have been chosen for the ACBC experiment. These nine attributes reflect key drivers of the buying decision. It is important to note that all levels refer to the respective level at the farm gate. The levels for the buyer–supplier relationship have been set according to Kotler (1982), Kotler and Armstrong (2010), and Jang and Olson (2010), who describe different stages of integration within the food value chain.

Sample Characteristics

The survey, with the attributes presented in Table 1, was distributed among all five processing companies in Switzerland. The companies were asked to fill in the survey per product category (chips, fries, flakes) in order to determine the effect of the final product on supply requirements. Three surveys were submitted for the production of chips as well as flakes, and six surveys for fries. Two surveys have not

Table 2 Relative importance of attributes

Attribute	Relative importance as %	Standard deviation as %
Color	18 % *	3 %
Size (mm)	17 % *	5 %
Producer price (CHF/100 kg)	13 % *	4 %
Supplier relationship	12 % *	4. %
Storage stability (months)	11 % *	4 %
Distance of transport (km)	9 %*	5 %
Environmental effects	9 % *	3 %
Country of origin	7 %*	5 %
Societal effects	5 %*	2 %

*Significance at $p=0.01$

Table 3 Zero-centered, part-worth utility estimates (HB model with normally distributed part-worth utilities)

Attribute	Level	Average part-worth[a]
Size (mm)	35–42.49 mm	−34.40
	42.5–47.99 mm	2.81
	48–59.99 mm	3.51
	60–74.99 mm	18.31
	75–84.99 mm	31.90
	More than 85 mm	−22.14
Country of origin	Switzerland	16.66
	Surrounding countries	3.71
	Rest of EU	−1.80
	Non-EU	−18.57
Color	White	−19.14
	Light yellow	25.82
	Yellow	50.40
	Dark yellow	27.64
	Blue	−58.95
	Red	−25.78
Storage stability (months)	Max. 2 months	−10.16
	2 to 4 months	−5.08
	4 to 8 months	1.22
	8 to 12 months	14.02
Producer price (CHF/100 kg)	24–25.99 CHF/100 kg	32.82
	26–28.99 CHF/100 kg	39.53
	36–37.99 CHF/100 kg	−1.26
	38–39.99 CHF/100 kg	−9.02
	40–41.99 kg/100 kg	−22.71
	More than 42 CHF/100 kg	−39.36
Distance of transport (km)	0 to 50 km	6.42
	50 to 100 km	10.46
	100 to 150 km	13.26
	150 to 200 km	−7.36
	200 to 250 km	−6.05
	More than 250 km	−16.73
Supplier relationship	Single transaction without prior knowledge about supplier	−28.01
	Repeated transaction using single contracts	3.48
	Long-term and stable business relationship	21.97
	Vertically integrated supplier	2.57
Environmental effects	“unknown”	−14.45
	“GM-free”	25.77
	“positive effects on biodiversity”	−12.94
	“low CO_2 output”	−2.23
	“low use of water”	3.84
Societal effects	“unknown”	4.68
	“secure food provision”	−4.61
	“secure agricultural incomes”	2.90
	“preservation of natural resources”	−2.97

[a]Due to small sample size, no significance for attribute levels is reported

been answered, one from the field of chips and one from the field of flakes. The final sample thus includes 12 surveys and covers roughly 95 % of the total processing volume of potatoes in Switzerland.

Results

Relative Importance of Attributes

Technical attributes (color, size, and storage stability) account for 46 % of the total preference. Together with price, over 50 % of relative importance is explained (see Table 2). Price is seen as of medium importance and is at about the same level as the supplier relationship, both attributes having a large effect on the internal costs of any company involved. Environmental and societal effects and country of origin are the least important attributes.

Part-Worth Utilities

Results show that within the country-of-origin attribute, there is a strong preference for Switzerland (see Table 3). Additionally, preferences for GM-free products and short transportation distances also indicate preferences for potatoes grown in Switzerland. Especially, the GMO issue seems of great importance to processors. Within the attribute for environmental effects, "unknown" and "positive effects on biodiversity" have the smallest average part-worth utilities, which enhance the clear preferences for GM-free potatoes. On the contrary, the small range within the societal-effects attribute shows that environmental issues are not primary concerns in the buying decisions, and preferences seem to be somewhat hazy and heterogeneous.

Differences Among Chips, Fries, and Flakes

As seen in Table 2, standard deviations of part-worth utilities and percent certainty are high for certain attributes, indicating heterogeneity among respondents. Figure 1 shows that there are distinctive differences between product categories, explaining this heterogeneity. Country of origin is regarded as the most important attribute for the production of chips. In the markets for fries, color and size have the highest relative-importance shares. In the third market, the market for flakes, storage stability is most highly valued. Interestingly, producer price is considered less important by the producers of fries and flakes than by the producers of chips. This might be due to the market structure, as the largest producers of fries and flakes are closely connected to producers' associations while the processors of chips are privately held companies with little ties to the agricultural producers. The producers of flakes do not place special importance on country of origin. This is mainly due to the fact that a high proportion of flakes is sold to restaurants and catering services where price is even more dominant than in the retail sector.

Conclusion

The purpose of this study was to analyze the preferences of potato processors in terms of certain attributes of potatoes. The analysis is aimed at improving knowledge of producer's and producers association with regards to potential for differentiation based on product attributes. From the results outlined in the previous section, it is clear that within the limits of the implemented design, the price variable is an important decision criterion with a relative importance of 12 %.

The preference analysis clearly shows that there are large differences in relative importance when taking the final good produced into account. While chips are mostly sold branded and thus generally with a higher profit margin, fries and flakes are regarded as commodities. This is reflected in Fig. 1, where country of origin is most important for chips and least important for flakes. The commodity character of flakes is also illustrated by the high importance of storage stability, allowing processors to use production facilities to capacity.

In a world with standardized prices and technical attributes, the relationship between farmers and processors, as well as environmental aspects, determine up to 30 % of

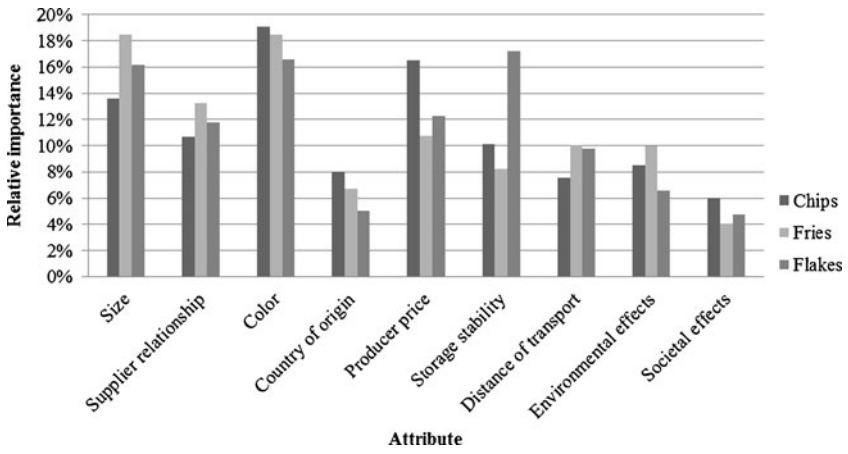

Fig. 1 Relative importance of attributes for product categories (sample sizes: #chips = 3, #flakes = 3, #fries = 6)

the buying decision, thus being five times more important than country of origin.

Reducing internal costs and facilitating processing by supplying potatoes fulfilling high quality standards will allow producers to build and support stable long-term relationships with processors. As our results show, these relationships are highly valued and thus serve to ensure future sales volumes to producers. Another possible differentiation strategy is characterized through surpassing processors and enhancing product attributes (in terms of environmental issues or the country of origin) to the final consumer of the goods. Increasing consumer awareness of these product attributes will result in higher demand for Swiss industrial potatoes, thus also increasing sales volumes at the production level. This is especially important, as there are clear indications in the press and in public debate that nutritional values, the issue of genetically modified foods, safety, and environmental matters are becoming increasingly important in the buying behavior of final consumers with regard to processed foods.

Overall, we conclude that there indeed is some potential for differentiating Swiss industrial potatoes at the production level. This holds especially when looking at product attributes related to the whole value chain, taking into account preferences of processors and producers, as well as retailers, and other sales channels. These preferences encompass the quality of the supplier–buyer relationship, the inherent technical aspects of potatoes, country-of-origin effects, and environmental aspects such as GM-free potatoes. Especially the latter two (country-of-origin effects and GM-issues) are generally becoming more important in the Swiss food markets (Bolliger 2009) and therefore differentiation based on these product characteristics needs to be thoroughly considered by producers and producers associations as a possible differentiation strategy.

It is to be expected that market-driven developments will influence the downstream functions of a company (e.g. sales channels or customers) before the upstream functions (e.g. supply logistics). Thus, further research in the area of differentiation of potatoes should be directed at sales channels and marketing functions in the restaurant and retail sectors. Additionally, as consumers are becoming more involved in nutrition, product safety, and the environment (Belasco and Horowitz 2009; Cicia and Colantuoni 2010), traceability of the final product back to its origin gains importance. This highlights the need for further industrial buying in the upstream channel as well.

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