Potato Marketing – Factors Affecting Organic and Conventional Potato Consumption Patterns

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Abstract— **In producing potatoes the treatment for disease and pests could be more difficult and costly for organic producers than for conventional. Hence, consumers' attitudes and willingness to pay for organic potatoes need to be considered in a grower's choice of production technologies. A bivariate probit model and cluster analysis were applied to survey data to evaluate factors that influenced Germany consumers' consumption patterns for conventional and organic potatoes. The results show that consumers associate organic potatoes with healthy ingredients, trustable origin and food safety. But a lack of varieties and inferior appearance of organic potatoes limit consumer interest in the organic products.**

With regard to socio-demographics, consumers with higher education level and with children in the household tend to consume organic potatoes more often than consumers with lower education and no children in the household. Cluster analysis results group potato consumers into three different market segments: "Trusting of industry", "Health-oriented" and "Price-oriented" segments. These results suggest adopting different marketing strategies to promote fresh potatoes to the different market segments.

Keywords— **organic, potatoes, consumption patterns**

I. INTRODUCTION

The demand for organic products around the world is developing quickly and shows impressive growth rates. As a result, organic farming is one of the fastest growing segments in agriculture today [1, 2]. One of the largest markets for organic food products in Europe is Germany. Due to an increasing consumer demand organic products reached in Germany a market share of 32% in 2006, which equals a turnover of 4.6 billion Euros out of 14.3 billion Euros turnover in Europe [3]. Against this background, this paper focuses on organic and conventional consumption patterns in Germany, i.e. what factors are affecting the consumers' demand. Organic produce and fruits are among the most demanded products in organic markets. As potatoes are very popular in Germany and account for almost 50% of the overall German per capita produce consumption [4] this paper focuses on organic and conventional potatoes, respectively.

What makes organic farming potentially attractive are the possible higher financial returns. But, similar to other produce, the risk of organic potato production is higher than that of conventional production [5]. Pimentel [5] estimated the costs of organic potato production to be about 50% higher and the yield about 50% lower than those of conventional potato production. Due to the higher risks and costs associated with organic potato production, producers must charge a premium to make their business profitable. The price premium obtained for organic potatoes is about 73% higher than that of the price of conventional potatoes [6]. Other produce in the United States and Europe [2] show similarly high premiums for produce at farm level.

In order to maintain consumers' willingness to pay these price premiums and to develop production and marketing strategies we have to understand their choices. It is necessary to know which product characteristics consumers value the most. Moreover, we have to investigate what differences exist between those who consume conventional and organic potatoes; and why some consumers are motivated to pay more for organically grown potatoes, whereas others are not. The objective of the present study is to

investigate what factors affect conventional and organic potato consumption and how these factors support the adoption of different marketing strategies.

Research related to organic potato consumption is sparse. For the U.S. market, Bernard et al. [7] investigated consumers' willingness to pay for Non-GM foods when an organic option is present, but the products included in their study were processed foods such as potato chips, instead of fresh produce. Loureiro and Hine [8] studied consumers' willingness to pay for local, organic and GMO free potatoes. Although they included consumers' attitudes towards potato freshness and nutrition, important attitudes toward certain product characteristics such as appearance, variety, etc. were not included in their study. Among studies of European consumers, Magnusson et al. [9] investigated consumers' preferences for organic milk, meat, potatoes and bread and found that consumers were satisfied with the availability of organic foods and perceived organic foods as healthier than conventional counterparts. The consumers in their study considered the price premium to be the major obstacle to their purchase of organic foods.

Our study differs from the previous research because we use a statistical approach (bivariate probit model) that enables us to make a direct comparison of consumption patterns between organic and conventional potatoes. Data on consumer purchase decision-making for organic and conventional potatoes from Germany provides good evidence on a fresh product with economically significant sales. Moreover, we are able to include several product attributes that enable targeted marketing efforts and, eventually, successful product development. The comparison allows us to determine directly what motivates consumers to enter the market (the extensive market) as well as purchase more organic potatoes once in the market (the intensive market). The results provide evidence on how consumers' perceive quality characteristics of potatoes, factors important for purchase decision-making and how socio-demographics affect their consumption patterns. The bivariate probit analysis plus the additional market segmentation study through cluster analysis provide important implications for marketing strategies fresh

organic potato growers may adopt in different market segments.

The remainder of the paper is as follows. Section 2 describes data and methodology. Section 3 presents the results and section 4 gives conclusions and marketing implications.

II. DATA AND METHODOLOGY

A. Data

The data come from a private household survey we conducted in 2004 in a medium-sized city in Northern Germany using questionnaire-based face-to-face interviews. The survey included questions on purchase patterns and frequency of consumption of conventional and organic potatoes, attitudes and socio-demographics. All respondents were older than 18 years. The sample was randomly derived from a social address register and consisted of 260 participants.

B. Bivariate probit

Consumers' consumption patterns for conventional and organic potatoes are expressed in two categories: "consumption less than once a week" and "consumption more than once a week". We use the two categories to measure the corresponding degree of satisfaction consumers derive from their consumption of the two types of potatoes. A bivariate probit model is used to estimate the probability of consumers consuming "more than once a week" or "less than once a week" because the dependent variables are categorical and because each participant was asked about consumption practices for both conventional and organic potatoes. In contrast to the univariate probit the bivariate probit accounts for the possibility that the consumption patterns might be correlated: consumers who are frequent conventional potato consumers might be more (or less) likely frequent organic potato consumers.

Consumers' satisfaction derived from consuming potatoes depends on measurable factors including their use of certain quality attributes (potato production methods, packaging, appearance, origin, etc.) to make the potato purchase decision and their socio-demographics (e.g. education). The bivariate probit

yields estimates of parameters on these product and consumer characteristics. Furthermore, it captures the correlation between the consumption patterns.

The specification of the bivariate probit model is

$$U_i^{Con} = X_i{}'\alpha^{Con} + \varepsilon_i^{Con}, y_i^{Con} = 1 \quad if \quad U_i^{Con} > 0, y_i^{Con} = 0 \quad otherwise$$
$$U_i^{Org} = X_i{}'\alpha^{Org} + \varepsilon_i^{Org}, y_i^{Org} = 1 \quad if \quad U_i^{Org} > 0, y_i^{Org} = 0 \quad otherwise$$
$$E[\varepsilon_i^{Con}|X] = E[\varepsilon_i^{Org}|X] = 0$$
$$Var[\varepsilon_i^{Con}|X] = Var[\varepsilon_i^{Org}|X] = 1$$
$$Cov[\varepsilon_i^{Con}, \varepsilon_i^{Org}] = \rho$$

(1)

where $i = 1, \mathsf{L}, 215$; the term U_i^{j} is the latent unobservable satisfaction level for consumer i derived from consuming j type of potato; y_i^{j} is the observed consumption frequency with $y_i^{j} = 1$ meaning consumer i consumes more than once a week and $y_i^{j} = 0$ meaning consumer i consumes less than once a week; $j = Con, Org$ with Con meaning conventional and Org meaning Organic; ε_i^{j}'s are the random disturbance items and they are assumed to follow bivariate normal distribution with mean zero, standard deviations equal to one and correlation between ε_i^{Con} and ε_i^{Org} equal to ρ, which is to be estimated; α^{j} is the coefficients of the explanatory variables to be estimated; and X_i is a vector of explanatory variables including consumers' attitudes and consumers' socio-demographic characteristics.

The empirical specification of the satisfaction function underlying the bivariate probit model makes reference to both consumers' use of product characteristics to make the potato purchase decision and consumers' socio-demographic characteristics. The satisfaction function is formulated as follows:

$$U_i^j = \alpha_0^j + \alpha_1^j Service + \alpha_2^j Packdesign + \alpha_3^j Packsize + \alpha_4^j \Pr ice + \alpha_5^j Health$$
$$+ \alpha_6^j Nutrients + \alpha_7^j Taste + \alpha_8^j Brand + \alpha_9^j Origin + \alpha_{10}^j Freshness$$
$$+ \alpha_{11}^j NutritionInf + \alpha_{12}^j Variety + \alpha_{13}^j Appearance + \alpha_{14}^j Safety + \alpha_{15}^j Label$$
$$+ \alpha_{16}^j Child + \alpha_{17}^j Education + \alpha_{18}^j Income + \alpha_{19}^j Age + \alpha_{10}^j Gender$$
$$+ \alpha_{21}^j Household + \varepsilon_i^j \qquad (2)$$

The bivariate probit model based on the empirical representation of the latent non-observable utility function in (2) is estimated using maximum likelihood method.

C. K-means cluster analysis

In addition to the bivariate probit model estimation, cluster analysis is used to do a market segmentation analysis, i.e. to investigate the relationship between consumers' potato consumption patterns and their attitudes. A k-means cluster analysis was carried out to assign respondents to groups with as much similarity within and difference among the groups as possible. K-means ([10]) is one of the simplest algorithms to do cluster analysis. The algorithm's goal is to minimize the following objective function:

$$J = \sum_{j=1}^{K} \sum_{i=1}^{n} \left\| x_i^{(j)} - c_j \right\|^2$$

(3)

where $\left\| x_i^{(j)} - c_j \right\|^2$ is the distance between a data point $x_i^{(j)}$ and the cluster center c_j, is an indicator of the distance of the n data points from their respective cluster centres (also called centroid); K is the number of clusters; and n is number of data points. The distance we use here is Euclidean distance.

III. RESULTS

A. Descriptive statistics

The summary statistics of the participants' consumption patterns of conventional and organic potatoes, their use of product characteristics to make the potato purchase decision and socio-demographics are defined in Table 1.

Table 1 Summary statistics

Variable	Variable Description	Mean	Standard Deviation
Conventional	Conventional potato consumption, 1=more than once a week, 0= less than once a week	0.78	0.41
Organic	Organic potato consumption, 1=more than once a week, 0=less than once a week	0.32	0.47
Service	Dummy variables equal to 1 if participant thinks the product characteristic is important to make the purchase / consumption decision, 0, otherwise.	0.18	0.38
Packaging design		0.15	0.36
Packaging size		0.45	0.50
Price		0.61	0.49
Health		0.52	0.50
Ingredients		0.20	0.40
Taste		0.83	0.38
Brand		0.27	0.44
Origin		0.62	0.49
Freshness		0.77	0.42
Nutrition information		0.28	0.45
Label		0.29	0.46
Variety		1.58	0.82
Appearance		0.75	0.43
Food safety		0.21	0.41
Children	Number of children in household (HH)	0.30	0.70
Education	1= school less than 8 years; 2= school 8-10 years; 3= school 11-13 years; 4= university degree	2.60	0.99
Income	Monthly household NetIncome: 1=less than 400 €; 2=400 to 800 €; 3=800 to 1300 €; 4=1300 to 1800 €; 5=1800 to 2300 €; 6=more than 2300 €	3.78	1.60
Age	Age in integer years [a]	43.21	17.96
Gender	1=female, 0=male	0.55	0.50
Household	Numbers of persons in HH [b]	2.06	1.01

[a] The oldest participant is 86 years old and the youngest participant is 20 years old.

[b] The smallest household has 1 person, the largest household has 5 persons.

The results show that 78% of the participants consume conventional potatoes more than once a week and 32% consume organic potatoes more than once a week (Table 1). Most participants think taste (83%) and appearance (75%) are important to make the potato purchase decision. In contrast, packaging design (15%) and brand (27%) are less important. The average age of the participants is 43 years old and 55% are female. As we expected, the proportion of participants who consume organic potatoes more than once a week is less than the proportion of participants who consume conventional potatoes more than once a week. The Wald test of proportion indicates that the proportions are significantly different from each other ($\alpha = 0.01$).

B. Impact of consumers' use of product characteristics and socio-demographics on their organic and conventional potato consumption patterns

Consumers' use of quality characteristics and their socio-demographics determine their consumption patterns of organic and conventional potatoes. The estimation results are presented in Table 2. Note, the value $\hat{\rho}$, the estimated correlation between conventional potato consumption and organic consumption, is estimated to be 0.25 (P-value=0.11). The positive correlation indicates that consumers who consume conventional potatoes more frequently are also more likely to consume organic potatoes more frequently, but the correlation between the consumption patterns is not significant at the 0.10 significance level.

The results in Table 2 show that participants' use of product characteristics to make the potato purchase and their socio-demographics affect the consumption of conventional and organic potatoes in different ways. Participants' use of potato ingredients (Ingredients) to make the purchase decision has a positive effect on organic potato consumption ($\alpha = .05$); participants who consider ingredients of potatoes to be important consume organic potatoes more often. Although the attitude towards ingredients affects participants' purchase of conventional potatoes in a negative way, the effect is not statistically significant. Participants may think organic potatoes have more healthy ingredients than conventional potatoes [8].

Ranking potato origin as an important attribute is positively associated with more frequent consumption of organic potatoes.

Table 2 Estimation of bivariate probit model for potato consumption patterns

Variable	Conventional potatoes		Organic potatoes	
	Parameter estimates	P-value	Parameter estimates	P-value
Intercept	-0.83	0.28	-2.49***	0.00
Service	-0.09	0.77	-0.13	0.64
Packaging design	0.60*	0.10	-0.15	0.61
Packaging size	0.36	0.12	0.22	0.28
Price	-0.16	0.51	0.03	0.87
Health	0.22	0.41	0.29	0.20
Ingredients	-0.22	0.43	0.49**	0.04
Taste	0.29	0.33	-0.43	0.13
Brand	-0.13	0.64	0.33	0.18
Origin	-0.36	0.17	0.65***	0.01
Freshness	0.29	0.29	0.38	0.15
Nutrition information	0.53**	0.05	0.04	0.86
Label	-0.61**	0.03	-0.41*	0.10
Variety	0.16	0.28	-0.27**	0.04
Appearance	0.47*	0.08	-0.40*	0.10
Food safety	-0.54*	0.06	0.38*	0.10
Children	0.41	0.16	0.46*	0.05
Education	-0.03	0.83	0.24**	0.04
Income	0.01	0.92	0.07	0.34
Age	0.02**	0.03	0.01	0.14
Gender	-0.32	0.19	0.29	0.19
Household	0.11	0.54	-0.29*	0.10
$\hat{\rho}$	0.25	0.11	---	---

*** significant at the 1% level; ** significant at the 5% level; * significant at 10% level.

Providing nutrition information such as recipes for potato dishes, available at the potato counter, has a significant and positive effect on conventional potato consumption frequency, but no statistically significant effect for organic potatoes. Labels, such as seals of approval, have a significantly negative effect for consumption of both conventional and organic potatoes, results that suggest that consumers who care about these types of labels are less likely to consume potatoes.

The variable Variety affects the consumption of organic potatoes significantly in a negative way: participants who like purchasing special kinds of potatoes are likely to consume organic potatoes less often. Attitudes towards appearance of potatoes and the importance of food safety affect participants' consumption of conventional potatoes and organic potatoes in the opposite way. Those who think potato appearance to be more important consume conventional potatoes more often and organic potatoes less often. However, less than perfect appearance associated with organic potatoes is also associated with reduced use of pesticides. Previous studies (e.g., [11]) showed similar results for golden delicious apples. Those who consider food safety to be important are likely to consume organic potatoes more often and conventional potatoes less often.

Among socio-demographics factors, the number of children at home (Children) has a positive effect and the size of household has a negative effect on the consumption of organic potatoes. That is, households with children are likely to consume more organic potatoes while larger households tend to consume less organic potatoes. Education level (Education) has a positive effect on the consumption of organic potatoes: the participants who have a higher education level tend to consume organic potatoes more often. Age affects conventional potato consumption significantly positively: older people are likely to eat more conventional potatoes.

C. Market segmentation of potato consumers

In order to enable producers to develop marketing strategies for specific consumer segments, we analyze in this section how consumers' attitudes influence their potato consumption behaviour using cluster analysis. Therefore, interviewees were asked about their general attitudes on the food industry, production methods and location, towards food price versus food quality, health concerns, etc. They received a statement battery containing opinions such as "Food industry guarantees good quality", "I would prefer the

purchase of local products", "Healthy diet is very important, I choose the foods I buy very carefully" and "Expensive food has a better quality" and had to evaluate every statement on a 5-point Likert-Scale (5=I strongly agree, 1=I strongly disagree).

We applied a k-means cluster analysis to group the participants based on their opinions and to investigate the effect on the respondent's choice of organic potatoes and conventional potatoes. A three cluster solution gives the best results. In cluster 1 (n=91), called the "Industry-trusting" group, the participants trust the food production process more than the other two clusters; they think the food industry can provide them with healthy food to eat so they do not care about the origin of products too much, instead, they care about the taste of food more than the production methods. The participants in cluster 2 (n=77), the "Health-oriented" group, are very concerned about their health, they would rather buy expensive food to avoid contaminants, they are concerned with the origin of food very much and they prefer to buy local food. The participants in cluster 3 (n=47), the "Price-oriented" group, care about the price of food very much; they believe that cheap food has equal quality to expensive food and that an increasing price does not insure better taste; at the same time they do not trust the food industry.

To see how these three groups differ in their choices of organic potatoes and conventional potatoes and in their socio-demographics we conducted ANOVA and MANOVA[1] analyses. The results are shown in Table 3a and 3b. We can see that the three groups do not differ significantly in their consumption patterns of conventional potatoes (P-value=0.77) but they do differ in consumption of organic potatoes (P-value<0.01). The three groups also differ in their number of children at household (P-value=0.06), education level (P-value<0.01), income level (P-value=0.07), age (P-value <0.01), and gender (P-value=0.03). The Health-oriented participants consume organic potatoes significantly more often than those in the other two groups. The average number of children in this group is the highest; the participants in this group are most educated compared with those in the other groups; the participants have

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[1] ANOVA is univariate analysis of variance and MANOVA is multivariate analysis of variance.

higher income and they are older that those in the other two groups. The proportion of females in this group is also the highest.

Table 3a Potato consumption patterns and socio-demographics of clusters

Group / Variable	Industry-trusting (n=91)		Health-oriented (n=77)		Price-oriented (n=47)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Conventional	0.76	0.43	0.79	0.41	0.81	0.40
Organic	0.19	0.39	0.49	0.5	0.28	0.45
Children	0.29	0.73	0.43	0.80	0.13	0.34
Education	2.86	0.86	2.69	0.95	1.94	1.03
Income	3.64	1.60	4.12	1.57	3.51	1.60
Age	38.27	17.04	47.00	16.91	46.55	19.41
Gender	0.45	0.50	0.65	0.48	0.57	0.50
Household	2.02	0.99	2.22	1.14	1.87	0.74

Table 3b Potato consumption patterns and socio-demographics of clusters

Group / Variable	Test results	
	ANOVA P-value	MANOVA P-value
Conventional	0.77	
Organic	<0.01	<0.01
Children	0.06	
Education	<0.01	
Income	0.07	
Age	<0.01	
Gender	0.03	
Household	0.15	<0.01

The proportion of participants who consume organic potatoes more than once a week in the Industry-trusting group is the lowest among the three groups. This group has the youngest participants and the lowest percentage of females. The Price-oriented group has the highest consumption of conventional potatoes compared with the other two clusters. Only 13% of these households have children living in the

household. The education level is the lowest as is the income level. Their age is comparable with the Health-oriented consumers. The MANOVA results show that the three groups differ in the consumption pattern of potatoes in general (P-value<0.01) and also differ in the participants' overall socio-demographics (P-value<0.01).

IV. CONCLUSIONS AND MARKETING IMPLICATIONS

Our comprehensive study of consumption patterns of conventional and organic potato consumers using survey data from Germany – one of the countries with the highest share of organic produce – provides useful information for organic potato growers. The results from a bivariate probit estimation of conventional and organic potato consumption patterns have important marketing implications. Firstly, consumers associate organic production methods with healthy ingredients, trustable origin and food safety. Hence, in promoting organic potatoes the health benefits due to certain ingredients of organic potatoes, the origin of production and food safety aspects of organic potato production should be especially emphasized. Secondly, less perfect appearance is not desired / favored by potato consumers, and might even prevent some consumers from choosing organic potatoes. Organic potato producers need to take consumers' limited tolerance of inferior appearance into account during the production process. Additionally, consumer education and promotion through recipes and tips for use may improve the market for organic potatoes with inferior appearance. Since the consumers with lower education are less likely to choose organic potatoes, informative or persuasive marketing strategies (or consumer education) that can enhance their knowledge about the advantages of organic production might be useful to increase the sale of organic potatoes in this particular group of consumers. In addition, the results indicate that households with children are a major market for organic potatoes. Promotion campaigns should continue to emphasize how organic potatoes are beneficial for children in order to keep and even enlarge this market.

Additionally, a cluster analysis shows that there are some market segmentations among potato consumers.

The consumers in the "Health-oriented" segment consume organic potatoes more often than the "Industry-trusting" and "Price-oriented" segments. Different marketing strategies should be adopted by organic potato growers. For the "Health-oriented" group, organic potato growers can continue to focus on the health benefits brought by organic potato consumption. The organic potato growers can increase the price premium appropriately to get higher profit but they will not lose the market since this group of consumers is not quite as sensitive to price. For the "Industry-trusting" group, organic potato growers could emphasize the lack of chemical residues used in organic production systems and enlarge the potential organic market by attracting more consumers by increasing "Industry-trusting" consumers' awareness of potential drawbacks of conventional production and the benefits of organic production. The "Price-oriented" group does not trust the food production system and they consider the high price premium to be the major obstacle that prevents them from buying organic potatoes. Lowering the price margin for organic potatoes to some degree (of course the price should be beyond the cost of production) or including sales promotion every now and then might gain a large market from this consumer group. However, future research should focus on quantifying consumers' willingness to pay for desired potato attributes to give more detailed recommendations to producers.

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