What are the preferences of Dairy Farmers regarding their Work?
A Discrete Choice Experiment in the Eastern Part of Switzerland

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Abstract— **The paper analyzes the preferences of dairy farmers with respect to their work by the means of a Discrete Choice experiment, which was carried out in the Eastern part of Switzerland. 304 dairy farmers, who intend to produce milk beyond the abolishment of the milk quota in 2009, were asked to choose between the status quo and alternatives consisting of several combinations with four attributes. The latter comprise work content, terms of employment, holiday per year and income per year. Using a probit model, the willingness to pay/accept is calculated. The results indicate that there is a strong preference to stay in dairy production. In order to achieve both, maintaining the level of utility and moving away from dairy production, an additional income (willingness to accept) per year of at least CHF 25'000.- would be necessary. The preferences of dairy farmers show that differences between the alternative work contents like suckler cows husbandry, farming without livestock and work outside of agriculture are minor.**

Keywords— **discrete choice, preferences, work content, dairy farming**

I. INTRODUCTION

To run a dairy farm is a demanding job. The treatment of the animals as well as the cattle breeding require high professional skills. In Switzerland, a large proportion of fodder is normally produced on the farm. Therefore, knowledge in plant production is also required. In addition, a highly time-consuming factor lies in the production of milk. This is mainly due to the milking process. Since the production goes on every day, spare time like holidays and free weekends need to be planned and organised well.

To illustrate the income situation, we compare the work income per family member (full time) with the comparable income. The latter is defined as an income a worker with comparable qualifications might earn in the industrial or service sector. It is differentiated between the plains, hilly, and mountainous areas. In the years 2004 to 2006 comparable income on average amounted to CHF 69'000.- in the plains, CHF 63'300.- in the hilly and CHF 58'200.- in the mountainous area respectively [1]. The work income per family member in dairy farms reached CHF 40'100.- in the plains (58% of comparable income), CHF 34'000.- in the hilly (54%) and CHF 30'000.- (51 %) in the mountainous area, respectively. Actual working hours are not taken into account in this comparison. Normally, they account for around 2000 hours per year in industry or the service sector and 2800 hours in agriculture.

The structural change in dairy farms is moderate. Between the dairy years 2000/01 and 2005/06 around 21 percent of all dairy farms in Switzerland stopped production [2, p.127], which represents a structural change of around 4 percent per year. Yet, dairy production in Switzerland still takes place under small structural conditions. On average, a dairy farm has 20 hectares and 18 cows [1].

Given the above-mentioned facts, it is unlikely that income is the only incentive for dairy farmers to stay in their business. More importantly, there seem to be nonpecuniary motives like tradition, socioeconomic context and job preferences (working in nature, working with animals or being independent) that affect the decision.

In literature several analyses about nonpecuniary motives exists. Egri [3] find different patterns of preferences and information behaviour between organic and conventional farmers in Canada. Comparing contract and independent production forms, Key [4] shows that hog producers in the US have a strong preference for autonomy. Davies and Hodge [5] investigate the level of support by arable farmers for the principle of cross compliance for

biodiversity objectives in a region of the UK. They found that two attitudinal factors referred to as 'Stewardship Orientation' and 'Technological Beliefs' are most important.

Since income is highly important for agricultural policy, it is useful to translate nonpecuniary incentives in willingness to pay. This is in the aim of this paper – to carry out an analysis by the means of a Discrete Choice experiment. Compared with other methods to measure willingness to pay (e.g. Contingent Valuation or Conjoint Analysis), Discrete Choice experiments offer two advantages: First, they are suited for hypothetical decisions. Second, several attributes of the object under consideration, in our case the job of dairy farming, can be analysed.

The Discrete Choice method is frequently used in agriculture. Shefer et al. [6] for instance, explore the adoption of varieties and fertilization techniques of greenhouse tomatoes in Southern Israel using Discrete Choice Models. Windle and Rolfe [7] use choice modelling to determine how sugar growers in Central Queensland (Australia) value different attributes of diversification. Breustedt et al. [8] examine the willingness of German farmers to adopt genetically modified oilseed rape by a Discrete Choice experiment. Ouma et al. [9] analyse cattle traits in Ethiopia and Kenya by means of a Choice Experiment.

The paper is structured as follows. In the second section the theoretical base of Discrete Choice experiments is presented. Section three deals with the data used while section four contains the results. In the last section, we draw conclusions.

II. DISCRETE CHOICE EXPERIMENT

With regard to their professional activity (*i* alternatives), we assume that all dairy farmers have a utility function consisting of two components (random utility):

$$U_i = V_i + \varepsilon_i \qquad (1)$$

V_i is the systematic component, while the random component is called ε_i. Out of a choice set dairy farmers are asked to choose the best alternative for them i.e. the alternative with the highest utility level. In our case, there is just the status quo 0 and one alternative i, defining a binary decision model. The probability that i is chosen by the dairy farmer is [10, chapter 4.1]:

$$P(i) = \Pr(U_i \geq U_0) \qquad (2)$$
$$= \Pr(V_i + \varepsilon_i \geq V_0 + \varepsilon_0)$$
$$= \Pr(V_i - V_0 \geq \varepsilon_0 - \varepsilon_i)$$

Assuming that $\varepsilon = \varepsilon_0 - \varepsilon_i$ the probability can be expressed by the means of the density function of ε [10, chapter 4.2]:

$$P(i) = \int_{-\infty}^{V_i - V_0} f(\varepsilon) d\varepsilon \qquad (3)$$

If a large number of observations are available, the probability can be reformulated [10, chapter 4.2]:

$$P(i) = \Phi\left(\frac{V_i - V_0}{\sigma}\right) = \Phi\left(\frac{\boldsymbol{\beta}'(\boldsymbol{x}_i - \boldsymbol{x}_0)}{\sigma}\right) \qquad (4)$$

Where Φ denotes the standardized cumulative normal distribution. $\boldsymbol{\beta}$ is a vector of coefficients and can be rescaled. Accordingly, using a rescaling factor $1/\sigma$ for both numerator and denominator, σ can be chosen to be equal to one. $\boldsymbol{x}_i$ and $\boldsymbol{x}_0$ are vectors of k attributes of the alternative i and the status quo 0.

Interested in the differences between the status quo and the alternative, we introduce the change of attribute k (A_k):

$$A_k = x_{ki} - x_{k0} \qquad (5)$$

We assume a linear specification for the deterministic part of the indirect utility function. In addition, we allow also quadratic form as well as interaction terms of attributes:

$$V_i - V_0 = \beta_1 + \beta_2 * A_2 + \beta_3 *(A_2)^2 + \beta_4 * A_4$$
$$+ \beta_5 *(A_2 * A_4) + \dots + \beta_k * A_k \qquad (6)$$

Given the A_k and the decision whether alternative i is chosen, the above equation is econometrically estimated by using probit.

Based on the utility function, the marginal rate of substitution [MRS, 11] between the change of attribute k (A_k) and the referring income change (A_{Income}) is defined as follows:

$$MRS_{k,Income} = -\frac{\frac{\partial V}{\partial A_k}}{\frac{\partial V}{\partial A_{Income}}} \qquad (7)$$

Since income is measured in monetary units, the MRS is a financial indicator of willingness to pay or willingness to accept [12].

III. SURVEY AND DATA

On 1st May 2009 Switzerland will abolish milk quotas. Since the decision was taken in 2003 the dairy farmer prepare their farms to cope with the new conditions. In order to analyse theses changes and the applied production technology, we conducted a survey in the Eastern part of Switzerland (Cantons Appenzell i. Rh., Appenzell a. Rh., St. Gall, Thurgau and Zurich). This region represents almost the different levels of altitude as well as the sizes of dairy farms for the whole country. Chosen by a random sampling 530 dairy farmers were asked about their future plans by telephone survey. 123 of them refused to answer, which corresponds to a rate of return of 77 percent. 407 dairy farmers were asked whether they plan to continue milk production after 2009. 103 farmers intend to stop production. Since the interest for the survey was focussed on dairy farmers, who want to stay in milk production, the analysis was stopped for them. The remaining 304 farmers were asked to fill out a questionnaire, which included items about change of milk production, production technology and socioeconomic factors. After a few weeks, a researcher went to the farm to conduct also an oral interview. Besides questions about production technology and cooperation with other farmers the interview included also a Discrete Choice experiment, which was focussed on nonpecuniary motives in their daily work. The interviews were carried out between August 2006 and March 2007.

To analyse the preferences of work, we define four attributes (table 1): Work content, terms of employment, holiday per year and variation in income.

Table 1 Attributes and Alternatives

Attributes	Alternatives
Work content	• Dairy production *(status quo)* • Suckler cows husbandry plus additional occupation • Farming without livestock • Out of agriculture
Terms of employment	• Self-employed *(status quo)* • Employed
Holiday per year	• 0 week • 2 weeks • 4 weeks *(status quo: 0.8 week)*
Variation in income per year	• CHF –6000.- • CHF 0 *(status quo)* • CHF +15'000.- • CHF +30'000.-

The work content includes four options. All interviewees are presently active in dairy production (status quo) followed by the option suckler cows husbandry plus an additional occupation. Suckler cows are less labour-intensive and therefore lower in income. As a consequence, an additional occupation is necessary. This can be in or outside agriculture. Farming without livestock means that there is a concentration of arable crops, fruit and vegetable growing in the plains and the hilly areas or fodder production in the mountainous area. For the last option, out of agriculture, it is necessary to leave the agricultural sector and to start another job outside agriculture.

All dairy farmers included in the survey run a farm. Hence, they are self-employed (status quo). All work content options are also possible to carry out as an employee of another farmer or enterprise.

"Holiday" offers three options: none, two or four weeks. The status quo here is varying between farms. Asked about their actual amount of holidays the farmers answered between 0 and 4 weeks with an average of 0.8 week. Accordingly, the difference (A_i) between the actual amount of holidays of the farmer and the number of weeks of holiday in the alternative is calculated individually.

The variation in income refers to the actual income, which was not directly inquired. The interviewees were asked to select an income class out of five possibilities. On average the income of the household is CHF 76'600.- which refers to 1,5 full time family member on the farm (CHF 51'100.- per full time

family member). Since this figure includes also income, which is earned outside agriculture, it cannot be compared with the referring values in section one of this paper.

Based on table 1, 96 (= 4*2*3*4) combinations are possible theoretically. Some of which are not realistic or unlikely to occur. For example, four weeks of holiday being standard for employees in Switzerland, it is not possible to state none or 2 weeks if employed. The respective combinations need to be excluded which leads finally to 55 possible combinations. Since all combinations are used in the survey, a restriction in terms of an orthogonal design is not necessary. The combinations are subdivided into 5 groups with 11 alternatives each. Similar combinations are assigned to different groups.

A card is prepared for each combination. In the interview with the dairy farmer, the status quo in terms of holiday is discussed first, and then the 11 cards are used. The sequence of the cards is changed in every interview.

The farmer decides whether or not to accept the card in each case. To accept a card means that the combination of attributes on the card implies a higher utility than status quo. The procedure was evaluated in a pretest to guarantee that dairy farmers had no problems to imagine what the alternative meant. In the survey they easily understood the questions.

With one exception, all 304 dairy farmers followed the Discrete Choice experiment. A data set of 3333 answers resulted of the survey (303 farms with 11 answers each). Out of the presented eleven cards they have chosen between 0 and 7. 18 farmers have selected no alternative. In total, 904 or 27% of the presented alternatives were chosen.

Due to the fact that the specific preconditions for the logit analysis are not given, the probit model is used for the econometric estimation of equation 6. The binary variable to explain is the decision about the alternative (accepted/not accepted). The attributes, some of them also in quadratic form, and interaction between attributes are used as explanatory variables. Therefore, the four options for work content are transferred into three binary variables, whereas the dairy production (status quo) is omitted. The terms of employment are treated similarly (employed = 1, self-

employed = 0). For income (CHF) and holiday (weeks) continuous variables are applied.

For the estimation process we start with all variables. Variables without influence are identified by the likelihood ratio test and are omitted. Alternatively we apply the AIC-procedure, which leads to the same result.

IV. RESULTS

Table 2 shows the probit model. To test the explanatory power we compare the model with a reduced version. The latter comprises no variables (only intercept). Using the likelihood ratio test, the null hypothesis (no significant explanatory with all variables used) is rejected on the 0.1 percent level.

Table 2 Probit Model

Variable	Co-efficient	Z Value	Pr(>|z|)	Odds Ratio
Intercept	0.01	0.22	0.829	1.01
Income	4.51E-05	7.76	<0.0001	1.00
Income square	-8.67E-10	-4.12	<0.0001	1.00
Suckler cow	-1.23	-15.4	<0.0001	0.29
Without livestock	-1.14	-14.5	<0.0001	0.32
Out of agriculture	-1.47	-12.4	<0.0001	0.23
Employed	-1.15	-8.83	<0.0001	0.32
Holiday	0.45	9.97	<0.0001	1.56
Holiday square	-0.11	-8.54	<0.0001	0.90
Income*Employed	-8.78E-06	-1.42	0.155	1.00
Income* Out of agriculture	-8.94E-06	-2.03	0.043	1.00
Without livestock* Employed	0.96	5.48	<0.0001	2.61
Out of agriculture* Employed	1.13	6.23	<0.0001	3.08
Out of agriculture* Holiday	0.10	2.53	0.011	1.11

Log Likelihood: -1602; df = 14, n = 3333

With the exception that includes the intercept as well as two of the interaction terms the coefficients of all variables are highly significant. Since the coefficients of logistics regression are not meaningful, we present the odds ratios [relation of probability to accept to probability not to accept = p/(1-p)].

Income has a minimal but highly significant influence on the decision. If the coefficient is

multiplied by 1000, which means an income increase of CHF 1000.-, odds ratio is increasing towards 1,05. Accordingly, additional income supports the decision to choose an alternative.

The odds ratios for the four variables SUCKLER COWS husbandry, farming WITHOUT LIVESTOCK, OUT OF AGRICULTURE and EMPLOYED are rather low. A decision towards an alternative, which comprises one of them, is unlikely. Finally, the odds ratio for an additional week of holiday is in favour to choose an alternative.

Based on the coefficients of table 2 the marginal rate of substitution resp. the willingness to pay/accept is calculated for the status quo (table 3). Therefore, the first derivatives are necessary.

Table 3 Marginal willingness to pay/accept at the status quo

Variable	CHF
Suckler cow	27'279.-
Without livestock	25'261.-
Out of agriculture	32'557.-
Employed	25'416.-
Holiday	-9871.-

The signs are as expected. Due to the fact that the coefficient for income is rather small, the amounts are high. A dairy farmer requires an additional income per year of CHF 27'279.- or CHF 2273.- per month to switch to SUCKLER COWS husbandry. This value reaches between 70 and 90 percent of the work income per family member reported in section one. The result for farming WITHOUT LIVESTOCK is slightly lower, which indicates that both alternatives SUCKLER COW husbandry and farming WITHOUT LIVESTOCK are comparable for dairy farmers. To work outside agriculture needs a compensation, which is around 20 percent higher than SUCKLER COW. To be EMPLOYED instead of self-employment (status quo) requires an amount of CHF 25'416.-. For an additional week of holiday, dairy farmers show a willingness to pay of CHF 9871.-. This value is far above the monthly income.

V. CONCLUSIONS

The paper analyzes the preferences of dairy farmers with respect to their work, who intend to produce milk beyond the quota abolishment in 2009. A Discrete Choice experiment is carried out, which leads to distinct results.

For dairy farmers income plays a minor role. Highly important is the work content. For all three alternative work contents (SUCKLER COW husbandry, farming WITHOUT LIVESTOCK and OUT OF AGRICULTURE) a compensation of at least CHF 25'200.- per year is necessary, which is more than 60 percent of income per family member in dairy production. As well known in literature the willingness to accept has a tendency to be overestimated [13]. Even under consideration of this aspect, there is an enormous preference to stay in dairy production. If we compare the willingness to pay for the two alternatives SUCKLER COW husbandry and farming WITHOUT LIVESTOCK we have to conclude, that cows without the production of milk (SUCKLER COWS) is not a real option for a dairy farmer.

The shown preferences lead to three further conclusions:

- First, there is evidence that dairy farmer in Switzerland have nonpecuniary motives.

- Second, the moderate structural change of dairy farms in the past and the small structural conditions today can be explained. To stop dairy farming and to find immediate job with an additional income of CHF 30'000.- is rather unlikely. To stay in the sector is the consequence.

- Finally, an agricultural policy program in order to motivate dairy farmers to stop milk production is likely to fail, since the necessary annual compensation is rather high.

From a methodological point, an extension should be made in future. A more detailed specification towards a random effects model will be carried out in order to consider farm specific effects. Furthermore, for several subgroups (region, age or education) the analysis will be conducted out separately.

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