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– a hedonic price study on dairy and plant based milk

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Abstract

The total number of milk cows in Sweden is decreasing and at the same time the market for plant based milk made of oat, almond, and soy beans is expanding. Society provides easy access to information and the choices of what to buy and eat are numerous. The need of understanding the market demand, how prices are determined and what factors are affecting the prices are therefore highly relevant and interlinked topics. This thesis will therefore estimate a price function for fresh milk in Sweden with the aim of determining the willingness to pay for plant based milk and to see if and in that case, how much, socioeconomic and demographic variables are influencing the milk price. A hedonic price model is applied using household scanner data from the year 2011. The results from the regression show that the willingness to pay for plant based milk is 32 % higher than the average milk price and the variable urban has a price premium of 4,3 %, indicating that the average price of milk is 4,3 % higher in urban areas, compared to rural areas. The results from the study give incentives for future research to further investigate the determinants of the milk price and the reasons behind the consumers' demand.

Contents

1. Introduction

This chapter will give an introduction to the research problem in this thesis and give a brief explanation of how the milk market looks today and explain some of the incentives from the government to promote Swedish food production. The purpose and research question for the thesis will be presented and in the end of the chapter will the limitations and disposition for the study be given.

1.1 Background

The Swedish milk market has gone through several big changes during the years. Initially being a protected agricultural area with guarantee prices and later milk quotas, the Swedish milk market is now unregulated since the 1st April 2015 (Dagens Nyheter, 2015). At the same time the modern society contains easy access to information and there is a huge variety of purchasing choices. Should we buy organic, locally produced or eat more vegetarian food? The choices are many for the consumer and there are a lot of questions as to why consumers and households behave the way they do. From the producer ‘s perspective, it is also interesting to see how they can benefit from a better understanding of what factors are influencing the consumers’ purchasing behaviour. The need of understanding how prices are determined and what factors are affecting the prices are therefore crucial for a comprehensive understanding of the subject.

Many Swedish milk farms have had difficulties surviving financially and the total number of milk cows in Sweden decreased during the year 2016 (svt, 2017). For some farmers, the solution has been to turn into organic production since organic farmers receive extra payment for the organic milk. Since 2015 it is possible for farmers to get compensation for organic production as part of the Swedish Rural Development Program (Jordbruksverket, 2016). The aim is to increase organic production. The Swedish Rural Development Program 2014-2020 consists of support and compensation and aims to develop the countryside. Prioritized areas are environment, sustainable development and innovations. This program is part of reaching the goals in EU’s growth strategy (Jordbruksverket, 2016).

The national food strategy, which is also part of the Swedish Rural Development Program, aims to promote a competitive food production in Sweden. From an international perspective, the Swedish food production is both environmental and climate effective and it has a high standard regarding animal welfare (Näringsdepartementet, 2016). The interest for healthy and sustainable produce is part of a growing market which also benefits Swedish exports. The common denominator is that there is a need of increased knowledge about the consumers’ demand and preferences.

There are several different methods on how to measure public goods and the economic value of environmental benefits or environmental impacts, of which one of them is hedonic pricing. Consumers’ preferences toward organic and local food products have been well documented in agricultural economics but there are still questions left to be answered. Many of the existing studies relate to fresh fruit and vegetables and not as much focus have been paid to

dairy products. Few studies investigate the willingness to pay for plant based milk. Moreover, there are two common ways of analysing consumers' preferences, by revealed and stated preferences. Many studies use the stated preference approach, where people are given choices by hypothetical surveys. The Contingent Valuation (CV) method is an example of a method which uses stated preferences to investigate the willingness to pay. A potential risk with using stated preferences methods is that there could be a bias in the estimated results, if the consumers' responses in the survey do not coincide with their actual purchasing behaviour. The revealed preference method however, of which hedonic pricing is one, is able to capture consumers' actual purchases and thus is able to give a more accurate description of the willingness to pay.

At the same time that the selling of conventional dairy milk is decreasing, the market for alternative milk, plant based milk made of for example oat, almond and soy beans is increasing (Sveriges radio, 2015). Even though the plant based milk stands for a small share of the total milk consumption in Sweden, it would be interesting to investigate the milk market with regard to both conventional dairy milk and with a special focus on plant based milk. This thesis will therefore study the milk market with the aim of estimating a price function for the price on fresh milk, it will determine if and by how much socioeconomic and demographic variables affect the price of fresh milk and will focus on the willingness to pay for plant based milk.

1.2 Purpose and research question

The purpose of this paper is to investigate how the implicit valuation on different attributes and household characteristics affect the milk prices by analysing the observed consumer choices made in a survey with heterogeneous bundles of milk attributes and household characteristics. It will focus on determining the willingness to pay for plant based milk.

My research question is as follows; *"how are milk prices affected by attributes such as the fat content, whether the milk is plant based or dairy milk and how are socioeconomic and demographic factors such as household size and geographical location affecting the milk price?"* Hopefully, this paper can answer these questions and help to increase the knowledge about the determinants of milk prices in Sweden and to better understand how different attributes and sociodemographic factors are influencing the milk price.

My hypothesis is that some of the sociodemographic factors have an impact on the price of fresh milk and it will be interesting to examine if and by how much these factors could influence the milk price. A previous study made on the demand character in organic food markets has shown that the budget share of organic food is higher in urban areas (Wier et al., 2008). A hypothesis could therefore be to test if the price of milk is affected by whether it's consumed in urban or in rural areas. The variable "urban" ought to have a positive impact if it can be expected that the price should be somewhat higher in urban areas, than in rural ones. The willingness to pay is positively linked to the income level as a higher income means that

more money can be spent on a certain product (Brännlund and Kriström, 2012). It is therefore interesting to see if higher income leads to higher milk prices in this study.

1.3 Limitations

Limitations have been made so as to narrow the scope of this thesis to only the price of milk consumed in Sweden and to divide the different categories of milk into light, medium, standard and other cow milk (for some special and not so common milk alternatives) regarding the dairy milk and to regard plant based milk made of oat, almond, rice and soybeans. Due to the small number of observations on the different categories of plant based milk I am going to examine plant based milk as one category of attributes when it comes to estimating the price function for milk. It would be interesting to also look at how factors like organic and locally produced variables may affect the price but the lack of specific data on these characteristics have limited the scope of the research.

The determinants of the milk price are limited to the characteristics that can be found in the data used in this model. This limits the study to consider the milk attributes fat content, plant based or dairy milk and to regard sociodemographic factors such as household income, household size and geographical location. It could seem that the sociodemographic factors are not such a big determinant of the milk price but this is going to be examined in the paper.

1.4 Disposition

The first chapter gives an introduction and background to the subject which is necessary in order to examine the subject in a broader context and to understand why it is an interesting and important field to study. The first chapter then continues with the purpose and research question and finishes with the limitations of the research. Chapter two consists of a literature review where earlier studies dealing with hedonic pricing and similar studies related to the subject are being presented. The theory needed to answer the research question will also be given. In the third chapter the method used to solve the research question will be presented along with an explanation of the data and variables used in the project. The results of the research will be presented in chapter four together with tables and texts that explain the numbers. A discussion of the results will be given in chapter five and in the last chapter the research question is answered and suggestions for future research are formulated.

2. Theoretical framework

This section starts with a briefing on previous research done in similar areas, which is relevant for this research. The previous research will be briefly summarized and the results of these studies will subsequently be discussed and referred to. In the following part of the chapter the theory about hedonic price modelling will be presented.

2.1 Literature review

Several studies have been undertaken in order to estimate price functions for different goods. The hedonic price technique has been widely used in studies regarding pollution and the valuation of clean air (Perman et al, 2003). Clean air is not a traded good but is an attribute that seems to have an impact on property prices. By looking at revealed preferences and holding other things equal, a positive relationship between house prices that people are willing to pay and the air quality can be established. Another field where hedonic pricing has been used is to examine the implicit valuation that consumers place on different labelling attributes in the wine market. Bodo Steiner (2002) has researched the implicit price for different wine labelling attributes by using a hedonic price function on a large number of wine bottles that were uniquely identified by labelling attributes such as region of origin, vintage etc.

One of the studies that I have read that is most similar to my research relates to the organic food markets in Great Britain and Denmark (Wier et al. 2008). In this study, the authors have investigated the food market in two European countries and identified the main differences and similarities between the markets. They focus on the consumers' priorities and perceptions, labelling schemes and sales channels and look at the prospects for future growth. In the study they use a set of household panel data that both include registered purchasing behaviour as well as information on stated values and concerns. The results show that there are several important factors in the decision to buy organic food. One of the most important factors is the "private good" attributes such as freshness, taste and health benefits. However, the valued attributes of organic food also include "public good" attributes such as animal welfare and environmental protection. The sociodemographic factors in the study show that the organic budget share is increased by factors such as higher disposable income, higher educational level and older age groups. Urbanisation also affects the organic budget share and the study shows that the budget share for organic is higher in urban areas, compared to rural areas.

In a study about the market for fluid milk in Hawaii (Loke et al. 2015), the authors have established price premiums for organic, local and other product attributes for fluid milk in Hawaii. This was done by applying hedonic price modelling to retail scanner data, which showed the consumers' revealed preferences. The authors used a Nielsen scanner data set with data from 3 major grocery chains and 19 different stores in the Honolulu metropolitan area. During the year 2011, weekly sales of local and imported fluid milk products were

recorded. Important data that were collected included weekly sales amount and sales units, organic origin, nutritional benefits claimed, fat content and package size. The average price per pound for each product was then computed and a total of 5 446 observations were used. A log-linear regression was estimated with the logarithm of the price per pound as the dependent variable and the independent variables organic, local, nutritional benefits claimed, fat content and package size were represented by binary variables.

There is a need of understanding how the markets are responding to the expanding proportion of organic and local food and the authors in this study found that both organic and local attributes have price premiums over imported, conventional, whole fluid milk. The estimated organic price premium was 24,6 % and for the local attribute the price premium was estimated to 17,4 %. Apart from that, they estimated a price premium of 19,7 % for nutritional benefits that were claimed. This could be interpreted that the nutrition information on food is valued as both beneficial and valuable. The reference category in the regressions is whole milk with the attributes imported, conventional, without nutrition claims and packaged in the smallest size. The results concerning the fat content exhibit minor price variations across the different categories of milk. Fat free milk has a price discount of 3 % compared to the reference category. According to this study, fat content should have a positive market value. One conclusion from the authors is that local producers could introduce more differentiated products in order to meet the consumers' needs.

2.2 The hedonic price model

Hedonic pricing is a common method to use when estimating price functions for different goods. It is the result of quality differentiated products sold in competitive markets (Haab and McConnell, 2002). By looking at the systematic variation in price of a good that is related to different characteristics of the good, it is possible to understand the willingness to pay for the characteristics. There are a lot of factors that affect the price of a good and hedonic pricing is a useful method to value non market goods such as ecosystem or environmental services (ecosystem valuation, 2000). The method has been widely used to estimate the variation in house prices due to different environmental attributes, but it can also be used to estimate the price for food products such as wine, vegetables and so on. The important basis is that the price of a good is related to its characteristics. The model was first used by Waugh in 1926 when he studied the price differences in fresh vegetables. It has since been developed further but it was not until Rosen completed the hedonic model that it was fully understood (Haab and McConnell, 2002).

A product in a differentiated market can be described with *n* attributes or characteristics, $z = (z_1, z_2, \ldots, z_n)$. Each product has a market price and is associated with a fixed value of the vector z, so the price of the product can be described by a function, $p(z) = p(z_1, z_2, \ldots, z_n)$. The price function gives the minimum price for any package of characteristics (Rosen, 1974). The equilibrium price, p(z), is determined by the consumers' tastes and the producers' costs. Under the hedonic theory, the price of a good depends both on the utility delivered by these

attributes and on the production costs of the good, thus reflecting market equilibrium where consumer demand meets market supply (Loke et al. 2015).

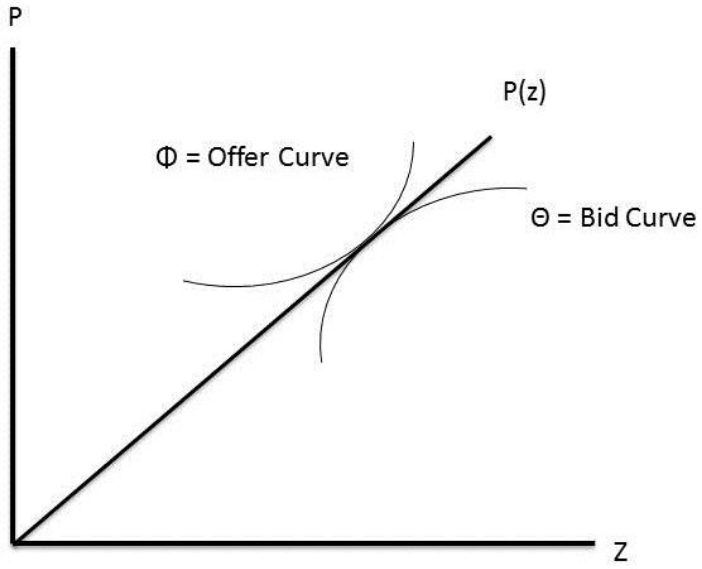
Consumers always tries to maximize their utility and the utility function can be written as $U(z_1, z_2,\ldots, z_n, x)$, where x is all other goods consumed and each z is a characteristic of a good Z. The price of x is set equal to 1 and the income, y, is distributed between the different goods; $y = x + p(z)$. The consumer chooses quantities of x and z by maximizing the utility function with respect to the budget constraint. The first-order condition for maximizing utility with respect to the budget constraint is $dp/dz_1 = p_i = U_{zi}/U_x$ (Rosen, 1974). The first-order condition for the optimization problem means that the marginal rate of substitution between one of the characteristics and the composite good is equal to the marginal price of the characteristic (Palmquist, 1991).

The expenditure a consumer is willing to pay for a product with characteristics z at a given income and utility index is described by the bid function, $\theta(z; u, y)$. At the same time, the minimum price for z in the market is $p(z)$. Utility is then maximized when $\theta(z^*; u^*, y) = p(z^*)$, where z* and u* are optimum quantities. This means that in equilibrium, the bid function is equal to the price.

Producers can be described in a similar way as consumers. As Palmquist (1991) describes Rosen's model; M(z) is the number of units produced by a firm and the cost function can be represented by $C(M, z; \beta)$ where β is a vector of firm-specific technologies and factor prices. Each firm maximizes profit, $\pi = M^*p(z) - C(M, z; \beta)$, by choosing M and z optimally. The first-order condition requires that a product is chosen so that the marginal price for each characteristic is equal to the marginal cost per unit of increasing the amount of that characteristic. The output level is chosen so that the price of the product is equal to the production cost (Palmquist, 1991). The price per unit of good z that the firm is willing to accept at a constant profit when quantities produced are optimally chosen is the offer function, $\phi(z_1,\ldots z_n, \pi, \beta)$. Since ϕ is the price that the producers is willing to accept for good z and $p(z)$ is the maximum price for z in the market, profit is then maximized when $\phi(z_1^*,\ldots z_n, \pi^*, \beta) = p(z^*)$.

The equilibrium price is determined by the interaction of the consumers and the suppliers (Palmquist, 1991). As consumers wish to maximize their utility and producers wish to maximize their profit, the equilibrium prices are determined where consumers and producers are perfectly matched. At the equilibrium, no individual can improve their position and the optimal choices are feasible. This relationship between the consumers' bid functions and the producers' offer functions can be represented by Rosen's diagram, where the two curves are tangent to each other.

Figure 1. Hedonic equilibrium



Created in Microsoft Power Point

To estimate the hedonic price function, Ordinary Least Squares (OLS) is used. The coefficients in the regression in OLS are chosen so that the estimated regression line is as close as possible to the observed data. The closeness is measured by the sum of the squared mistakes made when predicting Y given X (Stock and Watson, 2015). The price function can then be written as $Y_i = \beta_0 + \beta_1 * X_i + u$, where β_0 is the intercept of the line and β_1 is the slope. The term u_i is the error term which contains all the other factors apart from X that determine the value of the dependent variable Y, for a specific observation *i* (ibid).

3. Method

This chapter will present the empirical work of creating a hedonic price equation for the milk price in Sweden. This includes giving an explanation of the data set and the variables that were used in the model. Summary statistics will also be given and explained.

3.1 Model

To be able to study the potential impact of different characteristics of the milk and sociodemographic factors on the milk price, a dataset with a large number of households and observations on the price of fresh milk together with different characteristics of each household is examined. By using a hedonic price model it is possible to get the implicit price for the different characteristics and to see how much the price is affected by each attribute. The milk price will be a function of the attributes fat content, whether the milk is plant based or dairy milk, sociodemographic factors and geographical location.

The basic model for hedonic pricing is;

$$\mathbf{P = \beta_0+\beta_1*Z_1+\beta_2*Z_2+\ldots.+\varepsilon}$$

This function tells that the price of fresh milk is a function of the attributes that affect the price. The Z_i's are different attributes and with this model it is possible to find out what the hedonic price is of a certain attribute or characteristic, or in other words words how much value that is linked to a certain attribute. The first derivative of the price with respect to one of the attributes gives the implicit price for that attribute. The error term is assumed to have a mean of zero and is therefore not included in the calculations.

3.2 Data

For this study, a large number of cross-sectional household scanner data has been used to cover the consumption patterns of Swedish milk consumption. The data is collected from a marketing consulting firm called GFK. During three years, from 2011 to 2013, the households have answered questions about their consumption of milk, both dairy milk and plant based milk and for this project, data is used from the year 2013. The data contains information about the households but also registered purchasing behaviour and covers 1220 households. The large number of observations and the fact that the households are spread all over Sweden and have different sociodemographic characteristics makes the analysis both detailed and informative.

In total there are 1220 households in the dataset but only 1091 of them are used in this model since 127 households did not answer the question regarding their income and two of the observations were outliers. Household income was one of the variables in the original model and as the result would be biased if the 127 non answering observations would be included in the model, I have not calculated with them. Outliers are observations with extreme values of X or Y (Stock and Watson, 2015). As large outliers can make the OLS regression misleading and two outliers were found in the data set, they were excluded from the model. Both of them

were extremely high prices in the milk group "Other Cow milk", one of the observations had a mean price of 152 Swedish crowns and the other 154 Swedish crowns per package.

The data used in the model includes information about the different milk groups; light, medium, standard, other cow milk (which includes different kinds of less common milk like mini milk, old fashioned, "rural", protein, unidentified, latte del barista, calcium and "others") and plant based milk (which consists of oat, soy, almond, rice and oat+). The data also includes information about the household size, geographical location (whether the household is urban or rural) and information about the occupation of the inhabitants in the household. This may also include students, part time working, retired and temporarily working.

The reference category in this study is medium milk bought by a full time worker in a rural area. The coefficients of the independent variables in the regression will then be able to explain if there are any differences in the price from the other attributes, compared to the reference category.

3.3 Variables

The dependent variable in this model is the price on fresh milk and a log linear model will be used as is the case in the study of Loke et al. (2015). This means that the price will be computed as the natural logarithm of the price. The regression model is then:

$$\text{Ln}\,(Y_i) = \beta_0 + \beta_1 * X_i + u_i$$

In a log linear model, a one unit change in X is represented by a (β_1*100) % change in Y (Stock and Watson, 2015).

All independent variables used in this model are binary variables except household size, which mean that they have the value 1 or 0 depending on whether they have a certain characteristic or not (Stock and Watson, 2015). For example, a binary variable (also called indicator variable or dummy variable), could be if a household is urban or rural (1 = urban, 0 = rural).

Table 1. Description of variables in hedonic regression

Variable	*Description*
Ln (price)	natural logarithm of average price per package
Plant based	1 if plant based, 0 otherwise
Other cow milk	1 if Other Cow milk, 0 otherwise
Light	1 if light milk, 0 otherwise
Standard	1 if standard milk, 0 otherwise
Household size	This is the only continuous variable
Urban	1 if urban, 0 otherwise
Retired	1 if retired, 0 otherwise
Part time working	1 if part time working, 0 otherwise
Student	1 if student, 0 otherwise
Temporarily working	1 if temporarily working, 0 otherwise

In this dataset, most of the households are urban as can be seen from the summary statistics and there is a considerable difference between how many households that buy the different milk categories. In this study, the reference category is medium milk as that is the milk group that is most frequently bought by the households. The summary statistics give a good overview of the distribution of the characteristics.

Table 2. Summary statistics

Variable	Mean	Median	Minimum	Maximum
Average_Price	10,7976	9,31169	4,87422	60,7553
Ln_AveragePrice	2,32293	2,23127	1,58396	4,10685
Dummy_PLANTBASED	0,139322	0,00000	0,00000	1,00000
Dummy_MEDIUM	0,863428	1,00000	0,00000	1,00000
Dummy_LIGHT	0,359303	0,00000	0,00000	1,00000
Dummy_STANDARD	0,708524	1,00000	0,00000	1,00000
Dummy_OtherCOWMILK	0,210816	0,00000	0,00000	1,00000
Household size	2,07608	2,00000	1,00000	6,00000
Dummy_urban	0,846013	1,00000	0,00000	1,00000
Dummy_Retired	0,288726	0,00000	0,00000	1,00000
Dummy_Part time working	0,146654	0,00000	0,00000	1,00000
Dummy_Student	0,0265811	0,00000	0,00000	1,00000
Dummy_Temporarily working	0,0751604	0,00000	0,00000	1,00000

The mean values for the binary variables show how many percentage of the observations that possess a certain characteristic. The summary statistics show for example that the majority of the households bought medium or standard milk. Only a small share, 13,9 % of the households in the data set, bought plant based milk and 21,1 % bought the milk group other cow milk. Moreover it can be seen that a majority of the observations, 84,6 %, are urban households. 28,8 % of the households are retired people, while only 2,7 % are students. The minimum value of the binary variables is zero and the maximum value is 1, as no other values are possible. The mean price for milk is 10,8 SEK, with a minimum price of 4,9 SEK and a maximum value of 60,8 SEK.

Only a small amount of the milk in this data set is plant based, which is important to remember when analyzing subsequently the results in the regression. A larger share of the more expensive milk groups would give a higher average price on milk and even if the willingness to pay is considerably higher for plant based milk than for example standard milk, there may only be a small group of people buying the more expensive milk. However, it is still interesting to see how this milk category is affecting the milk price.

4. Results

In this chapter the econometric results from the regression will be analysed and presented. Both a log linear and a linear model were envisaged but as the log linear model was found better fitted to this type of data, (the R^2 being very low in the linear model) this model is going to be analysed in this study. The relevance of the model will also be tested.

4.1 Nonlinear model

The chart below shows the result from the regression when the dependent variable is the natural logarithm of the price. The statistical program Gretl is used when estimating the regression with OLS. The model is corrected for heteroscedasticity with robust standard errors. 1091 observations are used in the model. The statistical significance is represented by the p-value with the signs ***, ** and * at 1, 5 and 10 % level, respectively.

Table 3. Results from the regression using OLS

Dependent variable: Natural logarithm of the average price (Ln_AveragePrice)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	2,29301	0,0316048	72,5526	<0,0001	***
Dummy_ PLANTBASED	0,316796	0,0269878	11,7385	<0,0001	***
Dummy_LIGHT	−0,0177368	0,0180403	−0,9832	0,3257	
Dummy_ STANDARD	−0,00720566	0,0199672	−0,3609	0,7183	
Dummy_Other COW MILK	0,0964864	0,0275971	3,4962	0,0005	***
Household size	−0,0181098	0,00880073	−2,0578	0,0399	**
Dummy_urban	0,0429615	0,0199558	2,1528	0,0316	**
Dummy_Retired	−0,0758047	0,0183486	−4,1314	<0,0001	***
Dummy_Part time working	0,0186573	0,0295704	0,6309	0,5282	
Dummy_ Student	−0,0303578	0,057035	−0,5323	0,5947	
Dummy_ Temporarily working	−0,0248609	0,0335511	−0,7410	0,4589	

Mean dependent var	2,322935	S.D. dependent var	0,306143
Sum squared resid	84,70458	S.E. of regression	0,280054
R-squared	0,170851	Adjusted R-squared	0,163174
F(10, 1080)	18,30209	P-value(F)	3.22e-31
Log-likelihood	−153,9384	Akaike criterion	329,8767
Schwarz criterion	384,8201	Hannan-Quinn	350,6706

The constant and the coefficients for plant based milk, other cow milk and retirement show significance at 1 % level. The coefficients for household size and urban areas show significance at 5 % level. Generally the coefficients showed expected results.

According to the coefficients from the regression the hedonic price function is;

Ln(Price) = 2,29301 + 0,316796*Plant based - 0,0177368*Light milk - 0,00720566*Standard + 0,0964864*Other Cow milk - 0,0181098*Household size + 0,0429615*Urban - 0,0758047*Retired+ 0,0186573*Part time working - 0,0303578*Student - 0,0248609*Temporarily working

The willingness to pay for plant based milk is approximately 32 % higher than for the reference category medium milk. This result can be compared to the price premium for organic milk in the study by Loke et al. (2015). They found that the price premium for organic milk is 24,6 % and besides that, they also estimated a price premium for nutritional benefits that were claimed on some products to 19,7 %. Thus, it seems quite reasonable that the willingness to pay for plant based milk is about 30 %. The price premium for the milk group other cow milk is estimated to be 9,6 %.

The coefficient for urban is 0,043, which means that the willingness to pay for milk is somewhat higher in urban areas, compared to rural areas. The average price of milk is approximately 4,3 % higher in urban areas. This is a quite interesting result if compared to the study by Wier et al. (2008). They found that sociodemographic factors may influence the organic budget share. For example did they show that the organic budget share is increased by factors such as higher disposable income and the budget share for organic was also higher in urban areas, compared to rural areas. This study does not look at organic milk but it is nevertheless interesting to see that people in urban areas are willing to pay more for milk.

The coefficient for household size is – 0,018, which implies that bigger households in general tend to buy less expensive milk. The coefficient for retired people is – 0,076 which suggest that retired people tend to buy less expensive milk, compared to a full time worker. According to Brännlund and Kriström (2012), the willingness to pay is linked to the income level and the result from this regression thus seems credible as these groups could have a more strained economy than for example a full time working couple. The income level has also been found significant in earlier studies. Wier et al. (2008) found that higher disposable income was connected to a higher share of the budget spent on organic products.

The coefficients for light and standard milk were found to be insignificant. Loke et al. (2015) estimated a price discount for fat free milk of 3 % and made the conclusion that fat content should have a positive market value. The insignificance of these milk groups in this study is not surprising though, with regard to the small difference in price between light, medium and standard milk.

The price model can also be written without the natural logarithm of the price as dependent variable. The model then looks like;

$$Price = e^{2,29301 + 0,316796*Plant\ based - 0,0177368*Light\ milk - 0,00720566*Standard + 0,0964864*Other\ Cow\ milk - 0,0181098*Household\ size + 0,0429615*Urban - 0,0758047*Retired + 0,0186573*\ Part\ time\ working - 0,0303578*Student - 0,0248609*Temporarily\ working}$$

The average price for milk is then;

$$Price = e^{2,29301 + 0,316796*0,139322 - 0,0177368*\ 0,359303 - 0,00720566*0,708524 + 0,0964864*0,210816 - 0,0181098*2,07608 + 0,0429615*0,846013 - 0,0758047*0,288726 + 0,0186573*0,146654 - 0,0303578*0,0265811 - 0,0248609*0,0751604 = 10,20555047}$$

The average price for milk is 10,2 SEK and from this the price premium for plant based milk can be calculated;

Price premium for plant based milk: 0,316796*10,20555047 = 3,23 SEK

This may seem as a quite low value for the price premium for plant based milk but as mentioned earlier, the average price function is determined by the percentage share multiplied by the coefficients for the different attributes. The fact that only a small share of the total milk consumption consists of the more expensive milk groups, make the whole price function less expensive than if plant based milk had represented a bigger share of the total consumption. It is therefore a better measure to look at the willingness to pay in terms of percentage of the price.

4.2 Econometric credibility

To measure the credibility of the model, several factors may be of interest. From the model it can be seen that the adjusted R^2 value is 0,16 if rounded to two decimals. This means that 16 % of the variance in the price of milk is explained by the independent variables in the model. The R^2 is lower than in the study by Loke et al. (2015) but with regard to the restricted number of independent variables that were used in this model, the R^2 still explains some parts of the variation in the price. The standard error of regression (SER) is another measure of fit in multiple regression. The standard error of regression estimates the standard deviation of the

error term, u_i and is therefore a measure of the spread of the distribution of Y around the regression line. The SER is in this study 0,28 which indicates that the distance between the observed values and the estimated values from the regression is quite small.

In order to test if there is multicollinearity between the regressors, a Variance Inflation Factor (VIF) test was conducted. The variance inflation factor is equal to 1 if there is no correlation between the independent variable that is being investigated and the remaining independent variables (PennState Eberly College of Science, 2017). A VIF over 10 is a sign of multicollinearity between the independent variables.

Table 4. Variance Inflation Factors

Variables	Value
Plant based	1,012
Standard	1,029
Other Cow milk	1,041
Household size	1,083
Urban	1,023
Pensionär	1,223
Deltid	1,136
Studerande	1,036
Tillfälligt arbetande	1,081

According to the test, there is no multicollinearity between the independent variables.

5. Discussion and conclusion

The aim of this study was to estimate a price function for the price of fresh milk and to investigate if and in that case how, different attributes and sociodemographic factors are influencing the milk price. The focus was on determining the willingness to pay for plant based milk. The method that has been used in order to estimate the value of the attributes was to create a hedonic price function. The research question was;

"How are milk prices affected by attributes such as the fat content, whether the milk is plant based or dairy milk and how are socioeconomic and demographic factors such as household size and geographical location affecting the milk price?"

The results from the study imply that the attributes plant based milk, special milk (the milk group "other cow milk") and the socioeconomic and demographic factors household size, urban and retirement have significant results. The coefficient of determination, R^2, was 0,16 which means that the model predicts 16 % of the variance in price. This could be an incentive for further research to investigate what other variables could be a possible determinant of the price. The results from the regression mainly showed expected results and several of the variables from the original data set were found significant.

The willingness to pay for plant based milk was estimated to be 32 % higher than for the reference category. Plant based is thus the attribute with the highest impact on the price in this study. The milk group other cow milk has a price premium of 9,6 % while the sociodemographic factors have smaller impacts on the price. The price is approximately 4,3 % higher in urban areas, compared to rural areas. The household size and people who are retired also seem to have a small connection to the price. Even if the price in the store for a certain product is the same regardless of which type of household that is buying it, this relationship may show that larger households and retired people tend to choose less expensive milk.

One of the assumptions in the hedonic price theory is that perfect competition is assumed and that consumers and producers are price-takers with perfect information about the market (Loke et al. 2015). This implies that the consumer should know exactly what she or he is paying for, an assumption that may be hard to achieve in reality when it comes to small expenditures like food products. It seems more reasonable that the consumer makes an effort of finding as much information as possible when it comes to bigger expenditures, for example when buying a house. Another weakness with this model is that it only explains parts of the variation in price, which means that some variables that are important for the determination of the price can be excluded.

The results from this study raise several interesting questions. First of all, it can be discussed why people are willing to pay more for plant based milk than for dairy milk. Some similarities to previous studies made in this area could give possible explanations. Loke et al. (2015) found that the attribute nutritional benefits had a price premium of 19,7 % on fluid milk in Hawaii. This suggests that consumers value healthy products and find them beneficial. Plant based milk is taking increasingly more of the market share from dairy milk in Sweden (Råd & Rön, 2015). The reasons to the increasing popularity of these products are many. There is

growing health awareness among many consumers and after recent reports suggesting that milk is not so healthy, many consumers have tried plant based milk. The debate about organic food may also have influenced the sales.

It would be useful to have more variables like "people with allergies" to see why people buy plant based milk. It would also be interesting if the plant based milk could be compared with a variable for organically produced in the same study. If a household is buying mostly organic milk and plant based milk it would be easy to assume that they value some environmental or health benefits but if the household instead claimed that they were allergic and bought plant based milk of that reason, different conclusions could be reached. More preferences and stated values from consumers regarding food and environmental issues would also be good in order to be able to compare with their actual purchases and this would provide a deepened understanding of consumers' demands and the reasons that lie underneath them. Both the study by Wier et al. (2008) and Loke et al. (2015) imply that consumers value organic and nutritional benefits. Loke et al. (2015) found that both organic and nutritional benefits had positive price premiums on the price of milk. Wier et al. (2008) found that health attributes are one important reason as to why people value organic food.

As a conclusion the Swedish milk market is becoming more and more differentiated due to consumers evolving preferences. It is clear that plant based milk has a positive market value and is becoming more common among the other milk products in Swedish supermarkets. The results from this study is of interest to both policy makers when designing future food strategies but it may as well be of interest to producers who could differentiate their products or choose to offer new products in order to meet the diversified market demand. For future research there are therefore incentives to further investigate why people buy plant based milk and why it costs more than dairy milk and whether the willingness to pay coincide with some positive external effects from producing plant based milk instead from dairy milk.

The goal with the Swedish food strategy is to promote a competitive food industry and thus increase innovation, production, profitability and employment at the same time that the relevant national environmental goals are reached (Näringsdepartementet, 2016). The aim of this study has been to fill the knowledge gap about the willingness to pay for plant based milk and to better understand how sociodemographic factors may influence the price of fresh milk. Which route the food strategies take depends on how policy makers choose to interpret the strategies. There is a need for increased knowledge about market demand and how we can maintain a living and productive countryside. Hopefully this kind of information will be helpful when creating new food strategies and there are certainly incentives for many interesting and relevant studies to follow in this field.

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