Driving factors for school milk demand in Germany

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Abstract: School milk consumption has declined steadily in Germany. A research project was set up to retrieve quantifiable information on the different factors of influence and to develop solutions to improve the school milk consumption.. The main goal is to evaluate the impact of price, product range, distribution form, information campaigns, regional situation, county-based social index, socially-funded school milk distribution, and gender shares, as well as the immigration background share within a class. A total of 400 primary schools were selected by stratified random sampling. Surveys for principals and school milk managers were used to gain information on distribution problems throughout the milk chain, on the handling, and their attitudes towards school milk and milk in general. The price of school milk is being reduced stepwise in the 2008/09 school year. The quantity of consumption is reported per class. A multilevel analysis is applied to determine the factors driving consumption at the class level. First results will be validated. The paper comprises an extended introduction, followed by the research approach. A descriptive analysis is given following a detailed description of the experiment.. The estimation procedure is discussed before the results are presented. Finally, a qualification of outcomes and conclusions concerning further research are found.

Keywords: School Milk, Demand Subsidy, Food Demand, Multilevel Analysis.

1. Introduction

School milk sales have a long tradition with a two-fold objective: to win new consumers on the one hand, and to improve the nutritional situation of children by education on the other. EU budget support for school milk was established as a consumption aid in 1972. In Germany, the consumption of school milk has declined steadily since 1993. At present, 300,000 tonnes of milk equivalents are consumed within the school milk programmes of the EU, of which 41,000 tonnes are consumed by German children.

Several factors influencing the downward development in school milk consumption have been mentioned. These are related to the whole production, processing and distribution chain of school milk, but also to consumers and institutional price setting. Since 1993, the school milk subsidy has been reduced from 40 cents/kg milk to the current 18.15 cents/kg. Furthermore, discussions about adequate packaging had a negative impact on demand. Declining numbers of milk processing and delivering companies have made school milk less accessible, since the less profitable school dairy production line could not always be retained in the concentration process. In addition, the product range of school milk is limited as is the cooling capacity in schools. Financial pressure has decreased the technical staff at schools over time, thus causing a decline in the number of people who are willing to distribute/sell school milk.

An experiment and an accompanying research project[1] were set up by the German Federal Ministry of Food, Agriculture and Consumer Protection, supported by a state government[2] and the dairy industry, to retrieve quantifiable information on the different factors contributing to the school milk demand and to develop solutions to improve the school milk consumption.. In order to identify main factors driving school milk consumption along the whole school milk chain, a broad study was carried out in North Rhine Westphalia, a federal state located in western Germany. Within the complex project, our focus is on the following questions:

1) What impact does the price, respectively the school milk aid, have on the demand for school milk?
2) What socio-economic factors influence the school milk consumption?
3) To what extent is school milk substituted by other products?

[1] The project is conducted in cooperation with the Department of Nutritional Behaviour of the Max Rubner-Institut (MRI), Federal Research Institute of Nutrition and Food, Karlsruhe.
[2] State office for nature, environment and consumer protection, North Rhine Westphalia.

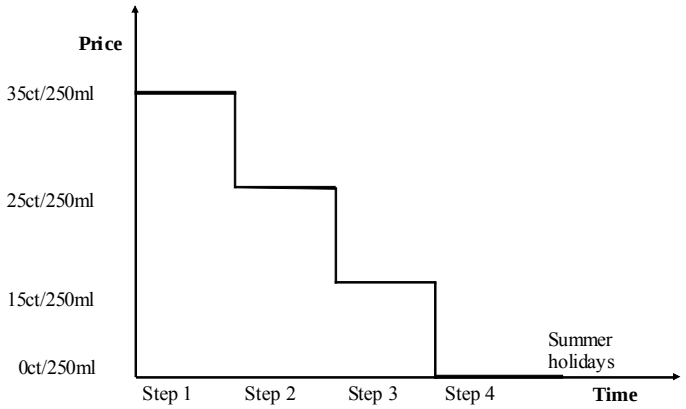
4) How does the situation in the selected schools and classes, including gender shares, immigration background shares, class years, attitudes of the principal and the school milk manager influence consumer share of school milk in class ?
5) Which impact does the range of products offered have on school milk demand?
6) To what extent do different distribution forms influence the demand?

This paper only considers a small slice of the objectives mentioned above, namely the price's impact and the influence of the situation in the selected schools and class years. It is structured as follows: first, a short description of the general design of the project is presented to enable the reader to classify the results in context and to better understand the related problems and caveats. Data generated by the project and used in the context of this paper are described in the same section. In the following, a short literature review is provided on school milk. A further section describes the applied methods. Based on the available data, a factor analysis is conducted to extract main factors influencing the attitude of some agents and a demand model is derived to allow for demand estimations under the given circumstances. Subsequently, model results are presented and discussed. A final section deals with the caveats of the approach and draws some preliminary conclusions.

2. School milk project

2.1. General Design

The project consists of a main project and several satellite projects. The general setup is as follows. Different surveys[3] are carried out in North Rhine Westphalia. The objective is to gain information on the impacts of prices, different attitudes to milk, consumption preferences or consumption behaviour, school milk processing, distribution problems throughout the chain on school milk demand. Regarded levels are pupils and their parents, classes, class years, schools and suppliers of school milk. Originally, 525 primary schools in North Rhine Westphalia were selected by stratified random sampling for which all required information is compiled. Most data is generated by an experiment: In the participating schools, the price of school milk is gradually being reduced during the school year 2008/09 from 35 cents/250 ml (Price Step 1) via 25 cents (Price Step 2) and 15 cents (Price Step 3) to 0 cent/250 ml (Price Step 4) as shown in Figure 1. The amount of consumption is monitored at regular intervals.



Source: Own illustration.

Figure 1. Price changes of school milk

The quantity of consumption is reported in two ways, or rather, in two sub-samples: i) the so-called class sample consists of 400 primary schools, the consumption quantity is reported per class and for the class years 2, 3 and 4 in the German primary education system and ii) the so-called pupil sample comprises 125 primary schools, consumption is reported on a personal basis per consuming pupil. Although the data on demand can be merged with survey information in each sub-sample, in the latter, the consumption of school milk can be merged with richer additional information obtained by additional pupil and parent surveys (e.g., children's and parents' attitudes to milk, socio-economic indicators and eating habits). Based on additional information from principals and school milk managers, the handling of school milk, decisions on the product range and attitudes towards milk and school milk were obtained. In addition, supplemental data on classes such as gender share, share of

[3] Surveys were developed by our colleagues from MRI.

pupils with immigration background, share of socially funded school milk, social index of the county, and the regional location of the school are available.

Data from the pupil sample of about 12,500 children will only become available later on. Thus, this contributed paper will be based on information from the class sample which includes the principals' and school milk managers' surveys. Characteristics on the class sample are presented in more detail in Section 2.2.

2.2. Sample characteristics and descriptive statistics

Primary schools collect and periodically forward school milk's quantity consumed in different classes by their respective pupils. Because data collection has not yet been completed for all price steps, and because only plausible information on milk orders are to be considered, a sub-sample is applied for these analyses covering the first and the second steps of the project. Moreover, the sub-sample also reflects the fact that questionnaires for the principals and managers were returned by the schools included. Additionally, criteria are implemented to improve data quality and reliability. The availability of gender numbers in a specific class and number on pupils of immigration background, respectively, are subject to these selection criteria, . The apportionment of classes to the second, third and fourth year level is a further fundamental constraint. As a result of age-dependent demand, all classes with multiple class years were excluded form the study. Also, all classes with unknown class year were not mentioned for analysis. Finally, not only a plausible but also a sufficient number of order information per price step of each class considered is a samples's constraint.

Table 1 shows the descriptive data of the used class sub-sample. Selection criteria described above determine that 1,190 classes in 227 schools are considered for estimations. Most analysed schools (97 %) had already offered school milk before the experiment. An average school in the selected sub-sample consists of 140 pupils with a minimum of 16 pupils and a maximum of 271 pupils. These abnormal school sizes are a consequence of excluding individual classes due to the selection criteria. The remaining classes are split in the following way: 31 % of the primary school classes belong to the second year level, 32 % to third year level and 37 % to fourth year level. The proportion of pupils is distributed similarly to the classes.

Table 1. Sample characteristics

Variable	Total number	Percentage	Mean	Min	Max
Number of schools	**227**				
Number of classes	**1,190**				
• 2nd year	370	31.1			
• 3rd year	377	31.7			
• 4th year	443	37.2			
Number of pupils	**27,034**		22.7	3	38
• 2nd year	8,383	31.0	22.7	6	38
• 3rd year	8,625	31.9	22.9	3	34
• 4th year	10,026	37.1	22.6	3	35
Number of boys	**13,635**	**50.4**			
• 2nd year	4,246	50.7	11.5	3	26
• 3rd year	4,335	50.3	11.5	0	23
• 4th year	5,054	50.4	11.4	1	24
Number of girls	**13,399**	**49.6**			
• 2nd year	4,137	49.3	11.2	1	20
• 3rd year	4,290	49.7	11.4	1	21
• 4th year	4,972	49.6	11.2	0	20
Pupils with immigration background	**5,702**	**21.1**			
• 2nd year	1,745	20.8	5.1	0	22
• 3rd year	1,877	21.8	5.4	0	22
• 4th year	2,080	20.7	5.1	0	18

Source: Own calculations.

A total of 27,034 pupils within the sub-sample are analysed. Boys (girls) account for a gender share of 50.4 % (49.6 %). Pupils with immigration background represent approximately 21 %. Detailed information of the distribution between years is displayed in Table 1. To account for size effects, a discrete variable is generated. From this follows that the sub-sample consists of 283 small-sized (< 20 pupils), 605 medium-sized (21 to 25 pupils) and 302 large-sized (> 25 pupils) classes, respectively.

Further variables are required in the factor and multilevel analyses to represent more in-depth information at the school level. They mostly emanate from the principals' and managers' survey described in Section 2.1. Others,

for example, reflect on spatial aspects like the location of the school. The most relevant information from the total sub-sample available is presented in Table 2.

Table 2. Information available from the sub-sample

Information from the class sample information (class survey)	**Variable Format**
Consumer share of school milk in class	Real
Immigration background share	Real
Girls' share	Real
Former participation in the school milk program	Dummy
Number of pupils per class	Category
Social hotspot	Dummy
Social index	Integer
Price step	Category
Information from the principals' survey	
School milk package	Dummy for glass bottle
Decision-making of parents with respect to school milk consumption	Dummy
Joint consumption of school milk with breakfast	Dummy
Excessive time effort for the organisation of the school milk program	Dummy
Other measurements to improve nutrition in the school	Dummy
Measurements related to milk	Dummy
Information on principal's attitudes towards school milk and school meals	Several statements of multiple choice
Principals' age and sex	Integer
Type of school milk (full-fat or partly skimmed)	Dummy variables for 6 different school milk packages
Information from the school milk managers' survey	
Type of contractor	Dummy variable for main dairy industries
Daily sale of school milk in the school	Dummy
Weekly milk supply	Integer (from 1 to 5)
Schedule of the supply	Real
Deposit for the packages	Dummy
Disposal of the packages	Dummy for "packages are returned to the contractor"
Milk is stored in refrigerator	Dummy
The milk manager is paid additionally to sell and to organize the logistics	Dummy
Excessive time effort for organisation of the school milk program	Dummy
Other non-subsidised milk and dairy products are also offered in the school	Dummy
Other beverages are also offered in the school	Dummy
Position of the school milk manager	Dummy for caretaker, teacher and school principal
Information on school milk managers' attitudes towards school milk and school meals	Several statements of multiple choice
School milk managers' age and sex	Integer

Source: Own illustration.

For factor analysis, answers to different statements containing information on principals' and school milk managers' attitudes towards school milk, school meals and nutrition in general were studied. Methodologically, they are requested to rank statements from "totally disagree" to "totally agree" using a five-point Likert scale. The main objective of these questions is the determine whether principals' or school milk managers' attitudes towards healthy diets and school milk beneficially influence pupils' demand. In the case of the multilevel analysis, all variables to be obtained from the questionnaries, including the factors obtained from the factor analysis, were assessed. Additionally, other variables from the official statistics, such as the population of the town where the schools are located were regarded. However, the pre-selection of relevant variables to explain

school milk demand is done using correlation analysis. Thus, only variables correlated with the average share of consumers in a class were included in the multilevel analysis for two different price steps.

Based on the correlation analyses on the dependent variable and all possible determining data, some relevant survey items were selected and presented in Table 3 to inform the reader. The first two items are attitudes of school milk managers and the last one is of school principals. Nearly all school milk managers (97 %) favour the offering of school milk in their respective school.

A positive school milk manager attitude towards a healthy diet probably supports pupils' milk demand. But 50 % of school milk managers do not connect a healthy diet with a positive feeling. Only 22 % of school milk managers feel good about providing a healthy diet, whereas one out of four school milk managers is undecided.

School principals are often the supreme authority in deciding about a school milk supply in their school. Therefore, their attitude to school milk is a driving factor determining pupils' school milk consumption and the success of such public programs. Three out of four school principals have a good feeling when pupils drink school milk during a break, while only 8 % of school principals reject the question.

Table 3. Additional variables from the principals' and managers' surveys

Item		Total Number	Percentage
Place of milk delivery	Outside on school grounds	17	7.5
	Designated storage room	121	53.3
	Other place	87	38.3
	Missing	2	0.9
Offer of other non- subsidised milk and dairy products	Yes	66	29.1
	No	160	70.5
	Missing	1	0.4
Offer of other beverages	Yes	69	30.4
	No	156	68.7
	Missing	2	0.9
What is your personal opinion that your school offers pupils school milk	I'm in favour of it	221	97.4
	I disapprove	6	2.6
	Missing	0	0
I'm feeling well, if I have a healthy diet	I totally disagree	47	20.7
	I rather not agree	65	28.6
	Neutral	57	25.1
	I rather agree	28	12.3
	I totally agree	22	9.7
	Missing	8	3.5
I'm feeling well, if pupils drink school milk during break	I totally disagree	6	2.6
	I rather not agree	13	5.7
	Neutral	19	8.4
	I rather agree	94	41.4
	I totally agree	78	34.4
	Missing	17	7.5

Source: Own calculations.

Roughly about 53 % of school milk is delivered to designated storage rooms and, thus, requires no additional time on the part of the school milk manager. The remaining 46 % of milk deliveries necessitate additional work. Substitute products have a lasting effect on pupils' school milk demand. But only one third of the analysed schools make use of the option to offer other milk and dairy products without subsidies, or to offer beverages.

The observed schools are located in urban as well as rural areas. In order to differentiate structural effects of the geographical position and its potential retroaction on school milk's demand, the population size of the respective town is included in the analysis at the school level. Detailed statistics of the population of North Rhine Westphalia are not presented. However, an economic differentiation of the location of a school provides more significant insight into economic demand-based structures than the geographical differentiation. Somewhat more than 35 % of the 227 schools are located in such hot spots.

3. Theory and Model

3.1. Literature on school milk demand

Literature on the impact of school milk aid and other possible factors on school milk demand are scarce and can be regarded as less analytical from a scientific point of view. Articles focus more on describing the programs and looking at bivariate relationships between consumption and other factors. In principle, questions covered in the paper are i) Why were school milk programs implemented? ii) Which countries have or had applied school milk programs? iii) Which factors influence school milk consumption? In the latter question the influence of prices are highlighted.

i. In the 1930s and 1940s, school milk was encouraged to improve the nutritional status of pupils. "The school milk program contributes to the realization of one of the basic aims of education – health. (…) Moreover, milk is such a common food that no school usually has trouble getting milk delivered ready to be served." [10] In the case of New Zealand the Milk-In-School Scheme was introduced to fill a food deficiency [4]. In general, the nutritional value of milk is broadly mentioned [8][9][15]. Furthermore, school milk has been also seen as a way to stabilize the market for dairy products [2][18]. Today, it is also stressed that children are future milk consumers who not only consume more milk than adults, but whose dietary habits as established in childhood will persist into adult life [6].

ii. Surveys between 1979 and 1999 by the International Dairy Federation and FAO show the international coverage of school milk programs [6][9][15]. School milk programs were at that time well established in the EU, the USA, Japan and South Africa. According to a 1999 FAO survey the importance of school milk varies strongly across countries. While school milk in Thailand contributed to a significant share of 30 % of the national liquid milk market, for most countries the share was around 1 %. Most countries subsidise school milk; still, in about 30 % of the countries covered in the study the full price is charged but supported by promotional programs. Even where milk is available free, evidence from Scandinavia indicates, if other beverages are provided free of charge, milk must be promoted with measures like the provision of refrigerators/chilled vending machines [6].

iii. Different studies mention a variety of factors which influence the consumption of school milk, such as the availability of a school lunchroom, the attitude of the principal, teachers and parents, the operation of regular "milk breaks", the size of the school, the kind of school (primary or secondary schools), the type of the milk program[4], the product variety, the opportunity to cool the milk and the price charged by students [10][18][19]. A survey of 1,860 pupils in 75 primary and secondary schools in Germany in 1996/1997 illustrates the positive image of school milk, especially among pupils of primary schools. Among them 85 % consider milk as natural, healthy and sporty [19].

In terms of the price effect, consumption of milk and dairy products will increase with subsidization as compared to in the absence of the subsidy. This, in turn assumes that the milk price is an important factor influencing consumption and more responsiveness of demand to changes in price. Some reports state that the reduction of subsidies has led to reduced consumption over time [2][6][19]. Increased time input as a consequence of higher bureaucracy to apply subsidised school milk negatively affects the offer of school milk at the level of schools. Additionally, it becomes apparent that the effect of prices is age-dependent. Older pupils value school milk as less inexpensive than younger pupils. Whereas nearly 30 % of pupils of primary schools will buy school milk because of this valuation, the portion of pupils in secondary schools decreases to 15 % on average [19].

A 1961 report and extension of the U.S. special milk program in Illinois investigated the relationship between milk consumption and milk prices charged to students. It was based on an annual census of participating schools. Each year county superintendents were surveyed. But the report could not find conclusive evidence that decreasing prices led to increasing consumption. Noticeable consumption differences could be observed between free milk, where consumption is high, and all other subsidised milk prices [10]. An experiment carried out in 1956 tried to highlight the influence of prices on school milk consumption [3]. The prices had been reduced by 25 %, 50 % and 75 %, respectively. Milk consumption increased, but with differences between elementary and secondary schools, where at the primary school higher changes could be observed compared to the secondary school. It is mentioned that part of the increased consumption was induced by increased availability, as milk was served twice a day compared to once a day previously. It could not be excluded that school milk was substituted for home milk. Based on a mailed survey, 25 % of the additional consumption is attributed to substitution effects.

[4] There are two former programs in the USA, the National School Lunch Program and the Special Milk Program

3.2. Exploratory Factor Analysis

Within the analysis, it is assumed that the school milk consumption is also influenced by principals' and school milk managers' attitudes towards school milk and school meals in general. To identify these underlying structures within the data, exploratory factor analyses were carried out. This method analyses structures of interrelationships among variables by defining underlying dimensions, so called factors[5]. The five-point Likert-Scales used ranged from "I do not agree at all" to "I totally agree", whereas the wording of all statements are listed in Tables 6-9. The Measure of Sampling Adequacy (MSA)-Test, Kaiser-Meyer-Olkin (KMO)-Test and the Bartlett Test of Sphericity were run to ensure that the sample is suitable for factor analysis; results of these tests can be found in Table 4. We assume that factors will be correlated. Due to this fact we carry out an oblique factor rotation using a promax rotation on Level 4 [7].

3.3. Multilevel analysis

In the analysis, different decision-units are considered which have certain aspects in common while others may differ, e.g., some data is available on class level, but others are only applicable at the school level. Thus, a multilevel analysis is applied. In general, multilevel analysis is differentiated into hierarchical analysis, cross longitudinal analysis or mixed models [10][17]. These approaches share the assumption that indiviudal decision-making is dependent on their environmental clusters. However, the definition of clusters may differ and the variability between clusters must be taken into account. Individual decision making (micro-level units) is highly influenced by the surrounding conditions. The scope of these surrounding conditions reaches from spatial conditions (e.g., countries, states), via temporal conditions (e.g., different preferences over time) and hierarchical conditions (e.g., classes, schools, etc.) to social, cultural and economic conditions (e.g., religions, elites, etc.). These conditions might overlap or be nested [5].

Applied methodologies might be classified based on a) the equation design, and b) the variable choice. In the former, there are several possibilities to design the multilevel analysis: i) by writing separate equations at multiple levels; ii) by writing separate equations at multiple levels and then integrating all of them in a single equation; and iii) by writing a single equation that specifies the multiple sources of variation [16]. Several possibilities exist considering the variable choices: i) by choosing variables at the micro level (usually Level-1) which are a function of the surrounding conditions (upper levels), ii) by choosing variables at upper levels that model the inter-level relationship in terms of characteristics of the surrounding conditions, and iii) by mixing variables from the micro level and the upper levels in the model to reflect the relationship at a multilevel [5][10].

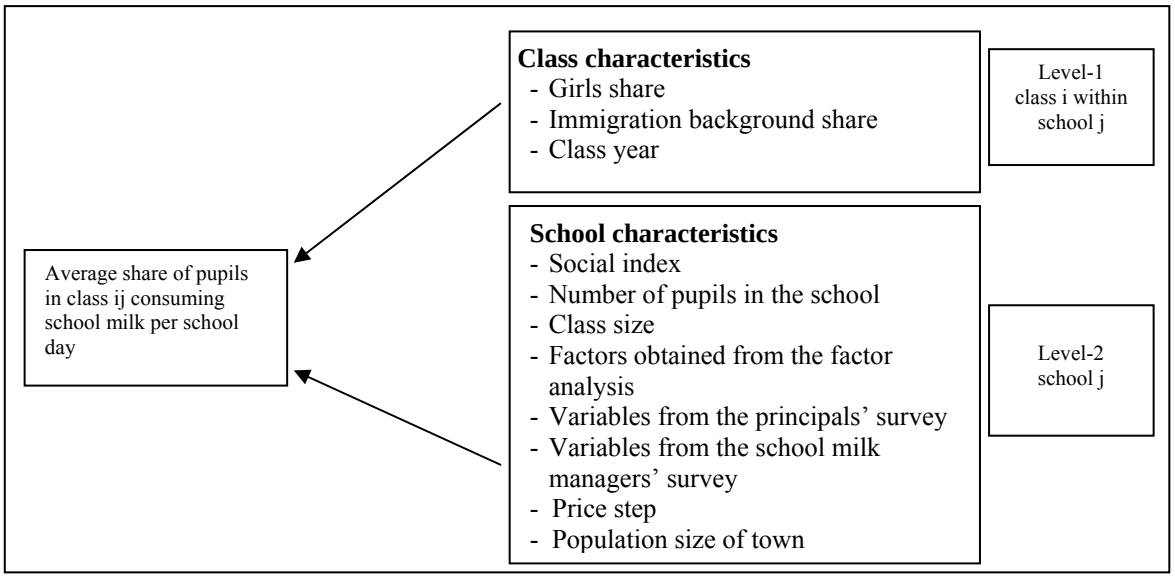
Current developments of multilevel approaches are more concerned with a proper treatment of the error structure for these models. While the pioneers' multilevel methods are mostly represented by the selection of variables which are supposed to have fixed effects, the more recent multilevel methods specify the value of variables as a mix of fixed and random effects. In a fixed effects multilevel model, the micro level coefficient is expressed as an exact function of macro level variables [5]. In contrast, random effects multilevel models contain error terms in the macro equations. The inclusion of these error terms at the macro level implies a more complex error structure in the single equation modality of the multilevel regression [5].

In the multilevel analysis applied here, the school milk consumption in the classes is a process governed by class characteristics and school characteristics. As a hierarchical model, the analysis takes into account the class characteristics within a school such as the share of girls in each class, the share of pupils with immigration background in each class, the class size and the class year. The variables governing school behaviour such as the attitude of school principal and of the school milk manager, the structure of school milk distribution, the storage conditions of milk in schools, etc., do not vary within schools but only between schools,. Thus, the current design of the multilevel regression model comprises two levels: Level-1 the different class years within a school and Level-2 the schools.

Figure 2 shows the causal structure of the estimated multilevel model.

In Section 2.2. it has already been described that data used to estimate the multilevel model stem from different sources. One has to keep in mind that this type of analysis requires a full set of information on all considered variables, meaning that all sets (classes) with incomplete data had to be excluded from the analysis. As this is still an on-going study only a preliminary sample can be analysed. Up to now only two price steps were completely collected and computerised.

[5] For details see Hair, Anderson, Tatham, 1998, p. 90.



Source: Own illustration.

Figure 2. The multilevel model design to investigate for the determinants of school milk consumption at the class

The current model applied is the following:

$$y_{ij} = f(f(v_{ij}), w_j)$$

With y_{ij} average consumer share in class i and school j, v_{ij} a vector of variables defining the class characteristics and w_j a vector of variables defining the school characteristics.

In the model the dependent variable represents an estimate of the average consumer share in class. The data was pooled based on the consumption data reported regularly by schools for the first two price steps.

4. Analysis und results

4.1. Results of the exploratory factor analysis

We already mentioned that we assume that school milk managers' as well as principals' attitude towards school milk and school meals will also influence pupils demand. For that reason we carried out exploratory factor analyses. In the beginning, suitability of the collected data for the analysis was proven. Results of all goodness of fit tests are shown in Table 4.

Table 4. Measure of fit for Factor Analysis

	School milk manager		Principal	
	Attitude towards school milk	Attitude towards school meals	Attitude towards school milk	Attitude towards school meals
Bartletts test of sphericity	0.000	0.000	0.000	0.000
KMO	0.813	0.733	0.797	0.676
MSA				
o Highest level	0.877	0.756	0.886	0.728
o Lowest level	0.515	0.603	0.550	0.561

Source: Own calculations.

Bartlett's test of sphericity analyses overall significance of all correlation within the correlation matrix. The achieved levels of 0.000 are very good. While the KMO measures the appropriateness for factor analysis for the entire correlation matrix, the MSA calculates this for each statement. For both, levels of at least 0.5 are required [7], while others ask for levels above 0.7 [11]. The found levels can be seen as good to at least sufficient. For all analyses a principle component analysis was carried out.

School milk managers' attitudes' towards school milk and school meals

A promax rotation on Level 4 was carried out and three factors were identified as influencing school milk managers' attitudes towards school milk. Together, they account for 57.5% (33.6 + 13.2 + 10.7) of the error variance (compare Table 5).

Table 5. Accounts for error variance in % and Cronbach's Alpha

	School milk manager			**Principal**		
School milk	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
Explained error variance	33.6	13.2	10.7	31.3	13.0	10.6
Crohnbach's Alpha	0.79	0.42	0.55	0.72	0.56	0.40
School meals	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
Explained error variance	28.3	15.0	11.9	27.1	15.6	13.0
Crohnbach's Alpha	0.74	0.47	0.37	0.65	0.49	0.1

Source: Own calculations.

Factor loadings are presented in Table 6. The first factor specifies respondents' support of school milk. Within this factor personal opinions are included as well as those from people esteemed. The nutritional value is mentioned as well as the good feeling if pupils drink school milk during the break. The second factor includes associated criticism towards school milk. It is explained that serving school milk might cause problems due to milk intolerances. It is also argued that offering additional milk in schools is not necessary because pupils can drink milk at home. The support of free school milk is covered by the third factor that includes items about free school milk for all pupils or those in low income families.

Table 6. Promax rotated factor loadings for school milk managers' attitude towards school milk

Statement	**Factor 1**	**Factor 2**	**Factor 3**
People I esteem think that children should get school milk.	**0.804**	0.035	0.058
School milk is recommended for children. Otherwise it would not be subsidised by the EU.	**0.804**	0.146	-0.145
If children drink school milk during the break, then I feel good.	**0.699**	0.033	0.100
School milk contributes to a satisfactory milk consumption of children.	**0.673**	-0.081	0.108
Each school should offer school milk.	**0.535**	-0.245	-0.078
School milk contributes to a healthy diet of children.	**0.533**	-0.232	-0.065
It's troublesome to offer school milk because some children do not tolerate milk.	-0.019	**0.783**	0.157
School milk is not necessary due to the fact that children can drink milk at home.	-0.032	**0.749**	-0.187
School milk should be offered free of charge to children in low income families.	-0.182	-0.129	**0.892**
School milk should be generally offered free of charge.	0.241	0.174	**0.711**

Bold items are used in the interpretation of the respective factor.

Source: Own calculations.

School milk managers' attitude towards school meals in general is analysed with a second factor analysis. Again, a promax rotation on level 4 was carried out and three factors were identified. Together, 55.2% of total variance is explained. Wording, as well as factor loadings, are presented in Table 7.

Support of school meals is described within the first factor. It is mentioned that fruits and vegetables should be sold like school milk in German schools, ideally free of charge. And, more generally, that schools should offer meals and drinks for the pupils. The second factor combines the health aspect of dairy products and a social component. It is argued that milk and dairy products are part of a healthy diet. The statement that esteemed people say that milk is unhealthy for children is explicitly rejected. It is also explicitly denied that just the parents are responsible for the healthy diet of their children. Despite this, the factor is called *support of dairy products*. The third factor reflects *nutritional awareness*. Here, respondents are opposed to the item that healthiness of food is not so important as long as it tastes good. Instead of this, respondents feel good if they eat healthy.

Table 7. Promax rotated factor loadings for school milk managers' attitude towards school meals

Statement	Factor 1	Factor 2	Factor 3
Fruits and vegetables should be offered free of charge in our school.	**0.823**	-0.025	-0.006
Fruits and vegetables are sold like school milk in other countries. This should be possible in Germany, too.	**0.818**	0.063	-0.142
The school should offer meals and drinks for the children during the breaks.	**0.795**	-0.089	0.057
People I esteem say that milk is unhealthy for children.	0.104	**-0.758**	0.303
Milk and dairy products are part of a healthy diet for children.	-0.008	**0.658**	0.071
Milk and dairy products are part of a healthy diet for adults.	-0.025	**0.594**	0.217
It is only parents' duty to assure for a healthy diet of their children.	-0.190	**-0.426**	-0.175
If food tastes good, it would not be so important for me, whether it is healthy.	0.128	0.092	**-0.878**
It gives me a good feeling if I eat healthy.	0.105	0.199	**0.612**

Bold items are used in the interpretation of the respective factor.

Source: Own calculations.

Principals' attitudes' towards school milk and school meals

Principal's attitudes are also analysed. Output of the analysis of attitude towards school milk is presented in Table 8. The three factors derived account for 54.9 of error variance.

At first sight, it is astonishing that factors are not equal to those from school milk managers. However, one can explain these results with different educational backgrounds. While principals are always teachers, school milk managers are most often school caretakers, or sometimes teachers, secretaries or parents.

The first factor summarizes statements of *recommendation of school milk*, some of them in a quite normative way. It also includes a statement on personal good feeling if children drink school milk during break. Factor two reflects the contribution of school milk for infant nutrition. Critical statements on school milk load negatively on this factor. This implies that raised objections on school milk are not accepted. The third factor is equivalent to the third of school milk managers. Again, normative statements about free school milk are raised within this factor. We call this factor *support of free school milk*, too.

Results of factor analysis on principals' attitude towards school meals are shown in Table 9. This time, 55.7% of error variance can be explained. Before carrying out the analysis, we had to delete two items due to bad MSA values. So the calculation is run with 8 items instead of 10.

Table 8. Promax rotated factor loadings for principals' attitude towards school milk

Statement	Factor 1	Factor 2	Factor 3
School milk is recommended for children. Otherwise, it would not be subsidised by the EU.	**0.885**	-0.138	-0.132
People I esteem think that children should get school milk.	**0.798**	0.110	-0.027
Each school should offer school milk.	**0.522**	0.214	0.186
If children drink school milk during the break, then I feel good.	**0.459**	0.351	0.043
School milk is not necessary due to the fact that children can drink milk at home.	0.057	**-0.778**	-0.010
It's troublesome to offer school milk because some children do not tolerate milk.	-0.021	**-0.659**	0.362
School milk contributes to a healthy diet of children.	0.099	**0.523**	0.254
School milk contributes to a satisfactory milk consumption of children.	0.217	**0.446**	-0.031
School milk should be offered free of charge to children in low income families.	-0.252	0.258	**0.765**
School milk should be generally offered free of charge.	0.194	-0.312	**0.759**

Bold items are used in the interpretation of the respective factor.

Source: Own calculations.

Results of factor analysis on principals' attitude towards school meals are shown in Table 9. This time, 55.7% of error variance can be explained. Before carrying out the analysis, we had to delete two items due to bad MSA values. Therefore, the calculation is performed using 8 items instead of 10.

We call the first factor *support of school meals*. It is specified that schools should offer food for the pupils and that especially fruit and vegetables should be available in schools comparable to other countries. The statement "it is only parent's duty to assure for a healthy diet of their children" is explicitly rejected. Within the second

factor, benefits of milk and dairy products for infant as well as adult nutrition are pointed out. As outcome, this factor is named *nutritional value*. The third factor covers respondents' health awareness. The items go along with health aspects of food in general and children's milk consumption in particular.

Table 9. Promax rotated factor loadings for principals' attitude towards school meals

Statement	Factor 1	Factor 2	Factor 3
The school should offer meals and drinks for the children during the breaks.	**0.841**	-0.056	-0.055
Fruits and vegetables should be offered free of charge in our school.	**0.748**	-0.018	0.089
Fruits and vegetables are sold like school milk in other countries. This should be possible in Germany, too.	**0.738**	0.069	-0.019
It is only parents' duty to assure for a healthy diet of their children.	**-0.274**	-0.239	0.060
Milk and dairy products are part of a healthy diet for children.	0.066	**0.768**	0.094
Milk and dairy products are part of a healthy diet for adults.	-0.056	**0.762**	-0.044
If food tastes good, it would not be so important for me, whether it is healthy.	0.016	-0.338	**-0.736**
People I esteem say that milk is unhealthy for children.	0.012	-0.372	**0.699**

Bold items are used in the interpretation of the respective factor.

Source: Own calculations.

Analyses of reliability for each single factor are presented in Table 5. Solely the first factor of each analysis reaches the required level of 0.6 and can be seen as stable [7]. That means that a survey's repetition probably reproduces the first factors. The outcome of factor two and three potentially differs.

4.2 Results of the multilevel analysis

The general multilevel analysis described above was applied as follows: Let y_{ij} be the average consumer share in class i obtained from the periodically collected quantity consumed within a school j, then the multilevel model to be estimated is defined by:

$$y_{ij} = \beta_0 + \beta_{ij} x_{ij} + u_j + e_{ij} + v$$

Where x_{ij} is a vector of covariates and β is the corresponding vector of parameter estimates. The vector of covariates includes a constant together with explanatory variables measured at any of the two levels. The class, school and residual error terms are e_{ij} $[N(0, \sigma_e^2)]$, u_j $[N(0, \sigma_u^2)]$ and v respectively.

All explanatory variables were correlated to average consumer share in class (results not included) to separate the most promising explanatory variables. Then step-by-step, they were included according to their availability as dummy, real or category, as shown in Table 2. Data handling and estimation were performed in STATA Version 9 using the command for linear random-intercepts *xtmixed*. When an additional variable led to insignificant results, or the regression did not converge, the respective variable was excluded.

Generated results for some of the analysed multilevel regressions with respect to consumer share in class are shown in Table 10.

Fixed effects

In the first model presented, the level-0 model which does not include any predictor variables, the average consumer share in class in the sub-sample amounted to a share of 36.8 % of pupils in a class consuming school milk over the two price steps.

In the Level-1 model class-variables were included in order to quantify the contribution of each of these variables to consume school milk. Concerning the Level-1 model, the results show a significant effect of the class-variables studied. The variables girls share, the immigration background share and the class year cause a decline in consumer share. In the case of girls, the average consumer share decreases by 0.098 per each 0.01 increase in the class girls share. These results support other reported findings. In this study, male pupils consumed daily both at home and at school more milk than female pupils [19]. A similar effect is to be observed by the share of pupils with an immigration background, which was to be expected as immigrants often originate from regions with low consumption pattern on milk and dairy products. Also higher class years led to a lower average consumer share in class, indicating that older children lose interest in the school milk, which is also confirmed by observation. Possible explanations are the increased interest in substitutes, a growing orientation in consumption patterns towards older children, a growing wish to be more flexible in their consumption pattern (a decision for at least a complete week) or the child's perception that milk is regarded as a product for very small children. The effect of class year obtained in the level-1 model accounts for -0.076, which means that in the

change from class year 2 to class year 3 in the average school, will result in a drop of the consumer share of -0.076.

Additionally to the structure depicted for the level-1 model, the level-2 model included the class variables discussed above and school variables. In Table 10, the results indicate that all three class-variables and three out of seven school-variables are significant. Contrary to expectations for substitution products such as other beverages and other non-subsidised milk and dairy products, we could not find any conclusive evidence that their availability has significant effects on the consumer share of school milk in class. Yet, it is required to evaluate the further price steps which are still unavailable for the current paper but are part of the on-going project in order to generate more conclusive results. Another aspect that is worth noting is the absence of an estimated influence of any variable derived within the factor analysis. Although these factor analyses were conducted to analyse the impact of the principals' and school milk managers' general attitudes towards school milk and school meals. Furthermore, some of the factors were correlated with the consumer share in class, the results obtained were not significant or the model did not converge (results not shown).

Table 10. Results of a multilevel analysis on consumer share in class

	Level-0 model		**Level-1 model**		**Level-2 model**		**Level-2 model compacted**	
Variable	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**
n	2380		2108		1880		1964	
Constant	0.368	0.007	0.390	0.029	0.418	0.053	0.509	0.006
Fixed effects								
Variables at the class level (class survey)								
Class year			-0.076***	0.004	-0.076***	0.005	-0.077***	0.005
Girls share			-0.098**	0.033	-0.102***	0.032	-0.110***	0.031
Immigration background share			-0.116***	0.025	-0.111***	0.025	-0.117***	0.025
Variables at the school level (class survey)								
Number of pupils in school					-0.0003**	0.0001	-0.003**	0.0001
Variables at the school level (principals' survey)								
I feel good if the children drink milk during the break					0.014*	0.008	0.0183**	0.008
Variables at the school level (school milk managers' survey)								
Place of delivery					0.0002	0.014		
Other dairy products are also offered in the school					0.007	0.018		
Other beverages are offered in the school					-0.016	0.018		
It is only parents' responsibility to assure a children's healthy nutrition					-0.011	0.007		
Other variables								
Effect of price step					0.094***	0.005	0.097***	0.045
Random effects								
σ^2_{school}: school	0.090	0.007	0.097	0.006	0.097	0.006	0.096	0.006
σ^2_{class}: class	0.101	0.005	0.061	0.005	0.067	0.005	0.070	0.005
residual	0.128	0.002	0.127	0.002	0.111	0.002	0.114	0.002
Log restricted likelihood	1036.71		1024.93		1059.31		1096.42	

* significant at the 10 percent level; ** significant at the 5 percent level, ***significant at the 1 percent level

Source: Own calculations.

By comparing the coefficients of class-level variables, the coefficients of girl share and immigration background share changed slightly. Nevertheless, the coefficients for these variables improved as their significance rose compared to the level-1 model. The estimates also indicate that at the school level: i) the number of pupils in the school, ii) the statement from the principals' survey "I feel good if the children drink milk during the break" as well as iii) the price steps are the significant variables.

As an empirical demonstration, the last two columns in Table 10 present the results obtained for the Level-2 model including, uniquely, the significant variables for the class and the school levels. As can be seen, the

significant coefficients remain stable to the exclusion of other non-significant variables with slight changes in the coefficient values for girls share, immigration background share, the statement "I feel good if the children drink milk during the break" and for the effect of the price steps.

Especially interesting are the effects of the price steps, this variable was found to be significant at the one percent level. The price decrease of the school milk from the Price Step 1 (35 cents/250 ml) to the Price Step 2 (25 cents/250 ml) induced the consumer share in class to increase 9.4 %. This increase in consumer share in class is proportionally higher for girls than for pupils with immigration background because the coefficient for share of pupils with immigration background increased while the coefficient for girls share remains unchanged in comparison to the Level-1 model. The price step did not affect the coefficient of class year in comparison to the findings of the Level-1 model.

Random effects

The fixed coefficients only represent the estimated average consumer share in class transformed scale for girls share, share of pupils with immigration background and on different class years. This value, however, does not remain constant across classes and schools. Variations in consumer share were decomposed into two levels. An approximation to the total unexplained variation is obtained by adding over the estimated unexplained variances from the random effects at different levels: $\sigma_T^2 = \sigma_v^2 + \sigma_e^2 + \sigma_u^2$ and hence the proportion of total variation attributed to each level was calculated.

For the Level-0 model, the results suggest that 28 % of the variance is attributable to the school, while the main influence is attributable to the class effect with 31 %. Finally, the remaining 40 % corresponds to other variables not included in this analysis. These estimates suggest that schools do differ in their average consumer share in class, and that there is even more variation among classes within schools.

Regarding the random effects attributed to the class level in the Level-1 model, the school variance accounts for 34 % of the differences, class variance for 21 % and 45 % of the variance stem from other variables. As this model includes class-variables, the class variance was considerably reduced by 40 % in comparison to the Level-0 model (variance from 0,101 to 0.061); leaving as major determinant of total variance the school level (0.097). The residual variance declined by less than 1 %, meaning that effectively, the included variables do capture variation in consumer share in class across classes. These results are not surprising, given that in this model the differences in consumer share in class across schools and classes is uniquely attributed to class changes without considering particular differences between schools.

Compared to the earlier model, in the Level-2 model, the variance at the school level remains constant (35 %) while the class variance even increased slightly (0.067). The residual variable decreased from 0.127 to 0.111 representing 40 % of the total variable. As the value of the residual has decreased in this model without significant changes in the school covariance, it might be expected that more variables have to be included in the model in order to disaggregate the school covariance. The inclusion of more variables will help to gain a better understanding of the development of the average school milk consumption in classes across schools. In further stages of this investigation, having information of the upcoming price steps, this objective will be reached.

5. Qualifications and conclusions

5.1. Qualifications

Currently, the class sub-sample is being enlarged by adding data on further price steps and also by integrating further schools respectively classes if non suitable information provided by schools could be corrected. This process will be done by consulting those schools. Thus, the number of units included in the analysis could increase, and it might be possible that determining variables now rejected, due to insignificance, will be included in a revised model. Also, the results presented in this article might be complemented and confirmed by further approaches which will be assessed using the pupil sub-sample.

For a wider study of the price effect on consumer share in class, an additional level (Level-3 model) will be included in the multilevel analysis reflecting the price steps mentioned in Section 2.1. It is important to identify in what groups the change in price will have the greatest effect, e.g., girls share or of immigration background share. Hitherto, in this study we have considered the currently available variables for the class sub-sample. However, it might be important to include additional economic explanatory variables, e.g., consumer prices of substitute products accessible in the market. Due to difficulties in collecting and obtaining these data, at the time of this analysis it was not possible to include further explanatory variables.

Comming back to the results of the multilevel analysis, further improvements can be made by including other kinds of school variables which should reduce the variance σ_u^2. These improvements will provide a more comprehensive explanation of the factors driving differences of consumer share at the school level. An inclusion

of the Level-3 might reduce the residual and therefore propose other influences in the behaviour of school milk consumers.

5.2. Conclusions

Main results from the factor analyses suggested a general consent in favour of school milk by school principals and school milk managers, at least in the schools providing school milk as represented in those surveys. To reach the political aim of improving pupils' access to school milk measures, convincing principals and school milk managers might be quite successful. However, the opinion of principals and school milk managers regarding the supply of school milk free of charge are ambiguous, the respective factors are not stable. The same holds true for the factor "evaluating critical opinions on school milk". The factor analysis could explain more than half of the principals' and school milk managers' attitudes towards school milk and school meals in general.

Contrary to expectation, the current sub-sample did not show significant effects of the availability of substitute products on the consumer share in class. A comparatively higher consumer share in classes is found when the total number of pupils in the school is small. This might be due to a more focused care of pupils in small schools. The inclusion of a variable comprising the effect of changing price from 35 cents to 25 cents appears to be important in increasing the average consumer share in class by 9.4 %. So an increase of consumption aid of school milk might have a positive impact on overall school milk consumption.

As desired, the results from the multilevel analysis show a declining variance when the level-0 model is compared to the Level-1 and the Level-2 model. Most of the reductions were explained through the inclusion of the class variables, while the inclusion of the available school variables did not appear to have a significant effect in the reduction of total variance. As expected based on experience, the girls share, the immigration background share and the class year are the main explaining variables, while the class size does not have a significant impact. This indicates that further measures should be directed towards those groups, if the nutritional situation is to be improved. It would be especially important for girls, as their calcium supply compared to their requirements is on average insufficient [12].

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