SCHOOL MILK DEMAND – INTERACTION BETWEEN POLICY AND OTHER FACTORS: SOME PRELIMINARY FINDINGS OF A REGIONAL PROJECT

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Abstract: Given the recent steadily declining consumption of school milk in Germany, a research project was set up by the German Federal Ministry of Food, Agriculture and Consumer Protection, in affiliation with other institutions, to retrieve quantifiable information on the different influencing factors and to provide approaches for improving the school milk demand. Main objectives are to evaluate impacts of factors like price, attitudes and habits (especially consumption habits), social background, gender, economic situation, knowledge, product range and distribution form, as well as of nutritional education measures. Primary schools in North Rhine Westphalia were selected by stratified random sampling. Price impacts are derived by an experiment in which the price of school milk was reduced stepwise during the school year 2008/09, and increased over the school year 2009/10, while quantities of demand were reported regularly – either for individuals or on class level - for the selected schools. Almost all other information/data is captured by questionnaires given to pupils, parents, class teachers, school principals, school milk managers, and delivery firms. Preliminary results of a multilevel analysis based on a subset of already available data indicate that the demand on the class level is influenced by girls' share, migrants' share, class year, class size, attitude of school principal, municipal size, and last but not least the price.

Keywords: school milk, demand subsidy, price experiment, multilevel analysis

JEL codes: C02

1 Introduction

Dairy products are part of a balanced diet, especially for children, because of the animal protein, vitamins and minerals they contain (Heine 1999). As school milk provides a way to help covering the basic daily nutritional requirements for this age group, school milk sales have a very long tradition. The European Union established the European School Milk Scheme in 1972 as a consumption aid to encourage consumption of healthy dairy products among children. Originally this programme had two objectives: on the one hand, it was a tool for improving the nutritional situation of children; on the other hand it offered a possibility to allure new milk consumers (European Council 1977; Jacobson 1961; Griffin 1999; CEAS and IADC 1999). Today the European School Milk Scheme also has an educational character and contributes to nutritional education with a better knowledge on products (European Commission 2008).

Within the arrangements of the programme, all children visiting a nursery, a primary or a secondary school are entitled to receive a maximum quantity of 250 ml of subsidized school

milk (or school milk equivalents) per school day (European Council 1977)[1]. Subsidized prices of school milk follow a maximum price policy, in which the maximum prices are fixed, in Germany by the federal states and, in return, distributing firms are granted a subsidy in compliance with existing regulations (BMELF 1985). During the school year 2008/09 about 327,000 tonnes of milk equivalents were consumed within the framework of the EU school milk programme, of which 38,000 tonnes are consumed by German children.

Consumption of school milk has declined steadily since 1993 in Germany. Various factors influencing the downward development have been mentioned. For example, the subsidy has been reduced since 1993 to its current level of 18.15 cents per kg milk. Furthermore, discussions about adequate packaging, waste or schools' problems in handling the milk are considered. Declining numbers of dairy firms engaged in producing school milk have additionally made school milk less accessible, since the less profitable school dairy production line could not always be retained within the concentration process of the German dairy industry. In addition, the product range of school milk is limited and 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 school milk (Wietbrauk 1976; Weindlmaier and Fallscheer 1997).

All mentioned reasons are related to the whole production, processing and distribution chain of school milk as well as to institutional price setting. However, attitudes of parents and children towards milk and milk products, their preferences and tastes, their habits towards a healthy diet, changing eating habits and preferences must also be taken into account.

This paper is organised as follows: Chapter two presents a very short description on general design of the German federal research project. Chapter three provides an overview on the currently available information; and chapter four describes the applied methodology - the multilevel approach - , the database and the empirical findings. A final section deals with the caveats of the methodology and draws some preliminary conclusions.

2 General design of the research project "Schulmilch im Fokus"[2]

To retrieve current data on influencing factors on school milk demand along the school milk chain the German Federal Ministry of Food, Agriculture and Consumer Protection set up the project "Schulmilch im Fokus"[3]. Main objectives are to evaluate factors like price, attitudes and habits (especially consumption habits), social background, gender, economic situation,

[1] School milk always covers a whole range of dairy products eligible for school milk subsidies, not only fluid milk.
[2] The project is conducted in cooperation with the Department of Nutritional Behavior of the Max Rubner-Institut (MRI), Federal Research Institute of Nutrition and Food, Karlsruhe.
[3] English translation: Focus on school milk.

knowledge, product range and distribution form, as well as of nutritional education measures and to quantify the impact. The results should form the groundwork for improving future school milk policies. Besides the main project conducted in North Rhine Westphalia several satellite projects were included, some situated in other German federal states or covering Germany as a whole. This paper will only address the main project.

Sampling units for the main project were primary schools chosen from the total set of all primary schools[4] in North Rhine Westphalia. The sample was drawn randomly in a multi-stage sampling procedure taking different strata into account. As characteristics of the stages in that process the socioeconomic status (social index) of the district derived from the spending on welfare aid at county level, the share of pupils with a migration background per school and former participation or non-participation in the EU School Milk Scheme were considered.

A price experiment was drafted to allow the estimation of price impacts on the demand. Here prices of school milk are reduced stepwise during the school year 2008/09. As shown in Figure 1, starting with 35 cents per package[5] in Price Step 1, the price is stepwise reduced to 0 cent at the end of the school year. During the school year 2009/10 price is increased again stepwise to 35 cents.

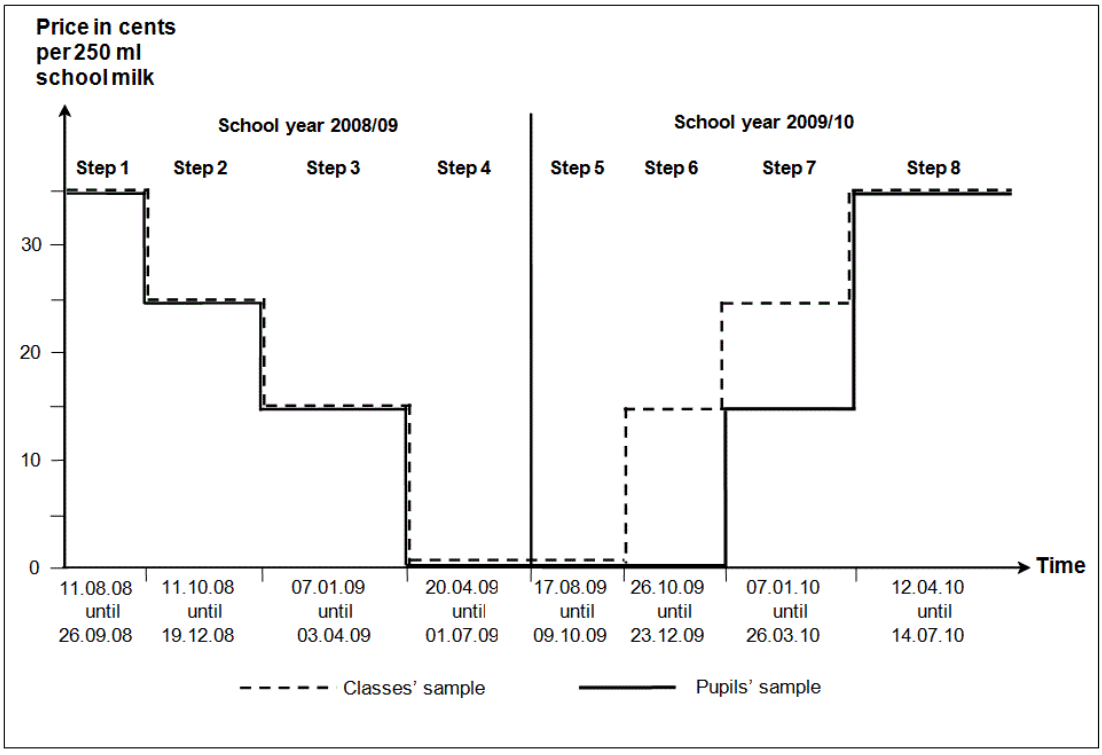

Figure 1. Prices of school milk during the price experiment
Source: own illustration.

[4] 3,392 primary schools with 737,455 pupils.
[5] Price of non-flavoured school milk was 30 cents per package. From the second to the seventh Price Steps, pure and flavoured milk are charged the same price.

Ordered quantities of school milk are reported regularly during the experiment. Almost all other information, respectively data, is captured by written questionnaires given to pupils, parents, class teachers, school principals, school milk managers and delivery firms[6].

As shown in Figure 1 too, the primary schools, which were included in the main project, are divided into two different samples: (1) a 'classes' sample' providing data on demand for the class year and (2) a 'pupils' sample' with data on individual demand and other individual data such as nutritional behaviour and attitudes at the individual level. All data collection at schools is restricted to the class years two, three and four including, in principle, pupils aged between 7 and 10 years old. Pupils of the first class year were not included due to their lack of reading and writing ability. For more details concerning the main project see also Salamon et al. 2010.

Within the project, the focus of this paper can be described by the following questions:

1) What impact does the price, respectively the school milk aid, have on the demand for school milk?
2) Which influence does gender share, immigration background shares, class years, attitudes of the school milk manager and principal in the regarded schools have on the consumer share of school milk in classes?

As the pupils' sample is currently subject to data evaluation procedures it cannot be regarded yet. Hence, the quantities of school milk ordered at class year are already available. Data is prepared for Price Steps one to three; however, Price Step four (distribution free of charge) is excluded from the empirical analysis since research has shown that people tend to react specifically to a price of zero. Zero prices can be regarded as a special price since most people do not choose the alternative with the highest cost-benefit difference (Shampan'er and Ariely 2006). This is contrary to the assumption of neo-classical demand theory. Therefore, consumption in Price Step four can be seen as the maximum possible demand. Additional information originates from questionnaires given to school principals and school milk managers considering, e.g., their attitudes towards school milk and meals.

3 First descriptive findings

Characteristics of the classes, as well as first descriptive results about consumption per pupil and school day, are presented within this chapter.

The classes' sample on which the paper's further analyses are based consists of 314 schools with 2,204 classes. Those classes with missing variables or unknown basic data (e. g., class

[6] Questionnaires given to pupils, parents, class teachers, school principals and school milk managers were developed by the Max Rubner-Institut (MRI), Federal Research Institute of Nutrition and Food, Karlsruhe.

year, gender shares, and share of pupils with immigration background) were excluded from the used data set.

Table 1 presents the characteristics for the selected classes and shows that in the sample 50,103 pupils are covered. Boys and girls account for a gender share of 50.5 percent and 49.5 percent, respectively. Pupils with immigration background represent approximately 25.7 percent. The spreading of classes to the second, third and fourth year level is relatively balanced.

Table 1. Sample characteristics

	Total number	Percentage
Number of schools	**314**	
Number of classes	**2,204**	**100.0**
– 2nd year	730	33.1
– 3rd year	723	32.8
– 4th year	751	34.1
Number of pupils	**50,103**	**100.0**
– Boys	25,322	50.5
– Girls	24,781	49.5
Pupils with immigration background	**12,872**	**25.7**

Source: own calculations.

As already mentioned, the following analysis is only based on the classes' sample data and includes only the first three Price Steps. However, much more differentiated results, especially concerning the individual decisions, will become available when the pupils' sample data is analysed.

At the initial price level, an average of 34 percent of pupils in classes two, three and four consumed school milk (see Figure 2). As the price of one package was reduced to 25 cents the consumption increased to 37 percent and finally up to 38 percent in Price Step three with a price reduction to 15 cents per package.

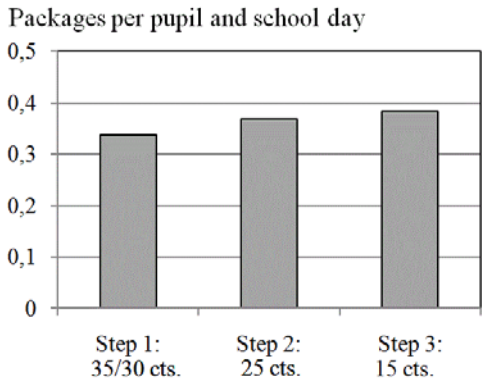

Figure 2. School milk consumption differentiated by Price Step
Source: own calculations.

Consumers generally differ in their preferences, as is to be expected in the case of pupils, too. Therefore, average consumption differs between the different milk flavours. In Figure 3 it is depicted that flavoured milk products contribute most to school milk consumption, with chocolate milk as the most popular. Thus, approximately 23 percent of pupils demanded chocolate milk over all three Price Steps, while only 4 percent of pupils bought unflavoured milk. Along the different Price Steps the biggest demand growth could be observed for chocolate milk, the other flavours like strawberry and vanilla exhibit similar consumption shares as pure milk over time.

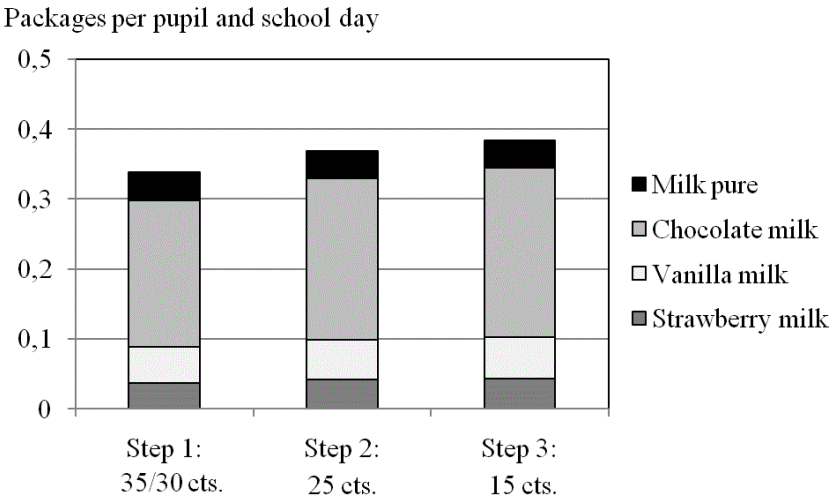

Figure 3. School milk consumption differentiated by Price Step and milk flavor
Source: own calculations.

Demand is not only affected by preferences but also by other factors like the age of the consumers. However pupils' age is not captured by the data compiled in the classes' sample. Although pupils in a class may be of slightly different ages, the class year might be used as a proxy for the age. As depicted in Figure 4, pupils at higher levels ordered - at each Price Step - less school milk than younger pupils. In total, 42 percent of pupils in the second class year demand school milk on average, whereas the corresponding consumer share of the class year

four is only 26 percent. With lower prices the impact of the class year becomes smaller. At Price Step 3 the absolute difference between class year 2 and 4 was reduced from 16 percentage points (at Price Step 1) to 11 percentage points.

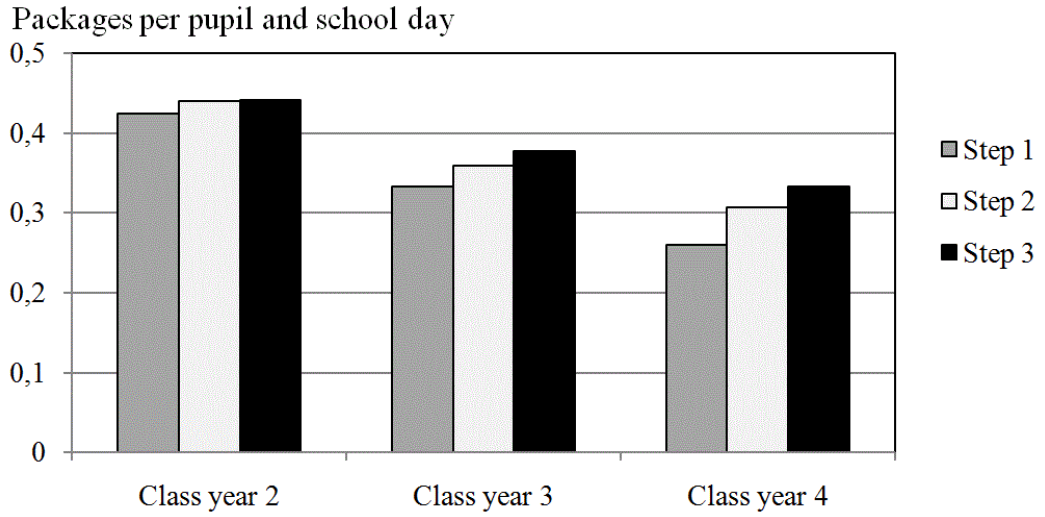

Figure 4. School milk consumption differentiated by Price Step and class year
Source: own calculations.

Further important characteristics of the classes' sample, such as urban-rural divisions and gender differences, as well as variables derived from school principals and school milk managers' survey will be presented in the subsequent chapter within the description of the database used for the empirical analysis.

4 Econometric Analysis

This chapter contains three subchapters which are organized as follows: First, the applied multilevel approach will be introduced and discussed with a focus on why this methodology is suitable for this kind of data. Then, the database and its sources are described in detail. The third subchapter contains the results of a multilevel analysis.

4.1 Applied multilevel approach

Multilevel analysis is mainly used in social science which, in the broad sense, includes sociology, education, psychology, but also in other fields such as the bio-medical sciences (Snijders and Bosker 1999). According to Bickel (2007, p. 8), multilevel modelling can be viewed as "a better way of doing regression analysis under specific circumstances." These circumstances are those in which observations are nested or grouped in identifiable contexts, e. g., pupils in classes, employees in firms, longitudinal measures of subjects, etc. In contrast to OLS (*ordinary least squares)* regression, multilevel regression has an inherently hierarchical structure, and it is designed to deal with nested data and thus, the nesting of observations within

groups is fundamental to multilevel models. In fact, nesting is the primary reason for doing multilevel analysis (Bickel 2007). Because of grouped or clustered data, observations from the same group are more similar than the observations from different groups which violate the assumption of independence of all observations. The amount of dependence can be expressed as a correlation coefficient: the intraclass correlation (Hox 2002).

As mentioned, multilevel modelling is a type of regression analysis. Similarly to regression models, the aim is to construct a model that expresses how the dependent variable depends on, or is explained by, the explanatory variables. Because of hierarchical data structure, the basic idea of multilevel modelling is that the outcome variable *Y* has an individual as well as a group aspect. The multilevel approach assumes that individual decision-making is dependent on environmental clusters. However, the definition of clusters may differ and the variability between clusters must be taken into account. The explanatory variable at the individual level is *X*, the explanatory variable at the group level is *Z* (also named contextual variable). The *X* variable, although it is a variable at the individual level, may also contain a group aspect. The mean of *X* in one group may be different from the mean in another group. In this case, *X* may have a positive between-group variance (Snijders and Bosker 1999: 39).

The main difference between common regression models and multilevel models is the fact that the equation defining the hierarchical linear model contains more than one error term: one (or more) for each level (Snijders and Bosker 1999: 38). Current developments of multilevel approaches are more and 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. 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 version of the multilevel regression. Random coefficient models allow the decomposition of the variance of the dependent variable into the within-context variance and the between-context variance (DiPrete and Forristal 1994).

Within the multilevel analysis applied here, we examine classes clustered in schools. For each class there are three measurements – one for each Price Step. With such data, it is usually illuminating to consider the variability associated with each level of nesting. For instance, there is variability between classes, but also between schools and Price Steps. Hence, the school milk

consumption in the single classes is a progress governed not only by the price but also by class and school characteristics. Longitudinal data structure of the classes' sample leads to a three-level model with classes as individuals and schools as groups. While repeated measures on individuals are incorporated at the first level, individual variables are to be found at the second, and organizational/contextual variables at the third level (Heck and Thomas 2009: 44; Snijders and Bosker 1999: 9).

The applied model can be written as:

$$Y_{pij} = \gamma_{000} + v_{0j} + u_{0ij} + e_{pij} .$$

As this equation contains no explanatory variables it is called empty model or intercept-only model. Y_{pij} is the average share of pupil ordering school milk per class *i* within school *j*, and γ_{000} is the fixed intercept of the average group. The variances at the first, second and third level are σ_e^2, σ_{u0}^2 and σ^2_{v0}, respectively. The residual errors are assumed to have a mean of zero, and a variance to be estimated (Hox 2002: 30f).

The intraclass correlation at the class and school level can be described in the following way:

$$\rho_{class} = \frac{\sigma_{uo}^2}{\sigma_{v0}^2 + \sigma_{u0}^2 + \sigma_e^2}$$

and

$$\rho_{school} = \frac{\sigma_{vo}^2}{\sigma_{v0}^2 + \sigma_{u0}^2 + \sigma_e^2} .$$

The intraclass correlation shows the decomposition of the variance across the available levels, or how much variance is explained at each level (Hox 2002: 31).

4.2 Database

To analyse determining factors of school milk demand, the dependent variable is defined as share of school milk drinking pupils per class and school day or rather the quantity of packages per pupil and school day. As shown in Figure 5, different explanatory variables are available at each level for the multilevel analysis. These variables stem from different sources: Within the survey, a questionnaire containing general information about class size, share of girls and boys in each class, share of children with immigration background per class, and class year were compiled. As main information source quantities of school milk ordered by class were reported in regular intervals during the price experiment. In addition, further information like social index, municipal size and consumer price of whole milk as a substitute were incorporated into the analysis. School principals and managers were asked to fill in a questionnaire, too. Some

index variables such as attitudes of principals, attitudes of managers or managers' satisfaction with organisation and payment were created from both questionnaires,. These indices all range from 0 (rejecting attitude) to 100 (supporting attitude). The questions from which the four index variables were created are listed in Appendix 1.

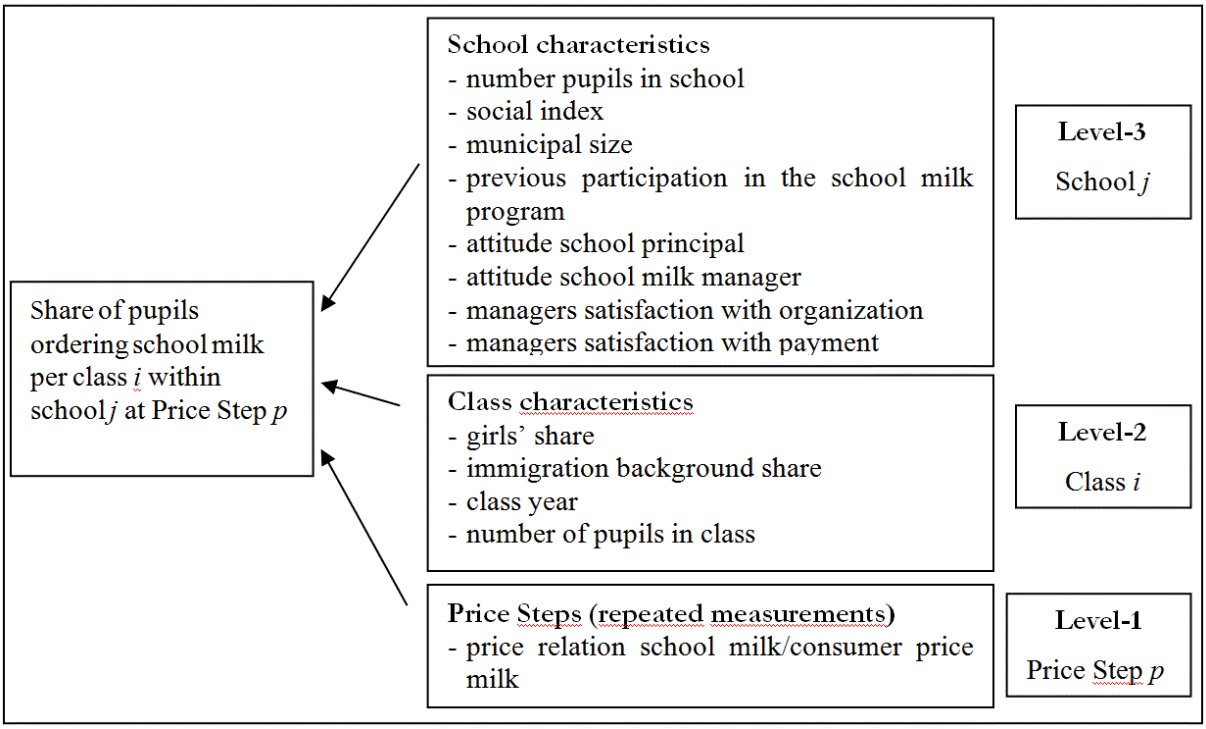

Figure 5. Levels and variables of the applied multilevel model
Source: own illustration.

4.3 Analysis and results

Data Handling and estimation were performed in the statistic program STATA Version 11.0 using the procedure *xtmixed* for linear random intercept model[7]. As a pre-process a correlation matrix was generated depicting the correlation across all available explanatory variables to minimize the risk of multicollinearity. With the exception of explanatory variables which were used in constructing attitudes indices as described above cross correlations between independent variables very low. In a further step a single regression model was estimated excluding step by step insignificant explanatory variables. Then that information was applied to establish a multilevel estimate. Beginning with the empty model (see section 4.1), multilevel analysis is a process which includes available variables for the different levels step by step. When an additional variable led to insignificant results, or the regression did not converge, the respective variable was excluded.

[7] Normally a logistic approach based on odds would have been used; however as a considerable number of observations were zero or one, the number of observations was significantly reduced. Therefore a linear approach was preferred, which will be especially important when in further analysis the Price Step four will be integrated. Nevertheless, also a logistic approach was estimated in which neither the explanatory variables nor the significant levels were different from the linear one.

Generated results for multilevel analysis are shown in Table 2, in which the first level is identified by Price Step variable, second level by class variable which is an index over all classes; and the third level is defined by schools' ID variable.[8]

Table 2. Results of multilevel analyses

	Intercept-only		**Random-intercept**	
Fixed part:	*Coefficient*	*Std. Err.*	*Coefficient*	*Std. Err.*
constant	0.3666***	0.0066	0.8740***	0.0666
municipal size			0.0125*	0.0059
previous participation in the programme			-0.1804***	0.0446
attitude school principal			0.0046*	0.0023
girls share			-0.0968***	0.0319
immigration background share			-0.1002***	0.0231
class year			-0.0674***	0.0038
number of pupils in class			-0.0044***	0.0010
price relation school milk/ consumer price milk			-0.0438***	0.0666
Random part:	*Std. Dev.*	*Std. Err.*	*Std. Dev.*	*Std. Err.*
σ_{v0}: school	0.0975	0.0054	0.0843	0.0053
σ_{u0}: class	0.1290	0.0025	0.1145	0.0025
σ_e: Price Step	0.0852	0.0009	0.0833	0.0010
Intraclass correlation:				
ρ_{school}	0.2846			
ρ_{class}	0.4981			
$\rho_{price\ step}$	0.2173			
Log restricted Likelihood	4038.22		3569.25	

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

Source: own calculations with STATA.

In the first model presented, the intercept-only model which does not include any predictor variables, the school milk consumption on average per pupil and school day correspond to 36.7 %[9]. This value, however, does not remain constant across classes and schools. Variations in consumer share were decomposed into three levels – the so-called random part. Generally the

[8] As in common terminology we call this model a three-level model. In contrast to common terminology, the *xtmixed* documentation of STATA calls such a three-level model a two-level because the lowest level, here repeated measurements, is not considered a level (Rabe-Hesketh and Skrondal 2007).

[9] The model assumes a similar linear function, because there is no difference to the logistical function which is often used in context of consumption habits.

intraclass correlation shows the decomposition of the variance across the available levels, or how much variance is explained at each level. The proportion of the variance explained by the classes' structure is about 50 % and this is the main part of the unexplained variation. The intraclass correlation at the schools level amount 28 % respectively at the lowest level 22 %.

From the intercept-only model to the random-intercept model, the random part decline for the three levels. So the explaining variables which are included in the fixed part of the random-intercept model reduce the unexplained variance of the grouping structure at school, class and Price Step level: At the school level the variance falls from 0.0975 to 0.0843, at the class level from 0.1290 to 0.1145 and at the lowest level from 0.0852 to 0.0833.

The decreasing value of the log restricted likelihood indicates that the random-intercept model fits better than the intercept-only model. The predictor variables which contribute significantly to the average share of pupil ordering school milk per class i within school j are contained in the fixed part. From a total of eight significant variables, three variables belong to the school's structure. This is the municipal size (grouped in quartiles), the previous participation in the school milk programme (yes=1, no=0) and the attitude of the school principal (index between 0 and 100). Therefore the consumption increases with a greater size of the town where the primary school is located, with a better attitude of the school principal and with no former participation in the school milk programme. For example, at schools with a previous participation in the programme, the average demand per day is about 0.18 packages lower per pupil and school day.

At class level the variables girls' share, immigration background share, class year and the number of pupils in class have a significant impact on consumption. With an increase in girls' share, the school milk consumption decreases per pupil and school day. In the same way an increase in immigration background share and an increase in class size a reduction of packages per pupil and school day are seen. Also higher class year led to a lower average consumer share in class. Altogether, school milk consumption is lower in classes with big class sizes, with a higher class year, with a higher share of female pupils and pupils with immigration background.

At the Price Step - the lowest level - there is a highly significant price relation between the price of school milk and the consumer price for milk. The relation increases with increasing school milk price and a decreasing consumer price of milk. A higher relation led to a lower average consumer share.

5 Qualification and conclusions

First descriptive statistics and figures reveal that school milk consumption is driven by various factors. For analysing the classes' sample database and to identify important influencing factors, the applied multilevel approach is appropriate. The only-intercept model consists of three levels and shows how much variance is explained at each level. At the lowest level, there are repeated measures for each class. The single classes are the individuals in this models, and schools the clusters at the highest level. Explanatory variables at each level are incorporated and a total of nine significant variables are identified. These variables decrease the level of variances.

Because the sample is not complete, we have considered the currently available variables in this analysis. The inclusion of the fourth Price Step is an important echelon towards the investigation of school milk consumption amongst pupils. However, it might be important to include additional economic explanatory variables.

Following preliminary implications could be drawn from classes' sample:

- School milk price contributes to pupils demand for school milk. As expected, demand increases with reduced price.
- Beside economic factors, socio psychological parameters influence the probability for school milk demand. The probability decreases with higher class years, with a higher share of pupils with immigration background and with a higher share of girls. In particular, the result show that future arrangements should target the group of girls, as this specific group has an insufficient calcium intake (Mensink et al. 2007). However, pointed arrangements for pupils with immigration background are much more complicated because of various cultural characters.
- Results from school level reveal that schools within bigger communities have a larger share of pupils ordering school milk. The reason for this might be a larger milk consumption at home in rural areas. The fact that school milk demand is significantly higher in small classes than in bigger ones could be due to a generally easier organisation of school milk distribution in small classes and small schools. Additionally, small schools with lower pupil-teacher ratios could provide more particular programmes concerning food and nutrition.

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Appendix

Appendix 1: Developed index variables from school principals and school milk mangers questionnaire

Index	Statement
attitude school principal	- School milk contributes to a healthy diet
	- I'm glad, if pupils drink school milk
	- Offer of school milk at all schools
attitude school milk manager	- school milk contributes to a healthy diet
	- I'm glad, if pupils drink school milk
	- Offer of school milk at all schools
managers satisfaction with organisation	- Excessive time effort for ordering at pupils
	- Excessive time effort for collecting money
	- Excessive time effort for ordering at delivery firm
	- Excessive time effort for acceptance of delivery
	- Excessive time effort for storage
	- Excessive time effort for milk distribution to pupils
	- Excessive time effort for return bottles and waste removal
	- Satisfaction with disposal of the package
	- Satisfaction with assistance of delivery firm
	- Satisfaction with delivery
managers satisfaction with payment	- Satisfaction with payment for school milk sales