Household Demand for Food in Switzerland. A Quadratic Almost Ideal Demand System

AWUDU ABDULAI*

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1. INTRODUCTION

Changes in food consumption and expenditures in developed and developing country households have been a topic for research throughout the twentieth century, as such it is well known that income influences food expenditure patterns. Given that income influences food expenditures, it is also likely that the distribution of income influences the distribution of food expenditures. Federal agencies dealing with food policy issues are therefore often interested in studies that examine the response of households to price and income changes.

In contrast to the myriad of empirical work on food demand in other developed countries, very few studies have analysed food consumption and expenditure of Swiss households (e.g., BENEGGER and STRASSER, 1986; SPYCHER, ABDULAI and JOERIN, 1999). These studies have concentrated on modelling aggregate demand that do not consider the potential effects of demographic factors. However, demographic factors can have significant impacts on food consumption arising from differences in preferences and price levels. Micro data that contains information on the influence of demographic factors may yield substantially greater precision in the estimation of the parameters than estimates based on aggregate data (ORCUTT, WATTS and EDWARDS, 1968). Moreover, some of the relevant explanatory variables at the household level may also exist in a form that cannot be readily aggregated. Nevertheless, demand studies at the aggregate level are still of practical relevance. It may be particularly important to investigate ag-

* Department of Agricultural Economics, Swiss Federal Institute of Technology, Sonneggstrasse 33, 8092 Zurich, Switzerland, Tel: +41 1 632 7930; Fax: +41 1 632 1086,
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gregate consumption and look for the existence of macro-trends that affect all households on average. Once the trends are disentangled from demographic effects, they might be considered to be the relevant structural change in food consumption and proxies for the role of non-price factors in food demand.

The unavailability of micro-level data has limited previous studies of Swiss food demand which have consequently concentrated on the aggregate consumption behaviour (e.g., SPYCHER, ABDULAI and JOERIN, 1999). The present study uses Swiss household survey data collected by the Federal Office of Statistics (BSF) to provide insights into the food consumption behaviour of Swiss families. We employ the Quadratic Almost Ideal Demand System (QUAIDS) model recently proposed by BANKS, BLUNDELL and LEWBEL (1996 and 1997) for the specification of a demand system with demographic effects. This model, in which expenditure shares are quadratic in the logarithm of income, has been derived as a generalisation of the PIGLOG[1] preferences and, hence, maintains all the relevant properties of its linear counterpart, (Almost Ideal Demand System [AIDS]), thus allowing for exact aggregation over households. Given that the model allows for more flexibility, this could be a significant development, especially if the estimates are intended for simulation or/and forecasting.

The application of the model to food demand in Switzerland is interesting because not very much is known about food demand in this country. Since lower income households may respond differently to changes in prices and income than higher income households, we partition the sample into four expenditure classes to examine their individual responses to price and expenditure changes.

The organisation of the paper is as follows. In the next section, the Quadratic Almost Ideal Demand System is defined and its theoretical properties are shown. Section three contains a description of the data used in the analysis, while the estimation methods and results are presented in section four. Finally, the last section provides a discussion of some of the study's implications.

2. QUADRATIC ALMOST IDEAL DEMAND SYSTEM

Since the development of the Almost Ideal Demand System (AIDS) model by DEATON and MUELLBAUER (1980), several authors have used it in analysing the demand for commodities in different countries. BLANCIFORTI and GREEN (1983) have applied this system to US food consumption data, while RAY (1982) employed it to examine household consumption patterns using household expenditure surveys for India. CHESTER and REES (1987) also applied the AIDS framework to British National Food Survey data and FULPONI (1989) to French expenditure time-series data. In recent studies, FILIPPINI

1. Demand with expenditure shares that are linear in log total expenditure alone have been referred to as Price-Independent Generalised Logarithmic (PIGLOG) by MUELLBAUER (1976). This class covers the Almost Ideal System of DEATON and MUELLBAUER (1980) and the Exactly Aggregable Translog model of JORGENSON, LAU and STOKER (1982).

(1995a, 1995b) employed it to examine electricity demand by time of use in Switzerland, while ABDULAI, JAIN and SHARMA (1999) applied it to investigate food consumption patterns with Indian household survey data.

However, questions have recently been raised as to the suitability of parsimonious representations of preferences, such as those implied by the popular empirical specifications (including the AIDS model) in fitting actual data enough. As indicated earlier, allowing for more flexibility could be a significant development, especially if the estimated model is intended for simulation and forecasting purposes. Using data from the British Family Expenditure Survey, BLUNDELL, PASHARDES, and WEBER (1993) therefore employed a quadratic extension of the AIDS model to assess the importance of using micro-level data in the analysis of consumer demand. BANKS, BLUNDELL and LEWBEL (1996 and 1997) recently derived a Quadratic Almost Ideal Demand System (QUAIDS) specification that retains the overall form of the quadratic model in BLUNDELL, PASHARDES and WEBER (1993) but introduces price dependence in a parsimonious way. JONES and MAZZI (1996) used this specification to analyse tobacco consumption and taxation in Italy, while MORO and SCKOKAI (2000) employed it to examine household food consumption in Italy.

In the present study, the Quadratic Almost Ideal Demand System (QUAIDS) derived in BANKS, BLUNDELL and LEWBEL (1996 and 1997) is used to describe consumer behaviour. This is a rank three budget share system that is quadratic in the logarithm of total expenditure.[2] It has the attractive property of allowing goods to have the characteristics of luxuries at low levels of total expenditure, say, and necessities at higher levels. The QUAIDS which is derived from a generalisation of the PIGLOG preferences starts from an indirect utility function of the form:

$$\ln V = \left\{ \left[\frac{\ln m - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \tag{1}$$

where the term $[\ln m - \ln a(p)]/b(p)$ is the indirect utility function of the PIGLOG demand system (i.e., a system with budget shares linear in log total expenditure), m indicates household income, and $a(p)$, $b(p)$ and $\lambda(p)$ are functions of the vector of prices p. To ensure the homogeneity property of the indirect utility function, it is required that $a(p)$ is homogenous of degree one in p, and $b(p)$ and $\lambda(p)$ homogenous of degree zero in p.

The $\ln a(p)$ given in equation (1) has the usual translog form

$$\ln a(p) = \alpha_0 + \sum_j \alpha_j \ln p_j + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j \tag{2}$$

2. The rank of a demand system equals the rank of the matrix of Engel curve coefficients (LEWBEL, 1991). GORMAN (1981) has shown that the rank of any exact aggregable demand system that is linear in functions of nominal income is at most three.

and $b(p)$ is the simple Cobb-Douglas price aggregator defined as

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \tag{3}$$

$\lambda(p)$ is defined as

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \quad \text{where} \quad \sum_i \lambda_i = 0 \tag{4}$$

By applying Roy's identity to the indirect utility function, the budget shares in the QUAIDS is given as

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)} \left\{\ln\left[\frac{m}{a(p)}\right]\right\}^2 \tag{5}$$

As is evident in equation (5), BANKS, BLUNDELL and LEWBEL (1996 and 1997) show that the coefficients of the quadratic term in these demand functions must be price dependent. This contrasts with the quadratic extension of the AIDS model in BLUNDELL, PASHARDES and WEBER (1993) where the quadratic term is price independent.[3]

For theoretical consistency and to reduce the number of parameters to be estimated, it is common to impose additivity, homogeneity and symmetry restrictions. A sufficient condition for the expenditure shares to be homogenous of degree zero in prices is: $\sum_i^n \gamma_{ij} = 0$, $\forall i$. Symmetric changes in compensated demand functions can be imposed by setting $\gamma_{ij} = \gamma_{ji}$, $\forall i \neq j$. Additivity requires $\sum_{i=1}^n \alpha_i = 1$ and $\sum_{i=1}^n \beta_i = 0$.[4] These conditions are trivially satisfied for a model with n goods when the estimation is carried out on a subset of $n-1$ independent equations. The parameters of the dropped equation are then computed from the restrictions and the estimated parameters of the $n-1$ expenditure shares. The fourth restriction involves concavity of the expenditure function. This restriction has, however, no obvious parametric representation. THEIL (1976) argues that the rejection of demand properties should not be attributed to unorthodox consumer behaviour; and as such analysts should guide these data to yield a sensible picture that complies with the theory by simply imposing theoretical constraints.

In line with BANKS, BLUNDELL and LEWBEL (1996 and 1997), we choose to allow demographic effects to influence preferences through the intercept in equation (5), or

$$\alpha_i = \rho_{i0} + \sum_{j=1}^{S} \rho_{ij} d_j \tag{6}$$

3. The QUAIDS specification retains the overall form of the quadratic model in BLUNDELL, PASHARDES and WEBER (1993) but introduces this price dependence in a parsimonious way.
4. The theorem 1 provided in BANKS, BLUNDELL and LEWBEL (1997) makes the QUAIDS satisfy the integrability properties.

where d_j is the jth demographic variable of which there are S. This translating approach is used to include the demographic variables because of its simplicity (POLLAK and WALES, 1978).

The formulae for the elasticities in the QUAIDS are given by BANKS, BLUNDELL and LEWBEL (1997). They are obtained by first differentiating equation (5) with respect to $\ln m$ and $\ln p_j$, respectively, to obtain:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\} \tag{7}$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_k \gamma_{jk} \ln P_k \right) - \frac{\lambda_i \beta_j}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\}^2 \tag{8}$$

The expenditure elasticities are then derived as $e_i = \mu_i / w_i + 1$. The uncompensated or Marshallian price elasticities are given by $e_{ij}^u = \mu / w_i - \delta_{ij}$, where δ_{ij} is the kronecker delta, which is equal to one when $i = j$, otherwise $\delta_{ij} = 0$. Using the Slutsky equation, $e_{ij}^c = e_{ij}^u + w_j e_i$, the compensated or Hicksian price elasticities can be calculated and used to assess the symmetry and negativity conditions by examining the matrix with elements $w_i [e_{ij}^c]$, which should be symmetric and negative semi-definite in the usual way.

3. THE DATA

The data used in the analysis are drawn from a Swiss Household Expenditure Survey that was conducted by the Federal Office of Statistics (BSF) in 1998. The BSF conducted a nation-wide household survey to obtain information on household earnings and consumption patterns that is comparable to other European countries. A multi-stage random sampling procedure was used to select an initial sample of 12,804 households from seven major regions of Switzerland (see Table 1 for information on the regions).[5] As the survey progressed, 3,509 households dropped out. Of the remaining 9,295 households, an average of 775 households were then required to keep a daily diary for each month about information on earnings and expenditure. The households were categorised into four income ranges – according to monthly income – with each category consisting of 25 % of the sample. The income categories included: households with monthly income of less than 5,000 Fr.; between 5,000 and 7,300 Fr.; between 7,300 and 10,400 Fr.; and over 10,400 Fr. Information was then collected from these households through a Computer Aided Telephone Interviewing approach from January to December 1998.

All commodity items were classified into one of seven commodity groups: six food aggregates and the non-food expenditure. The six food aggregates include: bread and cer-

5. For details of the sampling technique and classification of the regions, refer to Bundesamt für Statistik (2000).

eals; meat and fish; milk, cheese and eggs; fats and oils; fruit and vegetable; and other foods. The "other foods" group comprised of all other foods, including sugar and beverages. The non-food group includes all non-food goods and services. We have included the non-food group to examine the effects of expenditure on non-food items on food consumption. Economic theory does not provide any guidance on the number or composition of commodity groups, and this decision is usually made on *ad hoc* basis by the researcher. The construction of the commodity groups used in this analysis was influenced partially by past studies of the European food sector and by a classification reflecting the similarity of food items from a consumer's viewpoint. A major advantage to this particular food-grouping scheme is that it reduces the total number of parameters in the model, thus making demand system estimation more manageable. Also, information was collected on various demographic characteristics of households including household size, age of respondent, education, and occupation. Dummy variables for regions were included to capture any regional taste differences that are not generated by price differences, while monthly time dummies were used to reflect the month in which information was collected from the household.

Unlike non-food products, where the physical quantities of purchase were not included, households reported the quantity of their consumption of food products in their survey diaries. Since prices for food products were not provided by the survey, implicit prices for individual commodities were derived from the purchased quantity and total expenditure data. Price indices for the aggregated commodity bundles were computed using the geometric mean with expenditure shares as weights. The price obtained is effectively a value and quantity ratio, which is called a "unit value" by DEATON (1988). The price calculated this way is household specific, representing household purchase decisions. Each group price is a weighted average of prices on specific items faced by the household. The variation in food group prices is due to differences in consumed items in each group and variation in prices of each item across households. The latter is due to quality differences, seasonal effects, and regional market conditions.[6]

Overall, the variation in commodity group prices (Table 1) is large, allowing us to obtain precise estimates of the aggregate price effects. For non-food items, the prices used are monthly consumption price indices at national level from BSF: they are equal for every observation within the same month. Table 1 presents definitions of the variables used in the analysis. Included in the table are the household characteristics that were allowed to influence the α_i intercept parameters in each share equation.

6. However, it needs to be mentioned that while directly observed prices, and other variables adequately taken into account would produce direct price elasticities, the price elasticities computed from unit values might be exaggerated because of the quality effect reflected in unit values (DEATON, 1988).

Table 1: Description of Variables Used for Expenditure Analysis

Variable	Definition	Mean
INCOME	Monthly household income in Swiss francs	8356
HHSIZE	Total number of household members	2.4
ZURICH	1 if household is located in Zurich region, 0 otherwise	17.2
NWEST	1 if household is located in the North West, 0 otherwise	13.4
CSWITZ	1 if household is located in central Switzerland, 0 otherwise	8.7
EAST	1 if household is located in the East, 0 otherwise	14.4
GENEVA	1 if household is located in Geneva region, 0 otherwise	18.7
LOWLAND	1 if household is located in lowland region, 0 otherwise	23.0
TESSIN	1 if household is located in Tessin, 0 otherwise	4.6
JAN	January dummy	0.0789
FEB	February dummy	0.0713
MARCH	March dummy	0.0727
APRIL	April dummy	0.0688
MAY	May dummy	0.0880
JUNE	June dummy	0.0879
JULY	July dummy	0.0808
AUG	August dummy	0.0794
SEPT	September dummy	0.0917
OCT	October dummy	0.0937
NOV	November dummy	0.0979
XMAS	December dummy	0.0887
EXP	Per capita monthly total expenditures	3052.67
BRCE	Expenditure share on bread and cereals	0.01522
MEFH	Expenditure share on meat and fish	0.02303
MCEG	Expenditure share on milk, cheese and eggs	0.01735
FATS	Expenditure share on fats and oils	0.00264
FRVG	Expenditure share on fruit and vegetable	0.01632
OFOD	Expenditure share on other foods	0.01226
NONF	Expenditure share on non-food items	0.91317
PBRCE	Price of bread and cereals	2.3788
PMEFH	Price of meat and fish	2.9779
PMCEG	Price of milk, cheese and eggs	1.7519
PFATS	Price of fats and oils	2.2573
PFRVG	Price of fruit and vegetable	1.3867
POFOD	Price of other foods	3.2535
PNONF	Price of non-food items	4.5701

4. ESTIMATION AND EMPIRICAL RESULTS

In this section, the estimation technique used in the analysis and the estimated parameters from the QUIADS model, as well as the price and expenditure elasticities of the individual-household expenditure allocations are presented. A common problem encountered in estimating a complete demand system is that there are too many variables relative to the number of observations available for estimation. A widely employed approach used to solve this problem is the two-stage budgeting procedure. This procedure assumes that the consumer's utility maximisation decision can be decomposed into two separate steps. In the first stage, the consumer determines the allocation of total expenditure between various commodity groups, e. g., food, housing, transport, entertainment, etc. In the second stage, the expenditure is allocated among different food groups. The price and expenditure elasticity estimates obtained from the two-stage budgeting are conditional or partial elasticities in the sense that a second-stage conditional demand system is estimated. These elasticity estimates are not very suitable for policy purposes. Furthermore, conditional demand elasticities are difficult to compare with the results of other studies. Hence a first-stage estimating procedure is employed in the present study. The unconditional or total elasticity estimates derived through this procedure is more suitable for policy recommendations.

The non-linear system was estimated using an iterative procedure (BROWNING and MEGHIR, 1991). In the first step, the Stone price index ($\ln P = \sum w_i \ln p_i$) was used to estimate the parameters of equation (5) with homogeneity and symmetry restrictions imposed using seemingly unrelated regression technique. In a second step, a new price index was computed using the estimated parameters and equation (2), and the system was re-estimated using the new price index. The steps were repeated until the parameters converged. Adding-up, homogeneity and symmetry were maintained in the estimation. The other-food equation was deleted because of singularity in the variance-covariance matrix when all seven equations are included. Parameters of the deleted equation were obtained through the adding-up condition of demand parameters.

Table 2 presents the parameter estimates of the symmetry-restricted QUAIDS model. The standard errors given in brackets are calculated with WHITE'S (1980) formula that accounts for non-parametric forms of heteroscedasticity. For all estimated equations, it is consistently observed that both the own- and cross-price parameters are statistically significant. All expenditure parameters are also significant at the 5 % level. The significance of quadratic terms in expenditure for the individual food and non-food groups is clearly evident in the Table. The estimates of expenditure classify all food groups as necessities while the non-food group is a luxury. Most of the demographic variables included in the model are significant. The coefficient for household size is positive and significant for all food groups, while it is significantly negative for the non-food group. This is an interesting result that can be given an intuitively appealing interpretation. In order to feed extra mouths from a limited budget, spending patterns need to be re-adjusted. As household size increases for a given level of expenditure and prices, families are compelled to adjust their pattern of demand towards food items and away from non-food commodities. The regional variables appear to have a relatively small influence across budget shares.

Test results used to consider the statistical evidence in support of the QUAIDS model and other restrictions of demand theory are presented in Table 3. The specification test reported is the test statistic for the restricted model with linear Engel curves for all commodity groups against the alternative of quadratic Engel curves in all seven commodity groups. The computed value of $\chi^2_{54} = 523.17$ had a p-value of zero against the $\chi^2(54)$ distribution. Hence the AIDS model was rejected in favour of the QUAIDS model. This indicates that the traditional Working-Leser specification is not a suitable form in the present analysis of consumer behaviour in Switzerland. The test for symmetry yielded a χ^2_{26} of 20.73, against a critical value of 25.0, as such the null hypothesis of symmetry could not be rejected.

The results in Table 3 also show that the null hypothesis of overall absence of demographic effects is strongly rejected, indicating the significance of demographic variables in consumer behaviour analysis.

The interpretation of price and income effects is best discussed in terms of elasticities. Tables 4 and 5 report uncompensated and compensated price elasticities, as well as expenditure elasticities for both the QUAIDS and the (nested) AIDS specification. A comparison of the elasticity values in the two tables shows the bias that occurs from using the linear specification for the sample under study. Changes are particularly noticeable for some expenditure elasticities, as the QUAIDS specification accounts for a quadratic expenditure term. These results suggest that attention needs to be given to model specification in food demand analysis. Focusing on the results of the QUAIDS specification, it can be observed that the expenditure elasticities of all commodity groups are positive, ranging between 0.30 and 1.02. This indicates that all the commodities are normal goods, consumption of which will increase with rising incomes. However, expenditure elasticities for all food groups are less than one, while that of the non-food group is above one, indicating that only the non-food group can be classified as a luxury, while food items belong to the necessity category.

Both uncompensated and compensated price elasticities are also given in Table 4. The negativity property is satisfied, since all own-price effects are negative. The uncompensated price elasticities show that own-price elasticities ranged between −0.65 and −1.59. The own-price elasticity of fruits and vegetables, other foods and non-food were found to be greater than unity, while the elasticity for the bread and cereals, meat and fish, as well as milk, cheese and eggs revealed inelastic demand. This indicates that a uniform percentage decrease in prices of all commodities would elicit a greater demand for fruits and vegetables, other foods and non-food groups. Bread and cereals and fats and oils groups show the lowest (absolutely) own-price elasticities, reflecting their status as staple-food groups. Not surprising, the non-food group has the highest (absolutely) own-price elasticity (−1.59).

Table 2: Estimated Coefficients of the Quadratic Almost Ideal Demand Systems.

	BRCE	MEFH	MCEG	FATS	FRVG	NONF	OFOD	EXP	EXPSQ
BRCE	0.00393							−0.02143	0.00171
	(0.00015)							(0.00113)	(0.00018)
MEFH	−0.00117	0.00228						−0.01378	0.00025
	(0.00021)	(0.00058)						(0.00276)	(0.00011)
MCEG	−0.00025	0.00015	0.00096					−0.02998	0.00256
	(0.00014)	(0.00027)	(0.00023)					(0.00140)	(0.00023)
FATS	−0.00074	−0.00020	−0.00024	0.00080				−0.00747	0.00081
	(0.00006)	(0.00010)	(0.00007)	(0.00007)				(0.00044)	(0.00007)
FRVG	−0.00093	−0.00069	−0.00099	−0.00032	−0.00166			−0.02544	0.00245
	(0.00017)	(0.00032)	(0.00021)	(0.00009)	(0.00036)			(0.00169)	(0.00027)
NONF	−0.00348	−0.00014	−0.00089	0.00100	0.00252	−0.00006		0.08977	−0.00554
	(0.00047)	(0.00096)	(0.00059)	(0.00032)	(0.00073)	(0.02505)		(0.00519)	(0.00083)
OFOD	−0.00225	0.00266	−0.00023	0.00126	−0.00029	0.00208	0.00106	0.00834	−0.00225

	CONSTANT	HHSIZE	LOWLAND	GENEVA	ZURICH	NWEST	EAST	CENTRAL
BRCE	0.08659	0.00410	−0.00125	−0.00251	−0.00134	−0.00137	−0.00123	−0.00136
	(0.00235)	(0.00007)	(0.00033)	(0.00035)	(0.00034)	(0.00035)	(0.00036)	(0.00039)
MEFH	0.07006	0.00548	−0.00361	−0.00085	−0.00708	−0.00654	−0.00483	−0.00513
	(0.00577)	(0.00017)	(0.00078)	(0.00083)	(0.00082)	(0.00085)	(0.00086)	(0.00093)
MCEG	0.09960	0.00512	0.00070	−0.00081	−0.00029	−0.00051	0.00029	0.00053
	(0.00284)	(0.00009)	(0.00041)	(0.00043)	(0.00042)	(0.00044)	(0.00045)	(0.00048)
FATS	0.01815	0.00069	−0.00027	−0.00041	−0.00025	−0.00040	0.00004	−0.00021
	(0.00148)	(0.00003)	(0.00013)	(0.00013)	(0.00013)	(0.00014)	(0.00014)	(0.00015)
FRVG	0.07919	0.00289	−0.00086	−0.00080	0.00046	−0.00109	−0.00104	−0.00113
	(0.00358)	(0.00010)	(0.00049)	(0.00051)	(0.00051)	(0.00053)	(0.00054)	(0.00058)
NONF	0.65730	−0.02083	0.00282	0.00388	0.00716	0.00826	0.00498	0.00615
	(0.11417)	(0.00033)	(0.00157)	(0.00165)	(0.00163)	(0.00169)	(0.00172)	(0.00186)
OFOD	−0.01089	0.00255	0.00246	0.00150	0.00135	0.00166	0.00179	0.00114

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	NOV
BRCE	−0.00074	−0.00159	−0.00109	−0.00139	−0.00068	−0.00155	−0.00121	−0.00193	−0.00066	−0.00006
	(0.00038)	(0.00039)	(0.00039)	(0.00039)	(0.00037)	(0.00037)	(0.00038)	(0.00038)	(0.00037)	(0.00036)
MEFH	−0.00485	−0.00586	−0.00682	−0.00413	−0.00303	−0.00504	−0.00293	−0.00544	−0.00623	−0.00412
	(0.00091)	(0.00094)	(0.00093)	(0.00095)	(0.00089)	(0.00089)	(0.00091)	(0.00091)	(0.00088)	(0.00087)
MCEG	−0.00126	−0.00191	−0.00030	−0.00049	−0.00081	−0.00148	−0.00140	−0.00118	−0.00110	0.00021
	(0.00047)	(0.00049)	(0.00048)	(0.00049)	(0.00046)	(0.00046)	(0.00047)	(0.00047)	(0.00046)	(0.00045)
FATS	−0.00020	−0.00049	−0.00036	−0.00009	−0.00027	−0.00027	−0.00008	−0.00029	−0.00030	−0.00005
	(0.00015)	(0.00015)	(0.00015)	(0.00015)	(0.00014)	(0.00014)	(0.00014)	(0.00014)	(0.00014)	(0.00014)
FRVG	−0.00162	−0.00266	−0.00082	0.00022	0.00115	0.00190	0.00361	0.00117	0.00007	0.00114
	(0.00057)	(0.00058)	(0.00058)	(0.00059)	(0.00055)	(0.00055)	(0.00056)	(0.00057)	(0.00055)	(0.00054)
NONF	0.01320	0.01773	0.01260	0.00727	0.00638	0.00998	0.00421	0.01074	0.01184	0.00613
	(0.00182)	(0.00187)	(0.00186)	(0.00189)	(0.00177)	(0.00177)	(0.00181)	(0.00182)	(0.00175)	(0.00174)
OFOD	−0.00452	−0.00523	−0.00321	−0.00139	−0.00273	−0.00354	−0.00220	−0.00307	−0.00363	−0.00326

Notes: Terms in parentheses are standard errors corrected for heteroscedasticity, using WHITE's (1980) formula. BRCE, bread and cereals; MEFH, meat and fish; MCEG, milk, cheese and eggs; FATS, fats and oils; FRVG, fruit and vegetable; NONF, non-food; OFOD, other foods; EXP, expenditure; EXPSQ, expenditure squared.

Table 3: Likelihood Ratio Tests of Restrictions

Restriction	$-2 \log L$	*Critical value*	*Conclusion*
AIDS specification	526.13	$\chi^2(54, 0.95) = 79.08$	Rejected
Symmetry test	20.73	$\chi^2(15, 0.95) = 25.0$	Accepted
Non-demographic effects	41.56	$\chi^2(17, 0.95) = 27.6$	Rejected

Note: The likelihood ratio test is given by $2(L_\Omega - L_\omega)$, where L_Ω is the unrestricted maximum log-likelihood and L_ω is the restricted maximum log-likelihood. It has an asymptotic $\chi^2(k)$ distribution, where k is the number of required restrictions.

Table 4: Price and Expenditure Elasticity Estimates from QUAIDS Model

	PBRCE	PMEFH	PMCEG	PFATS	PFRVG	PNONF	POFOD	EXP
Uncompensated								
BRCE	−0.6561	−0.0097	0.0946	−0.0239	0.0356	0.0327	0.1509	0.3759
	(0.113)	(0.002)	(0.021)	(0.008)	(0.017)	(0.018)	(0.066)	(0.043)
MEFH	−0.0049	−0.8613	0.0630	0.0030	0.0201	0.3217	−0.0197	0.4782
	(0.002)	(0.307)	(0.032)	(0.006)	(0.008)	(0.113)	(0.007)	(0.212)
MCEG	0.0886	0.0882	−0.8108	0.0162	0.0595	0.2118	0.0436	0.3030
	(0.033)	(0.029)	(0.198)	(0.007)	(0.027)	(0.086)	(0.019)	(0.081)
FATS	−0.1293	0.0341	0.1104	−0.6486	0.0550	0.4185	−0.1598	0.3197
	(0.052)	(0.012)	(0.046)	(0.073)	(0.022)	(0.087)	(0.061)	(0.032)
FRVG	0.0315	0.0244	0.0558	0.0074	−1.0009	0.2903	0.1006	0.4910
	(0.022)	(0.006)	(0.009)	(0.008)	(0.207)	(0.096)	(0.045)	(0.057)
NONF	−0.0103	−0.0054	−0.0092	−0.0007	−0.0044	−1.5876	0.0028	1.0160
	(0.004)	(0.002)	(0.003)	(0.001)	(0.001)	(0.136)	(0.001)	0.174)
OFOD	0.2083	−0.0126	0.0822	−0.0318	0.1540	0.7230	−1.020	0.3974
	(0.046)	(0.002)	(0.027)	(0.019)	(0.044)	(0.208)	(0.088)	(0.062)
Compensated								
BRCE	−0.6503	−0.0010	0.1011	−0.0229	0.0417	0.3760	0.1555	
	(0.113)	(0.001)	(0.022)	(0.008)	(0.016)	(0.019)	(0.066)	
MEFH	0.0024	−0.8503	0.0713	0.0042	0.0279	0.7584	−0.0138	
	(0.002)	(0.306)	(0.031)	(0.006)	(0.009)	(0.115)	(0.006)	
MCEG	0.0932	0.0952	−0.8056	0.0170	0.0644	0.4884	0.0473	
	(0.031)	(0.028)	(0.198)	(0.006)	(0.026)	(0.085)	(0.019)	
FATS	−0.1244	0.0414	0.1160	−0.6478	0.0602	0.7104	−0.1559	
	(0.053)	(0.014)	(0.045)	(0.073)	(0.023)	(0.088)	(0.061)	
FRVG	0.0389	0.0357	0.0643	0.0087	−0.9929	0.7387	0.1066	
	(0.022)	(0.007)	(0.008)	(0.009)	(0.206)	(0.098)	(0.044)	
NONF	0.0058	0.0189	0.0091	0.0021	0.0128	−0.6598	0.0158	
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.105)	(0.002)	
OFOD	0.2143	−0.0034	0.0891	−0.0308	0.1605	1.0858	−1.0151	
	(0.045)	(0.002)	(0.028)	(0.019)	(0.045)	(0.209)	(0.088)	

Notes: standard errors in parentheses. BRCE, bread and cereals; MEFH, meat and fish; MCEG, milk, cheese and eggs; FRVG, fruit and vegetable; FATS, fats and oils; NONF, non-food; OFOD, other foods; EXP, expenditure.

The compensated price elasticities provide a more accurate picture of cross-price substitution between commodity groups, since they are a measure of substitution effects net of income. In the matrix of the compensated price elasticities, it can be observed that own-price effects are relatively large and negative. They are, in absolute terms, smaller than the uncompensated elasticities. The fact that the signs of some compensated elasticities are different from those of the uncompensated elasticities suggests that expenditure effects are significant in affecting consumer demand decisions. Most of the cross-price elasticities are positive, indicating that the relevant food groups are substitutes, as would be expected. However, their low magnitudes suggest that substitution possibilities are quite limited. It is also interesting to note some of the exceptions where there is some complementarity between food groups. Amongst the food groups, there is complementarity between bread and cereals and meat and fish and between fats and oils and bread and cereals.

To illustrate the variation of elasticities across households, Tables 6 and 7 report expenditure and uncompensated own-price elasticities for households grouped by the four income classes provided in the survey data.[7] The values are computed at the mean point of the households' sub-samples. As expected, expenditure elasticities for bread and cereals, fish and meat, milk, cheese and eggs, other foods, and the non-food groups show that the highest values are in the low and medium-low income groups. Contrary to expectation is the behaviour of income classes with respect to consumption of fats and oils and fruit and vegetable. Although exhibiting the lowest expenditure shares in conformity with Engel's law, expenditure elasticities appear to be highest for the high income group for the consumption of these food groups. This is probably due to the fact that the high income households tend to consume the highest quality component of each of these aggregates. The expenditure elasticities also reveal that food aggregates are necessities for all households, while the non-food aggregate consistently shows up as a luxury good.

The differences in the expenditure elasticities in Table 6 are reflected in the variation of the uncompensated own-price elasticities in Table 7. A comparison of the own-price elasticities again shows differences between the four income classes, with generally greater responses to changes in prices for low income households than high income households.

7. The low-income group refers to those households with monthly income of less than 5,000 Swiss Francs; the low-medium are those households with income between 5,000 and 7,300 Swiss Francs; the medium-high are those households with income between 7,300 Swiss Francs and 10,400 Swiss Francs, while the high income class refers to those households with monthly income of more than 10,400 Swiss Francs.

Table 5: Price and Expenditure Elasticity Estimates from AIDS Model

	PBRCE	PMEFH	PMCEG	PFATS	PFRVG	PNONF	POFOD	EXP
Uncompensated								
BRCE	−0.7020	−0.0516	0.0385	−0.0329	−0.0086	0.2713	0.1449	0.3404
	(0.118)	(0.019)	(0.013)	(0.014)	(0.007)	(0.082)	(0.059)	(0.037)
MEFH	−0.0362	−0.9009	0.0256	−0.0035	−0.0103	0.4635	−0.0164	0.4453
	(0.004)	(0.362)	(0.018)	(0.004)	(0.005)	(0.097)	(0.006)	(0.084)
MCEG	0.0350	0.0390	−0.8775	0.0051	0.0085	0.4889	0.0398	0.2612
	(0.026)	(0.016)	(0.213)	(0.009)	(0.003)	(0.192)	(0.011)	(0.076)
FATS	−0.1881	−0.0247	0.0341	−0.6558	0.0030	0.8073	−0.2094	0.2335
	(0.057)	(0.018)	(0.016)	(0.083)	(0.002)	(0.186)	(0.013)	(0.048)
FRVG	−0.0096	−0.0138	0.0058	−0.0001	−1.0385	0.5209	0.0896	0.4456
	(0.027)	(0.004)	(0.002)	(0.002)	(0.143)	(0.118)	(0.027)	(0.059)
NONF	−0.0064	−0.0017	−0.0045	0.0002	−0.0007	−1.3752	0.0303	1.0580
	(0.002)	(0.006)	(0.003)	(0.001)	(0.003)	(0.166)	(0.012)	(0.188)
OFOD	0.1786	−0.0296	0.0535	−0.0456	0.1196	0.8359	−1.0485	0.4248
	(0.042)	(0.007)	(0.019)	(0.022)	(0.033)	(0.124)	(0.178)	(0.071)
Compensated								
BRCE	−0.6969	−0.0438	0.0444	−0.0320	−0.0031	0.5822	0.1491	
	(0120)	(0.017)	(0.012)	(0.013)	(0.005)	(0.083)	(0.058)	
MEFH	−0.0289	−0.8899	0.0339	−0.0022	−0.0025	0.9001	−0.0106	
	(0.003)	(0.359)	(0.019)	(0.003)	(0.003)	(0.099)	(0.006)	
MCEG	0.0389	0.0450	−0.8730	0.0058	0.0128	0.7275	0.0430	
	(0.025)	(0.015)	(0.214)	(0.008)	(0.004)	(0.194)	(0.012)	
FATS	−0.1845	−0.0193	0.0382	−0.6552	0.0068	1.0206	−0.2066	
	(0.057)	(0.018)	(0.017)	(0.084)	(0.002)	(0.188)	(0.14)	
FRVG	−0.0029	−0.0035	0.0136	0.0011	−1.0312	0.9278	0.0951	
	(0.026)	(0.004)	(0.004)	(0.002)	(0.142)	(0.120)	(0.028)	
NONF	0.0097	0.0227	0.0138	0.0029	−0.0166	−0.4091	0.0433	
	(0.002)	(0.005)	(0.005)	(0.001)	(0.087)	(0.164)	(0.013)	
OFOD	0.1851	−0.019	0.0608	−0.0444	0.1266	3.2238	−1.04330	
	(0.044)	(0.006)	(0.017)	(0.021)	(0.031)	(0.126)	(0.175)	

Notes: standard errors in parentheses. BRCE, bread and cereals; MEFH, meat and fish; MCEG, milk, cheese and eggs; FRVG, fruit and vegetable; FATS, fats and oils; NONF, non-food; OFOD, other foods; EXP, expenditure.

Table 6: Distribution of Expenditure Elasticities by Total Expenditure

Expenditure Group	BRCE	MEFH	MCEG	FATS	FRVG	OFOD	NONF
Low	0.3723 (0.036)	0.5348 (0.062)	0.3009 (0.019)	0.2243 (0.013)	0.4363 (0.057)	0.7032 (0.102)	1.0657 (0.019)
Middle-low	0.3582 (0.029)	0.5096 (0.033)	0.2843 (0.031)	0.1994 (0.022)	0.4496 (0.037)	0.5189 (0.043)	1.0592 (0.018)
Middle-high	0.3557 (0.031)	0.4824 (0.037)	0.2724 (0.018)	0.2545 (0.023)	0.4654 (0.052)	0.3602 (0.050)	1.0553 (0.021)
High	0.3097 (0.025)	0.3314 (0.046)	0.2034 (0.015)	0.4152 (0.029)	0.5088 (0.063)	0.0019 (0.002)	1.0491 (0.022)

Notes: standard errors in parentheses. BRCE, bread and cereals; MEFH, meat and fish; MCEG, milk, cheese and eggs; FATS, fats and oils; NONF, non-food; OFOD, other foods.

Table 7: Distribution of Uncompensated Own-Price Elasticities by Total Expenditure

Expenditure Group	BRCE	MEFH	MCEG	FATS	FRVG	OFOD	NONF
Low	−0.7215 (0.023)	−0.8795 (0.054)	−0.8538 (0.237)	−0.7539 (0.119)	−1.0008 (0.061)	−1.0377 (0.049)	−1.4413 (0.055)
Middle-low	−0.6731 (0.026)	−0.8708 (0.051)	−0.8229 (0.036)	−0.6594 (0.077)	−1.0001 (0.059)	−1.0317 (0.053)	−1.4863 (0.048)
Middle-high	−0.6388 (0.019)	−0.8622 (0.028)	−0.7969 (0.052)	−0.6003 (0.039)	−0.9988 (0.063)	−1.0280 (0.058)	−1.5403 (0.057)
High	−0.5385 (0.075)	−0.8188 (0.083)	−0.7204 (0.136)	−0.4675 (0.042)	−0.9943 (0.068)	−1.0220 (0.061)	−1.6660 (0.65)

Notes: standard errors in parentheses. BRCE, bread and cereals; MEFH, meat and fish; MCEG, milk, cheese and eggs; FRVG, fruit and vegetable; FATS, fats and oils; NONF, non-food; OFOD, other foods.

5. CONCLUDING REMARKS

This research represents an initial effort using the recent Swiss Federal Office of Statistics (BSF) household survey data to estimate a complete demand system for Switzerland, with special emphasis on the food commodity group. A Quadratic Almost Ideal Demand System (QUAIDS) specification introduced by BANKS, BLUNDELL and LEWBEL (1996 and 1997) was employed in the analysis. The quadratic terms in the QUAIDS were found to be empirically important in describing household budget behaviour in Switzerland, indicating that the traditional Working-Laser specification with linear Engel curves is not a suitable representation of food consumption behaviour in Switzerland. Price and expenditure elasticities were computed for six food aggregates and non-food expenditure. The six food aggregates included: bread and cereals; meat and fish; milk, cheese and eggs; fats and oils; fruit and vegetable; and other foods. Demographic and other conditioning variables were incorporated by a translating approach. A comparison of price and expenditure elasticities across income segments was also undertaken to provide insights into the structure of food demand in Switzerland.

Food consumption behaviour as revealed from the complete matrix of price and expenditure elasticities, shows some interesting patterns. First, the presence of significant price effects on budget-share equations for all food commodities indicates that price policy is an important agricultural policy instrument. For most commodity groups, demand is inelastic, with elasticities ranging between −0.64 and −1.59. Cross-price elasticities were quite low, suggesting limited possibilities of substitution.

Second, the estimated own-price and expenditure elasticities from the specification on groups segmented by income show that for most food commodities, own-price and expenditure elasticities were consistently higher for the lower income group. These results may provide insights for production and food policy interventions: For example, measures such as income supplements require knowledge on how individual income groups react to price and income changes. Hence, if the emphasis of policy analysis is centred on poverty status of households, then analysts should employ demand estimates indigenous to this income group, and not average estimates for the population as a whole.

Furthermore, all food groups were found to be necessities, while the non-food group consistently showed up as a luxury good, indicating that future increases in income are likely to be spent primarily on non-food items. This shows the growth potential in the non-food sector with increasing incomes. Among the food groups, demand for meat and fish and fruit and vegetable is expected to increase most, with rising consumer incomes. Parameters associated with household size were generally significant, supporting the hypothesis that the number of people in a household tends to influence its consumption pattern. For a given level of expenditure and prices, larger families are often compelled to adjust their consumption patterns to relatively inexpensive commodities, and away from expensive ones.

An extension of this model to a more disaggregated level may provide useful information on price and non-price factors affecting demand for particular foods. Given that marketing strategies benefit from knowledge of differential responses, such information could be particularly useful for the food industry as a tool for relevant market segmentation. Overall, the findings of this study suggest that the QUAIDS model which allows for more flexibility is superior to the traditional AIDS model. It is also evident that considering the structure of demand for each household type can have important policy implications.

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SUMMARY

In this paper we estimate a complete demand system for Switzerland, with emphasis on food demand, using a recent household expenditure survey. The Quadratic Almost Ideal Demand System (QUAIDS) is employed in the analysis of six food commodity and a non-food groups. The quadratic terms in the QUAIDS were found to be empirically important in describing household budget behaviour in Switzerland. For most food commodity groups, demand is inelastic, with elasticities ranging between −0.64 and −1.02. Cross-price elasticities are very low, suggesting limited possibilities of substitution between food groups. All food groups are found to be necessities, while the non-food group is a luxury. The estimated own-price and expenditure elasticities from the specification on groups segmented by income show that for most food commodities, own-price (absolutely) and expenditure elasticities are consistently higher for the lower income group.

ZUSAMMENFASSUNG

Mit Hilfe eines vollständigen Nachfragemodells wird der Konsum von Nahrungsmitteln analysiert. Die Daten stammen von der neusten Verbrauchserhebung des Bundesamtes für Statistik. Dabei werden sechs Gruppen von Nahrungsmitteln und eine Gruppe von andern Konsumgütern gebildet und mit einem quadratischen AIDS-Modell analysiert. Die Ergebnisse zeigen, dass der quadratische Term wesentlich zur Erklärung des Konsumverhaltens der Schweizer Haushalte beiträgt. Bei fast allen Gütergruppen ist die Nachfrage preisunelastisch; die geschätzten Werte für die direkten Preiselastizitäten bewegen sich zwischen −0.64 und −1.02. Die Werte für die Kreuzpreiselastizitäten sind gering und deuten darauf hin, dass die Substitutionsmöglichkeiten zwischen den verschiedenen Nahrungsmittelgruppen eng begrenzt sind. Alle Nahrungsmittel haben den Charakter von „notwendigen" Gütern (necessities) während die Nicht-Nahrungsmittel Eigenschaften von „Luxusgütern" aufweisen. In den meisten Fällen gilt: je tiefer die Einkommensklasse desto höher die Einkommenselastizitäten und der Betrag der direkten Preiselastizitäten.

RÉSUMÉ

Dans cet article, nous estimons un système complet de demande pour la Suisse. Un accent particulier est mis sur la demande de produits alimentaires, en utilisant une enquête récente des dépenses des ménages. Le système presque idéal de demandes quadratiques (SPIDQ) est utilisé dans l'analyse de six groupes de produits alimentaires et un groupe de produits non-alimentaires. Les termes quadratiques dans le SPIDQ se sont avérés empiriquement importants pour décrire le comportement lié au budget des ménages en Suisse. Pour la plupart des groupes de produits alimentaires, la demande est inélastique, avec des élasticités variant entre −0.64 et −1,02. Les élasticités-prix croisées sont très basses, suggérant des possibilités limitées de substitution entre les groupes de produits alimentaires. Tous les groupes de produits alimentaires apparaissent comme étant de première nécessité, alors que le groupe de produits non-alimentaires représente des produits de luxe. Les élasticités-prix propres et les élasticités-revenus des groupes classés en fonction du revenu montrent que pour la plupart des produits alimentaires les élasticités-prix propres et les élasticités-revenus sont de manière consistante plus élevées pour le groupe avec des revenus inférieurs.