PROBLEMS

Consumer Behaviour in an Early Modern Dutch Orphanage: a Wealth of Choice

Anne McCants
The Massachussetts Institute of Tecnology, Cambridge, MA

The historical study of diet is grounded in a desire to better understand the material world of the past. Knowledge about a people's access to food can tell us much about their prosperity, their health and even their ability to engage in sustained work. Yet, foodstuffs are not just rich in nutrients, but in cultural content as well. Both of these factors influence the decision to buy some foods and not others. The diets of western Europeans by the early modern period reflect not merely agricultural possibilities, but more and more the outcome of a process of consumer choice. Moreover, the relative importance of nutritional and cultural factors in this process is susceptible to change, both over time and according to income level.

The study of consumption behaviour with regard to the latter issue has its own long history, beginning with the pioneering statistical work of Engels.[1] However, the degree to which the determinants of food consumption behaviour have changed within social groups over time has been little studied. To do so properly reguires long runs of observations of purchasing behaviour for specific communities. But appropriate data for such an enterprise are scarce. My study of the account books of the Amsterdam Municipal Orphanage (the *Burgerweeshuis*) thus offers an unusual opportunity to assess purchasing behaviour over a span of nearly two centuries.

In 1639 the city of Amsterdam required the regents of the Burgerweeshuis to compile annual account books detailing every expenditure and receipt of the previous year. Summaries of these *Staatboeken* were to be turned over to the

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[1] In 1857 Ernst Engel presented the first statistical analysis of consumer behaviour, based on the household budgets of about 200 Belgian labourers. This study proposed the Law which bears his name, that the proportion of income spent on food declines as income rises. See his, *"Die Productions - und Consumptionsverhaltnisse des Konigreichs Sachsen,"* in *Zeitschrift des Statiatischen Bureaus des Koniglich Sachsischen Ministerium des Inneren,* Nos. 8 and 9, 1857.

civic authorities for review. These accounts were kept annually until 1812, when the dislocations associated with the Napoleonic Wars altered fundamentally the governmental oversight of charitable institutions. The Staatboeken for the years 1662-66, 1680, 1682 and 1726-27 are no longer extant, so these nine years are missing from the present study. For the remaining 165 years, the expenditure on every individual food purchase is known, and in all but a few cases the quantity bought and the unit price of the item is also known.

Sensitivity of food demand to income:

Before delving into the demand patterns for specific food items in the orphanage's diet, the larger picture of food demand relative to all other types of consumption must first be assessed. For the 169 years between 1639 and 1812 for which the budget allocations are known, expenditure on food and its basic processing — ie. milling and slaughter costs are included here, but cooking expenses are not — averaged 31% of the orphanage's total current account expenditures, with a standard deviation of only 5.8%. The lowest annual share was in 1736 at 18.9% and the highest was in 1672 at 48.7%. Although these two years are outliers from the general experience, they are nonetheless suggestive of the complexity of the decision-making process engaged in by the regents of the institution. 1672 was a year of very high prices. The deviation of the total food price index from its trend, as determined by an eleven-year moving average, measured a substantial 15%. Conversely, prices in 1736 were 10% below the trend. Moreover, during the decade of the 1730s the orphanage population was at its nadir, while the third quarter of the seventeenth century marked the peak of the influx of new orphans with the resultant problem of overcrowding.

There were of course other single years of either very high or low prices which did not result in strong deviations from the mean budget allocation for food. This reflects the variety of other variables that could also affect this measure. Total income, the borrowing or lending of money, deviations from the usual spending in other categories of the budget, the mix of food items and their relative prices, and the total number of calories provided per capita, as well as the size of the orphan population, all have some part to play in the process of budget allocation. For example, when the budget share for food is determined using total current income instead of expenditures, the mean falls slightly to 29% and the standard deviation increases to 7%. The lower mean percentage points to the general surplus of income over expenditures. However, the greater variability is an indication that increases (or decreases) in income were not directly translated into corresponding changes in food expenditures. Instead the — se changes were filtered through a decision — making process that included many other considerations.

Despite these annual fluctuations, the remarkably low share of the total budget allocated to food expenditures is evidence of the prosperity of this institution. Vandenbroeke, in his exhaustive study of Flemish living standards

from the Middle Ages to the present, argues that until the post- World War II period approximately 60% of all expenditures consisted of those for food and drink. A typical worker's family circa 1830 spent 66.6% of its income on food. And while we might expect an institution to fare better in this respect than an ordinary family, his evidence from an Flemish orphanage (unnamed) around the same time suggests that they spent an even higher percentage, namely 75.1% on food. The budget share for the (same?) orphanage circa 1600 was only slightly higher still at 78.7%.[2] Vandenbroeke's data are also consistent with the extensive work which has been done on English budgets from the early modern period.[3] By all accounts then, the Burgerweeshuis spent an unusually low percentage of both its income and its total expenditure on the provisioning of food. How then was this budget for food allocated between various food items?

A Model of Consumer Behaviour:

Consumers determine the quantity and the variety of their consumption bundle on the basis of their preferences, in conjunction with the limitations imposed by their resource allocation. This limitation, called the budget constraint, can be objectively measured by the total income available to the consumer and the prices of all the goods in his consumption bundle. This constraint is fixed and cannot be altered by the consumer as long as he is a price taker. It should be noted that even the availability of credit does not change the basic properties of the budget constraint. Credit merely adds a time dimension to the consumer's set of preferences. Those who borrow extensively show a strong preference for consumption in the current period relative to consumption later.

Unfortunately, preferences cannot be measured directly. No one sets out to market with an explicit demand function in hand to help them make their purchasing decisions. Instead, preferences are revealed by the choices that the consumer makes given market prices and available income.[4] These revealed preferences have both a static and a dynamic component. The former is indicated by the share of the budget spent on any given item or group of related items, at any one point in time. The latter is reflected by changes in either the budget shares or the quantities consumed in response to changes in either prices or income. Such changes are measured in terms of elasticities of demand. The estimation of these elasticities requires only the knowledge of the quantities

[2] CHRIS VANDENBROEKE, *Vlaamse Koopkracht,* 1984, pp. 267-8.

[3] See the debate between Carole Shammas and John Komlos in the *Journal of Economic History.* Her original article "Food Expenditure and Economic Well-Being in Early Modern England" appeared in 1983. His response appeared in 1988.

[4] For a complete mathematical development of the Generalized Axiom of Revealed Preference see Varian, *Mircoeconomic Analysis,* 1984, pp. 142-43.

purchased at a given price of the relevant goods and the assumption that changes in taste or the environment (ie. all other non-budget effects) are empirically-non-significant. The historian justly bristles at this latter assumption: changes in taste and environment are after all the stuff of good history. However, this feature of the theory can actually be of great use to the historian because it allows pure budget effects to be separated out from the more interesting culturally determined changes in behaviour.

The Mathematical Model:

The budget (either for all goods or for one subset of similar goods) is written by definition as:

$$q_1p_1 + q_2p_2 + \ldots + q_np_n = m \qquad (1)$$

where $q_1, \ldots q_n$ are the quantities of each good and $p_1, \ldots p_n$ are their corresponding unit prices. The fact that m is determined by the summation of all purchases, instead of by some outside measure of income, indicates that the true budget constraint is not nominal, but real; a change in any one price affects the income available for the purchase of all goods, not just the good experiencing the price change. Changes in taste or the environment (i.e. all other non-budget shocks) will also affect the demand for each good in the consumption bundle.

The demand for each good thus takes the following functional form:

$$q_i = f_i\,(m, p_1, \ldots p_n, z_1, \ldots z_n) \text{ for } i = 1, \ldots n \qquad (2)$$

where $z_1, \ldots z_n$ represent all of the non-budget variables. These variables are, however, very difficult to specify, and even more difficult to quantify. Empirical studies of consumption behaviour have as a result established the practice of assuming taste-change variables to be negligible in their effect on consumption, and have concentrated solely on the price-change variables. While this assumption is not likely to hold for our data, it will be imposed anyway to keep the price analysis within manageable proportions.[5] The issues involved will be reintroduced in the discussion of the price and income elasticities to shed further light on those results.

Equation (2) above does not define any of the relationships between prices, budget and quantity demanded; it merely asserts that such relationships exist. In order to carry out an empirical investigation further specification of this function is necessary. One specification of these relationships which yields consistent estimators, and allows for the imposition of the theoretically relevant

[5] Sugar and beer consumption are particularly good examples of this problem. Between the mid-XVIIth century and the end of the XVIIIth century, the provision of calories from sugar increased five fold. Over the same period, the provision of calories from beer decreased by 57%. Both of these changes reflect cultural trends which were not necessarily sensitive to relative price changes.

assumptions is the *Rotterdam Model.* [6] The basic demand equation in this model is written as follows:

$$dw_{it}\, d\ln q_{it} = b_i[d\ln m_t) - \Sigma\,(w_{jt}\, d\ln p_{jt})] + \Sigma$$
$$(s_{ij}\, d\ln p_{jt} \text{ for } i = 1, \ldots n \text{ and } j = 1, \ldots n \qquad (3)$$

where $ww_{it} = q_{it}p_t/m$ for each period of time t and changes in variables are measured as annual differences. The coefficients take the following interpretation:

$$b_i = w_iB_i \text{ for } i = 1, \ldots n \qquad (4)$$
$$s_{ij} = w_iE_{ij} \text{ for } i = 1, \ldots n;\ = 1, \ldots n \qquad (5)$$

where B_1 is the income elasticity of demand, and E_{ij} is the compensated (or pure) price elasticity of demand. [7] The total price elasticity of demand is given by the following equation:

$$E^*_{ij} = E_{ij} - B_iw_i \text{ for } i = 1, \ldots n;\ 1, \ldots n \qquad (6).$$

Three standard assumptions about the parameter values stand behind the model as estimated. The mathematical properties of each and the applicability of each to historical data will be discussed in turn. The strongest assumption concerns the symmetry of the final matrix of the estimated price coefficients. This restriction is imposed by specifying that $s_{ij} = s_{ji}$, i.e. the effect of a change in the price of goods on demand for good is identical to the effect of a change in the price of good on the demand for good i. This is true by definition if the consumer is maximizing utility subject to a budget constraint. [8] Also true by definition is the restriction that the income coefficients sum to one; i.e, $\Sigma b_i = 1$. This simply asserts that one extra guilder of income must be fully spent. And of course, it cannot be spent more than once.

However, if either the budget is not binding or the components of utility are not properly specified, the symmetry property no longer holds. While there is every reason to believe that the budget constraint was indeed binding for the regents of the Burgerweeshuis, we cannot be so certain that their true utility function has been captured by prices and quantities alone. Because the different foods in the diet varied widely in their provision of energy and nutrients, as well as in social value, the quantity of the various foods purchased is only an imperfect proxy for the utility provided by them. For example, it is theoretically

[6] The Rotterdam Model was developed by A. P. Barten and Henri Theil. An exposition on its use and its desireable estimating properties can be found in Theil, *The System-Wide Approach to Microeconomics,* 1980.

[7] The derivation of the Rotterdam Model has been presented in full by Schokkaert and Van der Wee, "A Quantitative Study of Food Consumption in the Low Countries during the 16th Century", *Journal of European Economic History,* 1988. Their method has been followed here very closely to ensure the comparability of these results with theirs. The final system of eleven demand equations was estimated using a Maximum Likelihood multivariate regression procedure supported by the mainframe version of TSP.

[8] See Varian, 1984, pp. 133-134 for a mathematical proof of this.

possible that a consumer would want to maximize the number of calories he received for a given budget subject to the basic restrictions that minimum protein and vitamin needs are also met. [9] If the problem were specified in this way, the result of a regression analysis would look very different than if food items are simply measured in their original units, or if they are measured by some hierarchy of social prestige. Nonetheless, this assumption must be imposed if the problem is to be a manageable one. The implications of this dimension to our problem will be discussed further following the presentation of the estimated coefficients.

The second assumption made is that the regents did not suffer from money illusion. In other words, they were only concerned with relative price changes and could differentiate between real and nominal changes in their income. The long-term price trend from the seventeenth century through the first half of the eighteenth was in fact quite flat so for the bulk of the period under observation the potential for money illusion is limited. [10] Moreover, the annual fluctuations in food prices continued to be of much greater amplitude than the secular increase in prices which began in the second half of the eighteenth century, making this assumption a reasonable one for our data. It is formally introduced into the system by specifying that $\Sigma s_{ij} = o$, over the range $(j = 1, ..., n)$. In any one equation the sum of all the price coefficients must amount to zero. In other words, if all prices changed by the same factor, there would be no change in the demand for any good because relative prices would not have been altered.

The final assumption is that the budget must be exogenously given and not related to prices in any way. Although the Burgerweeehuis did receive a portion of its rents from farm land in the form of dairy products and occasionally pigs, the value of the rent was not itself dependent on these food prices. The value of the rent was determined in advance with changes in prices only affecting the quantity of foodstuffs necessary to cover that value.

Nonetheless, this assumption remains a problematic one for the Burgerweeshuis data. Because a certain level of food consumption is necessary for maintenance of life and the regents had a social responsibility towards this end, there is a certain amount of asymmetry in the regents' behaviour during periods of very high prices. Relative price changes within a normal range were met with the predicted response of changing the mix of goods purchased. However, if price increases were so high that the loss in real income could not be compensated for by changing the mix of purchases towards cheaper calories,

[9] When George Stigler carried out this exercise in 1945, the resulting diet consisted almost entirely of dried navy beans, wheat flour and cabbage. See his, "The Cost of Subsistence," in *The Journal of Farm Economics,* Vol. 27 (May, 1945), pp. 303-314.

[10] A. Appleby, "Grain Prices and Subsistence Crises in England and France", *Journal of Economic History,* 1979, p. 871. Price data from the Amsterdam Exchange collected by Posthumus confirm this position. See his *Inquiry into the History of Prices in Holland,* Vol. I, 1946.

additional resources had to be enlisted for the purchasing of food. This could manifest itself in either reductions of other types of expenditure or in the borrowing of money. Examples of both can be found for this institution. The strategies employed by the regents in times of severe strain on the budget will be discussed at the conclusion of this paper.

The data:

Up to 36 different types of food have been recorded in the purchase accounts of the Burgerweeshuis, although many of these specific items were not bought in every year. Thus, the data in its original form presented two obstacles for the application of the Rotterdam Model. The number of equations which can be estimated simultaneously with reliable results for this type of data is limited to approximately ten. More equations than this not only use up degrees of estimating freedom, but also increase the risk of multicollinearity in the price or quantity variables. In addition, the system can only be estimated if there exists a complete time series of both purchases and prices for each of the goods in the system. Clearly, the purchases of the institution needed to be grouped into more general categories before proceeding with the estimation of income and price elasticities.

To this end the original data were transformed into an annual series of purchases of eleven basic commodities. The quantity bought in each category was measured in consistent units, usually kilograms, and the price was determined by a weighted average of the actual prices paid by the Burgerweeshuis for all goods within that category. The eleven categories are wheat, rye, legumes, meat (including whole oxen, cows, and pigs as well as bacon and sausage), butter, milk (both whole and buttermilk), sugar (primarily treacle), cheese, fish (all different types), beer and meal (including barley, gort and undifferentiated ground grains). Even with the food purchases grouped in this way, there were still occasional years when the Burgerweeashuis did not buy anything in a given category. For these years, the quantity was listed as an infinitesimally small number (it is impossible to take the log of zero) and the price was supplied either from the records of the Amsterdam Exchange, or for those goods for which prices were not volatile, from interpolation of surrounding years. [11]

[11] Posthumus, *An Inquiry into the History of Prices in the Netherlands,* Vol. I, 1946. A test of the model using the quantities of each commodity figured as per capita amounts was also undertaken. Consumer theory applies in its strictest application to the individual, so changes in the orphan population could generate spurious results if this was not accounted for. However, the coefficient estimates generated by the per capita amounts did not differ significantly from those generated by the data in its form described here. Moreover, the log of the likelihood function was reduced so it seemed best to use the data as originally assembled.

The total series was also divided at the year 1760 into two separate series, with 109 observations in the first and 51 observations in the second. This was done for two reasons. The price of gort, and also the quantity purchased, was not recorded until 1761 and thereafter. The first series therefore consists of only ten categories, the last group, that consisting of meal and gort, being left out of the system. Moreover, beginning in 1758, the Burgerweeshuis no longer purchased live pigs for slaughter, but instead bought bacon and pork sausage already processed. This product was more expensive per unit of edible weight reflecting the labour saving for the institution. Since the timing of this shift was so close to the break point in the gort series, it seemed sensible to truncate the first series at 1757 to avoid confusing a distinct change in the quality of purchased meat with a change in its unit price.

The last remaining difficulty lies in the measurement of rye and wheat as items in the budget and as items of consumption. The strong evidence that the Burgerweeshuis held considerable stores of these two grains suggests that purchases of these commodities were sensitive to price changes and inventory strategies, but not directly to current consumption. [12] On the one hand, utility theory asserts that the motivation behind a purchase is irrelevant; whether you buy grain to eat or to store you still try to maximize your total utility given the limits of your budget and relative prices. However, the addition to total utility at the margin may be very different for grain as a storage commodity as opposed to grain as a consumption commodity. The former is not necessarily dependent on other foods in the diet, while the latter clearly is. In light of this ambiguity about the proper specification of the data, the analysis was conducted twice. Not surprisingly, the results of the simultaneous demand equation system are very different depending on whether the data for purchased grain or milled grain (used here as a proxy for current consumption) is included.

The Results:

Table 1 gives the estimated income and substitution coefficients for the data between 1639-1757 with wheat and rye measured as the quantity milled annually. As we would expect, the income coefficients (b_i) are all positive,

[12] A separate analysis of the institution's purchase and consumption of rye and wheat indicates that the regents often held between a two- and three- years supply of both grains. Moreover, additions to the stock of rye in particular were more sensitive to the quantity of grain stocks already held than to changes in the price of rye. By the second half of the eighteenth century, changes in both rye and wheat holdings demonstrate an increased sensitivity to the size of existing stocks. See my unpublished dissertation «The Role of the Charitable Institution in the Early Modern Dutch Economy: the Case of the Amsterdam Burgerweeshuis,« UC Berkeley, 1991, pp. 124 and 129-32.

Table 1
ESTIMATION RESULTS USING MILLED QUANTITIES OF GRAIN. 1639-1757

	Wheat	Rye	Legume	Meat	Butter	Milk	Sugar	Cheese	Fish	Beer
S_{ij}										
Wheat	.0059	.0016	.0034	.0055	−.0058	−.0214	−.0128	.0164	.0012	.0059
		(.034)	(.062)	(0.79)	(−0.70)	(−2.19)	(−1.92)	(2.13)	(0.32)	(0.48)
Rye		−.0085	.0160	−.0079	.0056	.0259	−.0113	.0124	−.0056	−.0281
			(2.82)	(−1.29)	(0.66)	(2.91)	(−1.77)	(1.70)	(−1.42)	(−2.33)
Legume			−.0548	.0014	−.0020	.0156	.0117	.0128	.0003	−.0045
				(0.20)	(−0.16)	(1.43)	(1.37)	(1.32)	(0.52)	(−0.24)
Meat				−.0535	.0119	.0383	−.0011	−.0169	.0105	.0117
					(1.06)	(2.52)	(−0.11)	(−1.47)	(2.09)	(0.67)
Butter					−.0926	.0291	.0131	−.0080	.0040	.0445
						(1.72)	(1.04)	(−0.55)	(0.47)	(1.78)
Milk						−.0981	−.0020	−.0361	.0134	.0353
							(0.14)	(−2.10)	(1.73)	(1.28)
Sugar							.0248	−.0254	−.0071	.0100
								(−2.14)	(−1.19)	(0.52)
Cheese								−.0214	.0017	.0644
									(0.24)	(2.71)
Fish									−.0172	−.0014
										(−0.12)
Beer										−.1378
b_i	.0857	.1494	.0489	.0849	.2747	.1838	.0396	.0130	.0724	.0475
	(4.61)	(7.53)	(1.35)	(3.98)	(6.17)	(5.48)	(1.47)	(0.42)	(3.03)	(0.79)
Adjusted R square	.2395	.3988	.1797	.1998	.3937	.1326	.0847	.1543	.1419	.0447

Log of the likelihood function = 2259.07
The numbers in parentheses are the t statistics for each coefficient.

indicating that each of the basic commodities were normal; an increase in income is reflected in greater consumption of all goods. The own-price substitution coefficients (S_{ij}, where $i = j$) are all negative as expected with the exception of two commodities, wheat and sugar. A positive sign for the own-price substitution coefficient is generally interpreted as evidence that the commodity in question is a so-called Giffen good. If as the price of the commodity falls, less of it is demanded, that commodity is inferior relative to others in the budget. Bread, in particular rye bread, is often given as an example of a Giffen good, although Roger Koenker has argued that this is in fact "the most famous strawless brick of economic theory".[13] From his eighteenth-century data on household budgets in England, he concludes that the income effects of a change in the price of bread reinforced the pure price effects, even in the absence of real substitutes for bread. Moreover, it does not seem likely that sugar (or wheat for that matter) would qualify as a Giffen good, even if such a thing existed. Instead, it seems likely that our results are being driven by the strong time trend towards both more sugar in the diet and the greater use of wheat *vis-à-vis* rye.

Table 2 gives the equivalent results for the data with the bread grains measured as the quantity purchased annually. While many of the individual substitution coefficients do not change substantially, the overall results are very different. The own-price coefficient for wheat is now negative reflecting not the usage of wheat but rather the timing of its purchase. When the price of wheat falls, more of it is bought and stored for later consumption. Now it is the income coefficients which behave in unexpected ways. Four of them are negative, and the strength of the rye and wheat coefficients have increased three and five-fold respectively. Before we conclude that legumes, sugar, cheese and beer were in fact inferior goods however, it is helpful to remember how income is defined. Equation (1) above stipulates that income is equal to the sum of all purchases. Rye and wheat purchases, which could vary tremendously from one year to the next in terms of their value, formed a sizeable proportion of the total budget on average. This gives a great deal more volatility to the income measure than would be warranted in reality. Moreover, this volatility closely resembles that of the grain purchases themselves, explaining the very high values of b; for wheat and rye. Because big increases in income primarily reflect large purchases of grain, it is not surprising that purchases of some other commodities coincidentally fall off at the same time.

Although these latter results cannot be trusted to reflect true budget priorities, it is nonetheless interesting to compare the elasticities of demand generated by the two simulations, particularly for the variables rye and wheat. Table 3 gives the income and own-price elasticities of demand for each of the ten commodities. The elasticities have been computed using the mean budget shares over the period 1639-1757 and equations (4) and (5) above. For the reasons stated above, the income elasticity of demand for both grains falls dramatically when the milled series is used in place of the purchase series.

[13] R. KOENKER, "Was Bread Giffen?", *Review of Economics and Statistics* 1977, p. 228.

Table 2
ESTIMATION RESULTS USING PURCHASED QUANTITIES OF GRAIN. 1639-1757

	Wheat	Rye	Legume	Meat	Butter	Milk	Sugar	Cheese	Fish	Beer
S_{ij}										
Wheat	−.0942	.1535	.0020	.0014	−.0001	.0156	−.0122	.0231	−.218	−.0672
		(2.38)	(0.12)	(0.14)	(−0.01)	(0.99)	(−0.91)	(1.53)	(−1.84)	(−1.16)
Rye		−.2607	.0271	.0122	.0233	.0292	.0050	.0068	.0259	−.0223
			(1.84)	(1.47)	(1.26)	(2.09)	(0.44)	(0.53)	(2.44)	(−0.42)
Legume			−.0538	−.0012	−.0116	.0066	.0085	.0129	.0014	.0081
				(−0.17)	(−0.89)	(0.64)	(0.95)	(1.27)	(0.22)	(0.34)
Meat				−.0575	.0015	.0362	.0025	−.0181	.0086	.0144
					(0.14)	(2.38)	(0.24)	(−1.55)	(1.68)	(0.75)
Butter					−.1242	.0112	.0265	−.0068	−.0021	.0824
						(0.70)	(1.99)	(−0.45)	(−0.24)	(2.40)
Milk						−.1436	−.0094	−.0166	.0101	.0608
							(−0.67)	(−1.01)	(1.37)	(1.99)
Sugar							.0194	−.0422	−.0050	−.0042
								(−2.48)	(−0.79)	(−0.18)
Cheese								−.0344	−.0006	.0648
									(−0.08)	(2.33)
Fish									−.0148	.0032
										(0.19)
Beer										−.1352
b_i	.4811	.4608	−.0174	.0508	.1776	.1764	−.0126	−.0263	.0032	−.2935
	(4.58)	(3.84)	(−0.75)	(3.92)	(6.10)	(7.82)	(−0.71)	(−1.29)	(0.19)	
Adjusted R square	.1855	.3634	.1480	.2214	.3401	.2234	.0678	.1392	.0947	.0170

Log of the likelihood function = 1665.44
The numbers in parentheses are the t statistics for each coefficient.

Table 3
ELASTICITIES — 1639-1757

	Mean Budget Share		Income elasticity		Compensated own-price elasticity		Total price elasticity
	(pur.) (a)	(mill) (b)	(pur.) (c)	(mill) (d)	(pur.) (e)	(mill) (f)	(mill) (g)
Wheat	.081	.085	5.94	1.01	−1.16	0.07	−0.02
Rye	.098	.101	4.70	1.48	−2.66	−0.08	−0.23
Legume	.050	.049	−0.35	0.99	−1.08	1.11	−1.16
Meat	.231	.229	0.22	0.37	−0.25	−0.23	−0.31
Butter	.205	.203	0.87	1.35	−0.61	−0.46	−0.73
Milk	.122	.121	1.45	1.52	−1.18	−0.81	−0.99
Sugar	.012	.012	−1.05	3.33	1.62	2.09	−2.05
Cheese	.049	.049	−0.53	0.27	−0.69	−0.44	−0.45
Fish	.025	.025	0.13	2.91	−0.59	−0.69	−0.76
Beer	.126	.125	−2.33	0.38	−1.07	−1.10	−1.15

Even so, the elasticities remain at or above the value of 1, suggesting that neither grain was a true necessity in the diet.

Interestingly enough, meat, cheese and beer are the commodities which play this role with income elasticities well below one. Beer was the only regular drink for the orphans so its elasticity requires no explantion. The other two commodities however, do not fit our usual understnding of consumer budgets, particularly for the early modern period. Cheese may present something of an anomaly owing to the relatively small role it played in the diet in general. Carole Shammas has generated similar results for dairy products in late eighteenth century England and attributes them to small purchase sizes and high prices. [14] Meat on the other hand was bought with great consistency every year (except for the disastrous years after 1809) and does not seem to be very sensitive to changes in income. The persistence of unusually stable meat servings in the diet is both a testament to the general prosperity of the orphanage and the strength of the social value attached to meat consumption in the urban milieu of the Dutch *burgerij*. Meat had to be provided regularly, if for no other reason than that the staff expected it as part of their compensation. Milk, butter, fish and sugar all reveal themselves as luxuries in the diet, which is perfectly consistent with our prior expectations.

The compensated own-price elasticities can add even more richness to this analysis. These coefficients represent the sensitivity of commodity demand to changes in relative prices, as if the income effects of those price changes were non-existent, or had been "compensated" for. Looking at the figures in column (f) we see that purchases of meat and cheese were relatively indifferent to changes in price, which is consistent with their income elasticities. Butter, milk and fish also act as necessities when viewed only in terms of their sensitivity to price changes. In fact, because the sign on the sugar coefficient is the opposite of what is usually expected there are no true luxuries in the diet. Sugar may have played this role at the beginning of the seventeenth century, but the secular trend towards a greater use of sweeteners completely overwhelms the sensitivity of sugar to either falls in income or rises in price.

Our confidence in these results is strengthened by the fact that the elasticities for all of the commodities other than the grains are only marginally affected by the choice of data series used. If there were significant differences between the numbers in columns (e) and (f) it would be cause for concern that the difficulty in measuring the demand for rye and wheat had generated errors in the measurement of the other demand equations as well. Moreover, the changes in the elasticities for rye and wheat follow the pattern we would expect given the circumstances surrounding their purchase and use. When the series for grain purchases is used price sensitivity is high, especially for rye. This sensitivity disappears almost completely when the milled series is used. This

[14] C. Shammas, «The 18th century English Diet and Economic Change», *Explorations in Economic History,* 1984, p. 259.

does not so much reflect the role of bread as the dominant necessity in the diet (as one might expect in a very poor society), as it does the luxury the Burgerweeshuis enjoyed of eating relatively cheap grain, even when prices were very high. Although the regents had to be careful not to let the stocks run down to dangerously low levels, as might happen in a string of bad years, they could still count on the general principle that what goes up must eventually come down. High prices would again be followed by lower prices when stocks could be replenished. In the meantime it was prudent to continue eating bread in roughly similar amounts, especially if other foods were experiencing higher prices as well.

The data discussed above covers a period when there was little secular trend in prices and the institution experienced general prosperity. In the second half of the eighteenth century this picture began to change. The latter part of the century was marked by spectacular price increases for basic foodstuffs — the eleven-year moving average of the Burgerweeshuis food price index in 1806 was 60% higher than it had been in 1760 — and the destabilization of the institution's income in the face of economic dislocation and war. How then did the demand behaviour of the regents respond to these changes?

Tables 4 and 5 report the regression coefficients for the eleven food categories for the data between 1761 and 1812. Once again the system based on the quantities of grain milled each year provides results more consistent with the usual expectations about consumer behaviour than does that based on the grain purchases. Nevertheless, the differences between the two are less marked than for the earlier data, suggesting that the speculative behaviour of the regents was considerably reduced sometime in the mid-eighteenth century. A simple example illustrates this phenomenon well. Prior to 1760, the coefficient of variation on the quantity of wheat purchased is 58, while the coefficient of variation for wheat prices is only 32. After 1760 the two figures reverse positions, with quantity at 31 and prices at 34. The reversal is even more dramatic for rye. Before 1760 the coefficient of variation for quantity purchased is 61 while only 37 for prices. After 1760, the coefficients are 28 and 40 respectively. As the amplitude of the swings in the annual quantities of wheat and rye purchased fall over time, it becomes more difficult to distinguish purchase behaviour from consumption behaviour. The remainder of our discussion will therefore focus on the results of the system using the milled quantities of grain.

Table 6 presents the income and price elasticities of demand for the eleven commodity groups for the period 1761-1812. All of the income elasticities are positive with the exception of sugar. In the context of what we know to have been a situation of increased demand for this product, the sign on this coefficient is clearly a spurious result of a specification error; demand for sugar was increasing steadily over time, despite the setbacks in the institution's income. There is also a good deal of shifting in the responsiveness of the other commodities to income changes. Beer is no longer a necessity in the diet. The coefficient on cheese falls into the normally expected range, but that on fish becomes more difficult to explain. Both meat and milk become more sensitive

Table 4
ESTIMATION RESULTS USING MILLED QUANTITIES OF GRAIN. 1761-1812

	Wheat	Rye	Legume	Meat	Butter	Milk	Sugar	Cheese	Fish	Beer	Meal
S_{ij}											
Wheat	.0265	−.0044	.0159	−.0154	.0017	.0010	−.0038	.0126	.0114	−.0222	−.0157
		(−1.08)	(3.11)	(−1.24)	(0.18)	(0.09)	(−0.95)	(2.05)	(3.23)	(−1.53)	(−2.14)
Rye		.0048	−.0058	−.0042	−.0192	.0137	−.0050	−.0023	−.0102	.0207	.0119
			(−1.64)	(−0.50)	(−3.22)	(2.08)	(−1.96)	(−0.54)	(−3.94)	(2.13)	(2.66)
Legume			−.0011	.0018	.0275	−.0208	.0002	.0034	−.0006	−.0084	−.0121
				(0.12)	(3.22)	(−2.05)	(0.04)	(0.60)	(−0.17)	(−0.44)	(−1.84)
Meat				−.1057	.0208	.1327	−.0072	−.0065	.0183	.0167	−.0514
					(0.88)	(4.74)	(−0.67)	(−0.54)	(2.71)	(0.28)	(−3.34)
Butter					−.0506	.0311	.0215	.0318	−.0115	−.0504	−.0026
						(1.69)	(2.93)	(3.20)	(−2.18)	(−1.92)	(−.022)
Milk						−.3230	.0258	.0074	.0075	.1118	.0127
							(3.16)	(0.72)	(1.28)	(3.33)	(0.97)
Sugar							−.0368	.0138	−.0014	−.0178	.0048
								(3.24)	(−0.60)	(−1.53)	(0.94)
Cheese								−.0416	−.0004	−.0043	−.0139
									(−0.11)	(−0.30)	(−1.86)
Fish									−.0254	.0058	.0066
										(0.81)	(1.48)
Beer										−.1058	.0538
											(3.05)
Meal											.0060
b_i	.0231	.0256	.0146	.2084	.1856	.2754	−.0059	.0944	.0082	.0968	.0739
	(2.78)	(4.49)	(1.39)	(6.32)	(12.59)	(13.49)	(−0.88)	(12.55)	(1.93)	(2.34)	(6.65)
Adjusted R square	.0342	.1593	.4252	.7471	.6449	.4478	.4394	.6291	.2670	.2927	.7350

Log of the likelihood function = 1616.62
The numbers in parentheses are the t statistics for each coefficient.

Table 5
ESTIMATION RESULTS USING PURCHASED QUANTITIES OF GRAIN, 1761-1812

	Wheat	Rye	Legume	Meat	Butter	Milk	Sugar	Cheese	Fish	Beer	Meal
S_{ij}											
Wheat	−.0615	.0407	.0124	.0051	.0403	.0210	−.0136	.0113	.0078	−.0555	−.0081
		(2.83)	(1.47)	(0.20)	(2.44)	(1.09)	(−2.05)	(1.39)	(1.75)	(−1.77)	(−0.81)
Rye	−.0340	−.0039	−.0540	−.0532	.0214	−.0072	−.0040	−.0024	.0729	.0093	
			(−0.61)	(−2.87)	(−4.22)	(1.54)	(1.40)	(−0.62)	(−0.69)	(3.26)	(1.24)
Legume			−.0025	.0028	.0288	−.0226	−.0004	.0045	−.0036	−.0011	−.0144
				(0.18)	(3.21)	(−2.24)	(−0.12)	(0.79)	(−1.03)	(−0.06)	(−2.33)
Meat				−.0915	.0248	.1070	−.0084	−.0013	.0191	.0260	−.0296
					(0.98)	(3.75)	(−0.77)	(−0.11)	(2.75)	(0.41)	(−2.03)
Butter					−.0545	.0340	.0193	.0281	−.0083	−.0586	−.0007
						(1.77)	(2.53)	(2.80)	(−1.52)	(−2.00)	(−0.06)
Milk						−.3167	.0282	.0044	.0093	.1076	.0065
							(3.52)	(0.44)	(1.56)	(3.15)	(0.54)
Sugar							−.0320	.0136	.0001	−.0152	.0012
								(3.26)	(0.06)	(−1.27)	(0.26)
Cheese								−.0433	−.0038	−.0019	−.0076
									(−0.95)	(−0.13)	(−1.08)
Fish									−.0256	.0058	.0016
										(0.76)	(0.39)
Beer										−.1178	.0380
											(2.23)
Meal											.0696
b_i	.1786	.1308	−.0006	.1303	.1265	.1754	−.0033	.0707	.0074	.1146	.0696
	(7.44)	(9.22)	(−0.07)	(4.11)	(8.31)	(7.97)	(−0.57)	(10.45)	(2.00)	(3.04)	
Adjusted R square	.1972	.4087	.1519	.4770	.5762	.4641	.5366	.6557	.2570	.3060	.7635

Log of the likelihood function = 1488.26
The numbers in parentheses are the t statistics for each coefficient.

Table 6
ELASTICITIES — 1761-1812

	Mean Budget Share		Income elasticity		Compensated own-price elasticity		Total price elasticity
	(pur.) (a)	(mill) (b)	(pur.) (c)	(mill) (d)	(pur.) (e)	(mill) (f)	(mill) (g)
Wheat	.102	.106	1.74	0.22	–0.60	0.25	–0.23
Rye	.082	.082	1.60	0.31	–0.42	0.06	0.03
Legume	.053	.053	–0.01	0.28	–0.05	–0.02	–0.03
Meat	.242	.241	0.54	0.86	–0.38	–0.44	–0.65
Butter	.151	.151	0.84	1.23	–0.36	–0.34	–0.53
Milk	.124	.123	1.41	2.24	–2.55	–2.62	–2.90
Sugar	.033	.033	–0.10	–0.18	–0.97	–0.94	–0.93
Cheese	.056	.056	1.25	1.68	–0.77	–0.74	–0.83
Fish	.023	.023	0.32	0.35	–1.10	–1.09	–1.10
Beer	.069	.068	1.67	1.41	–1.72	–1.55	–1.65
Meal	.064	.063	1.09	1.17	0.06	0.10	0.03

to changes in income, the former doubling despite remaining under the value of 1. Finally, both of the bread grains now appear as the strongest necessities in the diet, with legumes following closely behind; this is of course the pattern we would expect a priori from a pre-industrial budget analysis. Perhaps this change, more than any other, hints at the weakening of the financial position of the Burgerweeshuis.

The interpretation of the compensated own-price elasticities provides greater challenges. A glance at column (f) reveals that three commodities have positive signs on this value. While those on wheat and rye could be excused following the logic presented earlier about consumption behaviour in the face of storage capabilities, no such argument exists for the porridge grains. The dampening of the volatility in grain reserves also weakens the position for positive signs on these coefficients as well. In fact, the combined price and income effects, measured by the total price elasticity of demand — based on equation (6) above — shown in column (g), indicate that all three of these commodities were Giffen goods. (Of course the elasticities on rye and meal are also very close to zero.) This does not seem likely for all three goods simultaneously as they were in fact substitutes for each other. Rather, it seems that the model as specified is missng some important component of the regent's consumption behaviour. (Other potentially relevant factors in their decision making behaviour will be discussed in the next section.)

Finally, it is interesting to note the changes in the total own price elasticities of demand for the various commodities between the two sub-periods of analysis. When this measure is negative and the absolute value is below 1 an increase in the price of a product will decrease the quantity purchased but still increase the expenditure on that commodity. Prior to 1760 this was the case for all but three commodities: milk, for which expenditures would stay approximately the same, and legumes and beer, for which expenditures would drop. Only sugar displays a positive sign on the total elasticity and it is not clear how that should be properly interpreted. After 1760 however, more commodities display greater sensitivity to price changes. This is particularly true of milk. A rise in its price is now met with a threefold drop in expenditure on it. Again, this finding fits well with the work of Shammas on English data. She asserts that a major trend of the eighteenth century was the declining availability of milk, and to a lesser extent meat, in the diet. [15] Only legumes, butter, meal, and the bread grains show less sensitivity to price changes, intensifying their position as staples in the diet.

Validity of the imposed assumptions:

At this point it may prove helpful to recall the basic theory behind this type of consumption analysis. The consumer's budget is assumed to be given exogenously; while it may change from one year to the next, these changes must

[15] Shammas, 1984, p. 266.

be unrelated to the price changes of the included variables. Moreover, even though the components which determine the utility an individual receives from the various goods in the budget are unknown, they are assumed to be consistent with regard to price changes in either direction. Both of these assumptions are probably violated to some extent by the data in question here.

The regents worked hard to maintain a certain level of quality and quantity in the total diet. When prices were high, or rising, the diet was not unduly sacrificed, although some effort was made to buy cheaper or fewer calories. But when prices were low, or falling, the diet was not increased commensurately. [16] Moreover, the total food budget, and the per capita food budget as well, were at least somewhat responsive to food prices. The correlation coefficient between the price index and total food expenditure is .52. For per capita food expenditures it rises to .58. (Both are statistically significant at the .001 level.) Clearly, the size of the budget allocated for food was not entirely independent of prices, nor was it fixed by the other obligations of the institution.

What were the options that the regents had at their disposal when faced with a rise in the prices they had to pay for food in the marketplace? Three basic scenarios present themselves. First, the regents could hold food expenditures fixed while substituting foods to maintain calories or social status at as high a level as possible. (This is the closest scenario to the econometric specification presented above.) Second, they could hold food expenditures fixed and keep the mix of foods the same, but let total quantities of each fall. Third, they could keep the mix of foods and the total calories in the diet the same and just let expenditures rise to cover the increased costs. This last case requires the availability of funds from somewhere else; either they could decrease other current expenditures, they could deplete reserves they might be holding, or they would have to borrow money. Any combination of all these options was also a possibility. While the regents of the Burgerweeshuis did in fact engage in decision-making of the first two types, they were fortunate to also have leeway to engage extensively in the third option. [17] It is this leeway which distorts the results of the econometric demand analysis.

[16] McCants, 1991, Chapter 3.

[17] The minutes of both the regent meetings and those of the regentessen, indicate that the managers of the orphan's diet were both conscious of and sensitive to changes in relative prices. For example, in 1800 the regentessen decided to substitute potatoes and cabbage for buckwheat meal porridge and white beans owing to the «dearness» of the latter. G.A.A., p.a. #367, oud archief 67. More importantly, the regents had the power to negotiate long-term contracts with provisioning merchants. On numerous occasions, particularly in the late eighteenth and early nineteenth centuries, concern over the high price of the food in question led to a reduction in the quantity purchased from the normal or expected level. In August of 1803 the extraordinary step was taken of cutting off business completely with a particular cheese merchant, one Pieter Zuilen, and "dese Leverancie vacant te verklaaren (leaving the position unfilled)". G.A.A., p.a. #367, oud archief 20-27.

In fact, the regents had so many different combinations of financial options, and they exercised all of them at one point or another, that it would be impossible to capture their true behaviour statistically. There are not enough years of observations to provide the necessary degrees of freedom. Instead if we look only at years of steep price increases (as measured by a ten or more point jump in the price index between two consecutive years) we can outline the consistent aspects of their behaviour. Of the sixteen years identified by this measure prior to 1800, ten were marked by cuts in either the total quantity of food purchased, or by a notable increase in the use of cheaper foodstuffs; three more years show only minor changes in this direction. Of these 13, all but four years also saw nominal food expenditures rise. Moreover, when a price rise was sustained for more than one year, the quantity/quality reduction was not concomitantly sustained, with the result that food expenditures rose significantly in the years following the initial cutback. Thus, while the type of decisions postulated by consumer theory were far from unknown to the regents, they did not mark the total extent of their behaviour.

To the degree that the regents did substitute goods when relative prices changed and/or their income fell, they did so in a pattern not entirely typical of other early modern communities. Rye and wheat were staples of the diet, but they were not the dominant commodities in terms of their response to changing economic circumstances. This was partly because the Burgerweeshuis had the capacity to store grain, but also because bread was not absolutely predominant in the diet. Schokkaert and Van der Wee's results of a similar budget analysis for the Infirmary of the Béguinage at Lier between 1526-1575 demonstrate that rye was undisputedly the most important element in that diet. [18] Expenditures on it were 40% of the total budget and it was the only commodity with an income elasticity of less than 1. Wheat, meat, beer and cheese were all luxuries in the diet, even though they were not out of reach for the nuns in this clearly comfortably supplied hospital.

We may wonder if Schokkaert and Van der Wee's results can offer a valid point of comparison for our data. The records of the Infirmary date from a period generally recognized as one of significant price increases, particularly for foodstuffs, and the tightening of living standards for the majority of Europeans. However, the pattern they describe has also been discovered to hold for English worker's budgets from the late eighteenth century. Using the budgets collected by Davies and Eden, Shammas has argued that expenditure on bread ranged from 50% of the budget in the north of England to 66% in the south. Moreover, she finds that all cereals together had an income elasticity of slightly less than 1, while the sensitivity of meat to changes in income was more than twice as high. [19] Koenker's analysis of similar data finds the spread

[18] Schokkaert and Van der Wee, 1988, p. 149.
[19] Shammas, 1984, pp. 259 and 259.

between bread and meat to be even greater. He figures their income elasticities to be .49 and 2.24 respectively. [20]

This contemporary evidence suggests that the commitment the regents had to both wheat and meat in the diet was extraordinary for its time, particularly given the usual circumstances surrounding provision for those members of society who are totally dependent on the charity of others. Moreover, this commitment was sustained over time, despite temporary price fluctuations in the market. Although relative prices could vary considerably between any given year and the next, a guilder spent on wheat consistently bought between 60% to 70% of the calories of that same guilder spent on rye. A guilder spent on oxen did significantly worse, buying only between 8% and 14% of the calories provided by an equal value of rye. (Of course, the meat did provide essential amino acids which the rye could not.) Considering that expenditures on meat alone accounted for an average 23% of the total food budget, there existed a great deal of latitude for reducing the cost of the diet while still maintaining a predetermined level of calories. This makes it all the more remarkable that meat purchases actually displayed such low income elasticities. And, of course, it highlights the severity of the financial crisis of the early nineteenth century when the regents for the first time purchased significantly less meat; in 1810 for example, no new livestock was bought at all.

In many respects, the purchasing behaviour of the Burgerweeshuis regents does not follow the pattern typically found for early modern European society. Not only is rye not the proverbial Giffen good of the *crise de subsistance,* but it is not even a true necessity in the diet. Instead, it is dairy and meat products which, in addition to being well supplied — between 40% and 55% of all protein in the orphan's diet come from animal sources — were bought with great consistency. This unexpected finding is a reflection of two related phenomena. First, the Burgerweeshuis was itself well endowed. It enjoyed sufficient resources to weather comfortably all but the most severe of economic crises. But more importantly, this fact is itself a reflection of the unprecedented wealth of Dutch society in its "golden age." Indeed, long after the staple trade had ceased to be highly lucrative in the later seventeenth century, the fruit of that trade was able to support a remarkable level of social welfare consumption.

[20] Koenker, 1977, p. 277.

BIBLIOGRAPHY

Appley, Andrew. "Diet in Sixteenth Century England: Sources, Problems, Possibilities," in *Health, Medicine and Mortality in the Sixteenth Century.* Ed. Charles Webster. Cambridge, 1979.

——— "Grain Prices and Subsistence Crises in England and France, 1590–1740." *Journal of Economic History.* 39 (1979): 865–884.

Braudel, Fernand. *The Structures of Everyday Life.* (Vol. I of *Civilization and Capitalism, the Fifteenth to the Eighteenth Century.)* New York, 1979.

Crafts, N.F.R. "Income Elasticities of Demand and the Release of Labour by Agriculture during the British Industrial Revolution." *Journal of European Economic History.* 9 (Spring, 1980): 153–168.

Forster, Elborg and Robert Forster, eds. *European Diet from Pre–Industrial to Modern Times.* New York, 1975.

Houthakker, H.S. "An International Comparison of Household Expenditure Patterns." *Econometrica.* 25 (1975): 532–551.

Koenker, Roger. "Was Bread Giffen? The Demand for Food in England circa 1790." *Review of Economics and Statistics.* 59 (1977): 225–229.

Komlos, John. "The Food Budget of English Workers: a Comment on Shammas." *Journal of Economic History.* 48 (1988): 149–152.

Lis, Catherina and Hugo Soly. "Food Consumption in Antwerp between 1807 and 1859." *Economic History Review.* 30 (August, 1977): 460–486.

Posthumus, N.W. *Inquiry into the History of Prices in Holland.* Vol. I and II. Leiden, 1946–64.

Schokkaert, E. and Herman van der Wee. "A Quantitative Study of Food Consumption in the Low Countries during the Sixteenth Century." *Journal of European Economic History.* 17 (1988): 131–158.

Scholliers, P. and C. Vandenbroeke. "The Transition from Traditional to Modern Patterns of Demand in Belgium," in *Types of Consumption: Traditional and Modern.* Budapest, 1982: 51–61.

Shammas, Carole. "Food Expenditure and Economic Well–Being in Early Modern England." *Journ al of Economic History.* 43 (March, 1983): 89–100.

——— *The Pre–industrial Consumer in England and America.* Oxford, 1990.

——— "The Eighteenth Century English Diet and Economic Change." *Explorations in Economic History.* 21 (1984): 254–269.

Stigler, George. "The Cost of Subsistence." *Journal of Farm Economics.* 27 (May, 1945): 303-314.

Stigler, Henri. *The System–Wide Approach to Microeconomics.* Chicago, 1980.

Varian, Hal R. *Microeconomic Analysis.* New York, 1984.