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The Demand for Meat: Conditional and Unconditional Elasticities

Abstract: The demand for meat and other foodstuffs is estimated as a part of a four-stage demand system. Correction formulae for price and expenditure elasticities are used to calculate unconditional elasticities by the use of the estimated conditional elasticities. A static specification is rejected at a 5 percent level for each sub-system and a dynamic specification is used to take account of habit formation in consumption. The unconditional own-price elasticities for beef, lamb, pork and chicken are calculated as −0.48, −0.23, −0.66 and −1.14, respectively. The corresponding conditional elasticities are estimated to be −0.59, −0.25, −0.78 and −1.15. The unconditional expenditure elasticities are calculated to be 0.72 for beef, 0.42 for lamb, 0.81 for pork and 1.00 for chicken. The corresponding conditional elasticities are estimated to be 0.98, 0.57, 1.11 and 1.36. These results show the importance of correcting conditional elasticities before elasticities from different studies are compared or before the elasticities are used for policy purposes.

INTRODUCTION

Demand elasticities for meat are of practical interest for several reasons. Numerical values of price and expenditure elasticities are important for the formation of agricultural and other public policies. Furthermore, farmers, their marketing organizations, food processors and the food retailing industry need to forecast demand to plan future production and sales. As a result, elasticities are used in various models. Demand elasticities particularly have been estimated in several studies concentrating on the demand for meat. Some recent examples in various journals are Chalfant *et al.* (1991), Chen and Veeman (1991), Cashin (1991), Burton and Young (1992) and Mdafri and Brorson (1993).

Two questions are the focus of this paper. First, in the above mentioned studies, elasticities are estimated under weak separability assumptions within a system consisting of various meat products while other goods are excluded from the analysis. This is a very common practice in applied demand analysis when a rather limited number of observations is available. However, by only studying one sub-system, the interconnections among sub-systems are neglected. Consider the four-stage utility tree presented in Figure 1. A change in the price of pork will affect beef consumption directly within the meat sub-system at stage 4. But, in addition, the change in the price of pork will cause a change in the price of meat (at stage 3). This change will cause the consumers to change their consumption of meat and the total expenditure allocated to meat (at stage 4) will change. This change in meat expenditure will, in turn, cause an indirect change in the beef consumption. The total effect of the price change is the sum of the direct effect and indirect effects at the various stages.

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Following Pollak and Wales (1992, p.47), the demand functions within a sub-system are called conditional demand functions. The estimated elasticities are then of course conditional elasticities. They will, in general, be different from unconditional elasticities calculated from a demand system that includes all goods. Since the unconditional elasticities are typically interpreted as being of greatest interest to policy-makers, it is an important to determine first, if we can expect large differences in the numerical values between the conditional and unconditional elasticities and, secondly, how we might correct for these differences by the use of estimates from a multi-stage demand system.

The second objective in this paper is to estimate the price and expenditure elasticities for disaggregate food commodities. These elasticities have rarely been estimated within a demand system framework in Norway; so the results are of intrinsic interest. One notable exception is Vale (1989) who applied household data. This implies a somewhat different interpretation of the estimated elasticities.

The outline of the paper is as follows. First, a dynamic version of the almost ideal demand system is presented. Second, weak separability and multi-stage budgeting are introduced. Approximate correction formulae for conditional elasticities derived in Edgerton (1992) are presented. Third, data and estimation procedures are briefly described. Finally, conditional and unconditional elasticities related to stage 1, stage 2, and the animalia part of stages 3 and 4 are discussed. Results for the complete utility tree described in Figure 1 are given in Rickertsen (1994).

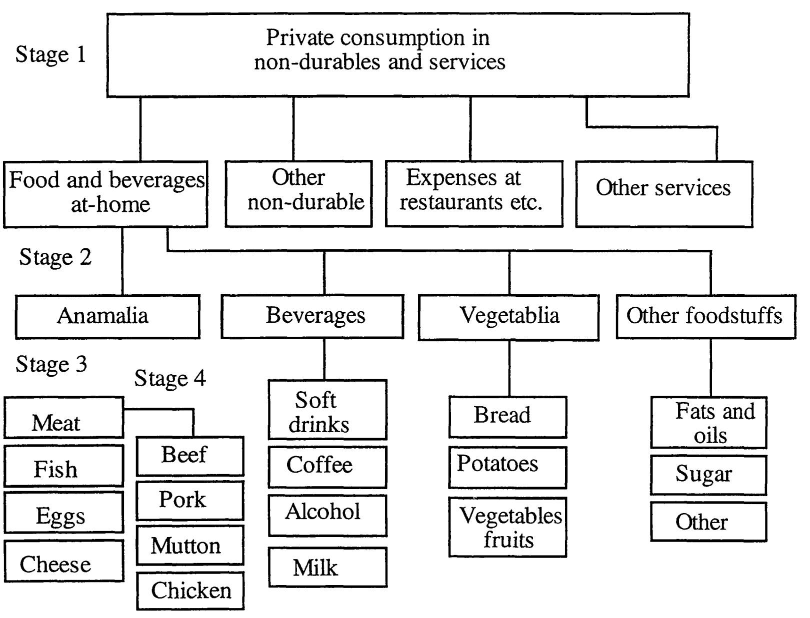

Figure 1 *Commodity Partitioning*

A DYNAMIC ALMOST IDEAL MODEL

The almost ideal demand system was first proposed in Deaton and Muellbauer (1980a). The ith good's budget share, w_i, is given by:

$$(1)\quad w_i = \alpha_i + \sum_{j=i}^{n} \gamma_{ij} \ln p_j + \beta_i \ln \frac{x}{P} \quad \text{for } i = 1,\dots,n$$

where ln$P$ is a price index defined by:

$$(2)\quad \ln P = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln p_k + \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} \gamma_{kj} \ln p_k \ln p_j$$

In Equations (1) and (2), p_i is the per unit price of good i and x is the total *per capita* expenditure on all goods included in the system.

The adding-up, homogeneity and symmetry restrictions may be expressed in terms of equality restrictions on the model's parameters of the form:

$$\Sigma_i \alpha_i = 1,\ \ \Sigma_i \beta_i = \Sigma_i \gamma_{ij} = 0 \ \text{(adding-up)}$$

$$(3)\quad \Sigma_j \gamma_{ij} = 0 \ \text{(homogenity)}$$

$$\gamma_{ij} = \gamma_{ji} \forall_{i,j} \ \text{(symmetry)}$$

Factors such as habit persistence suggest that consumers are unlikely to adjust fully in every time period. Consequently, a dynamic specification is desirable. Dynamics have been introduced into the almost ideal model in several ways, such as, to modify the intercept term of the price index, a_0 (e.g., Ray, 1985), to modify the intercept term of the share equations, a_i (e.g., Alessie and Kapteyn, 1991 or Assarsson, 1991), to estimate the model in difference form (e.g. Deaton and Muellbauer, 1980a) and to estimate the model within a general dynamic framework (e.g., Anderson and Blundell, 1983).

Following Assarsson (1991), the α_is are modified such that $\alpha_i = \alpha_{i0} + \Sigma_j \theta_{ij} w_{j(t-1)}$. This modification is quite simple and preserves the adding-up restrictions without increasing the numbers of parameters excessively. The ith good's budget share in period t is given by:

$$(4)\quad w_{it} = \alpha_{i0} + \sum_{j=1}^{n} \theta_{if} w_{j(t-1)} + \sum_{j=1}^{n} \gamma_{ij} \ln p_{jt} + \beta_i \ln \frac{x_t}{P_t}$$

where the price index lnP_t is defined by:

$$(5)\quad \ln P_t = \alpha_0 + \sum_{k=1}^{n} \alpha_{k0} \ln p_{kt} + \sum_{k=1}^{n} \sum_{j=1}^{n} \theta_{kj} w_{j(t-1)} \ln p_{kt} + \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} \gamma_{kj} \ln p_{kt} \ln p_{jt}$$

Equations (4) and (5) will be referred to as the dynamic true almost ideal demand model.

Adding up requires that $\Sigma_i \theta_{ij} = 0, \forall i$ in addition to the restrictions given by Equation (3). The restrictions $\Sigma_i \theta_{ij} = 0, \forall j$ are imposed to enable identification of the system.

The short-run own-price, cross-price and expenditure elasticities in period t are calculated as:

$$e_{iit} = -1 + \frac{\gamma_{ii}}{w_{it}} - \frac{\beta_i}{w_{it}}\left[\alpha_{i0} + \Sigma_k \theta_{ik} w_{k(t-1)} + \Sigma_k \gamma_{ik} \ln p_{kt}\right]$$

$$(6) \quad e_{ijt} = \frac{\gamma_{ij}}{w_{it}} - \frac{\beta_i}{w_{it}}\left[\alpha_{j0} + \Sigma_k \theta_{jk} w_{k(t-1)} + \Sigma_k \gamma_{jk} \ln p_{kt}\right]$$

$$E_{it} = 1 + \frac{\beta_i}{w_{it}}$$

WEAK SEPARABILITY AND UNCONDITIONAL ELASTICITIES

Let us divide our $m+n$ goods in two groups, A and B. The Marshallian demand function, $q^*_{A_i}$ for good i in group A is:

$$(7) \quad q^*_{Ai} = g^*_{Ai}(p_{A1},\ldots,p_{Am},p_{B1},\ldots,p_{Bn},x)$$

Weak separability allows us to divide the goods into sub-systems, such that a change in price of one good in one sub-system, A, affects the demand for all goods in another sub-system, B, in the same manner. Furthermore, weak separability makes it possible to divide the problem into several stages. Let us assume we have two stages.

At the first stage, the total expenditure is allocated between our two groups. This allocation is difficult because, in general, it is not possible to replace all the commodity prices and quantities within each group with a single price and a single quantity index. However, consider the following procedure based on Deaton and Muellbauer (1980b, pp.129–132) which is proposed in Edgerton (1992). Let the first-stage demand function for group A be approximated by:

$$(8) \quad q_A = g_A(P_A, P_B, x)$$

where q_A is expressed as real expenditure (at base year prices) and the Ps are true cost-of-living indexes. The indexes are themselves defined by $P_A = c_A(u_A{}^*, p_{A1},\ldots,p_{Am}) / c_A(u_A{}^*, p_{A1}{}^0,\ldots,p_{Am}{}^0)$ where c_A denotes the cost function associated with group $A, u_A{}^*$ the corresponding reference level of utility and $P_{Ai}{}^0$ the base period price of good i.

Weak separability is a necessary and sufficient condition for the second stage of the two-stage budgeting process. At the second stage, each group's expenditure function $x_A = c_A(u_A, p_{A1},\ldots,p_{Am})$ is minimized conditional on the utility level, u_A, implied by the first-stage demand functions (8). The resulting demand function for good i in group A is:

$$(9) \quad q_{Ai} = g_{Ai}(p_{A1},\ldots,p_{Am},x_A)$$

The demand functions, Equations (9) and (7), are conditional and unconditional demand functions, respectively. The two allocations, where stage one is defined by Equation (8) and stage two by Equation (9) yield identical results to an allocation made in one step, that is, Equation (7), given weak separability. However, the numerical values of the conditional and unconditional elasticities calculated by the use of Equations (9) and (7) are different. Edgerton (1992) derived formulae which recalculate the conditional to corresponding unconditional elasticities.

Let us concentrate on sub-system A. Following Edgerton (1992), let E_{AiA} denote the conditional expenditure elasticity for the ith good in group A, E_A the group expenditure elasticity for the Ath group, E_{Ai} the unconditional expenditure (= income) elasticity for good i within the Ath group, e_{Aij} the uncompensated conditional price elasticity between goods i and j in group A, e_{AA} the uncompensated own-price elasticity for group A and e_{AiAj} the uncompensated unconditional price elasticity for goods i and j in group A. The unconditional expenditure elasticities are calculated as:

$$(10)\quad E_{Ai}=\frac{\partial \ln g_{Ai}^{*}}{\partial \ln x}=\frac{\partial \ln g_{Ai}}{\partial \ln x_A}\frac{\partial \ln x_A}{\partial \ln x}=\frac{\partial \ln g_{Ai}}{\partial \ln x_A}\frac{\partial \ln g_A}{\partial \ln x}=E_{AiA}E_A$$

Note that $x_A \equiv P_A g_A(P_A, P_B, x)$. The relationship (10) is from a somewhat different line of arguments earlier suggested by, for example, Manser (1976, p.887).

The unconditional cross-price elasticity between goods i and j in group A is derived by the use of the chain rule on Equation (9)

$$(11)\quad e_{AiAj}=\frac{\partial \ln g_{Ai}^{*}}{\partial \ln p_{Aj}}=\frac{\partial \ln g_{Ai}}{\partial \ln p_{Aj}}+\frac{\partial \ln g_{Ai}}{\partial \ln x_A}\frac{\partial \ln x_A}{\partial \ln P_A}\frac{\partial \ln P_A}{\partial \ln p_{Aj}}=e_{Aij}+w_{AjA}E_{AiA}(1+e_{AA})$$

where $w_{AjA}=p_{Aj}q_{Aj}/x_A$ Note that $\partial \ln x / \partial \ln P_A = 0$ since income is given exogenously and $\partial \ln P_A / \partial \ln p_{Aj} = w_{AjA}$ by Shephard's lemma used on the true cost-of-living index which is proportional to an expenditure function. If the variation of prices with the utility level is rather small, other indexes may be good approximations to the true cost-of-living indexes. Paasche indexes are used here. The above formulae can by some notational difficulties be generalized to any number of stages and they are used to calculate unconditional elasticities for our four-stage utility tree described in Figure 1.

DATA, ESTIMATION AND TESTING

Annual National Accounts data from the Central Bureau of Statistics are used for the 1960–1991 period. At stage 4, disappearance data from the Agricultural Budget Commission and prices of representative goods are used. These prices are provided by various issues of Statistical Yearbook published by the Central Bureau of Statistics. It was impossible to construct a consistent data series for the consumer price of poultry and the producer price is used as a proxy variable.

The LSQ-procedure in the TSP-programme is used for estimation. This procedure iterates over the covariance matrix of the residuals and converges to the maximum likelihood estimators given the disturbances are multivariate normal. The method yields

Table 1 *Estimation Results: Stages 1 – 2 (t-values in parentheses)*

	α	θ 1	θ 2	θ 3	θ 4	γ 1	γ 2	γ 3	γ 4	β	w	R^2	BG
Stage 1													
Food	–0.119	0.401	–0.674	0.300	–0.027	0.193	–0.005	–0.143	–0.044	–0.092	0.36	0.99	0.71
	(–2.22)	(4.48)	(–4.06)	(3.50)	(–0.39)	(5.09)	(–0.43)	(–6.70)	(–1.79)	(–6.18)			
Restaurants	0.219	–0.144	0.564	–0.157	–0.263	–0.005	0.021	–0.003	–0.013	0.004	0.05	0.84	0.33
	(5.20)	(–2.57)	(4.70)	(–2.82)	(–5.57)	(–0.43)	(2.96)	(–0.21)	(–1.15)	(0.43)			
Other non-durables	0.426	0.116	0.268	0.416	–0.264	–0.143	–0.003	0.111	0.035	0.069	0.21	0.98	0.62
	(8.66)	(1.11)	(–1.41)	(7.54)	(–2.66)	(–6.70)	(–0.21)	(4.48)	(1.48)	(4.12)			
Services	0.474	–0.374	0.378	–0.558	0.554	–0.044	–0.013	0.035	0.022	0.019	0.38	0.96	0.37
	(6.85)	(–2.44)	(1.43)	(–4.92)	(4.54)	(–1.79)	(–1.16)	(1.48)	(0.67)	(0.87)			
	p-value for the hypothesis of no dynamics = 0.00												
Stage 2													
Animalia	0.327	0.419	–0.159	–0.348	0.088	0.023	–0.026	0.046	–0.043	0.005	0.32	0.89	0.96
	(1.59)	(2.00)	(–1.20)	(–1.20)	(0.67)	(0.47)	(–0.72)	(1.86)	(–2.92)	(0.09)			
Beverages	0.517	–0.286	0.397	0.181	–0.292	–0.026	0.073	–0.057	0.009	0.067	0.30	0.61	0.81
	(2.94)	(–1.70)	(3.10)	(0.65)	(–3.09)	(–0.72)	(2.36)	(–2.57)	(0.66)	(1.53)			
Vegetablia	–0.116	–0.118	–0.069	0.139	0.048	0.046	–0.057	0.054	–0.043	–0.102	0.24	0.96	0.17
	(–1.52)	(–1.67)	(–1.19)	(1.24)	(1.28)	(1.86)	(–2.57)	(3.02)	(–3.03)	(–5.30)			
Other	0.272	–0.014	–0.170	0.028	0.156	–0.043	0.009	–0.043	0.078	0.031	0.14	0.81	0.18
	(2.30)	(–0.13)	(–2.51)	(0.16)	(1.58)	(–2.92)	(0.66)	(–3.03)	(4.26)	(1.02)			
	p-value for the hypothesis of no dynamics = 0.02												

Table 1 (continued) *Estimation Results: Stages 3 – 4 (t-values in parentheses)*

	α	θ				γ				β	w	R^2	BG
		1	2	3	4	1	2	3	4				
Stage 3													
Meat	0.122	0.838	0.313	−1.316	0.165	0.053	−0.007	−0.013	−0.033	−0.014	0.63	0.96	0.59
	(0.44)	(6.51)	(1.39)	(−4.88)	(0.56)	(1.41)	(−0.40)	(−0.77)	(−1.67)	(−0.26)			
Fish	0.574	−0.527	−0.077	0.695	−0.091	−0.007	0.023	−0.007	−0.009	0.030	0.19	0.94	0.99
	(2.74)	(−5.21)	(−0.41)	(3.05)	(−0.46)	(−0.40)	(1.44)	(−0.48)	(−0.84)	(0.76)			
Cheese	0.163	−0.153	−0.096	0.588	−0.339	−0.013	−0.007	0.017	0.004	−0.006	0.11	0.90	0.22
	(1.16)	(−3.13)	(−1.17)	(6.35)	(−3.09)	(−0.77)	(−0.48)	(1.63)	(0.67)	(−0.19)			
Eggs	0.141	−0.158	−0.140	0.032	0.265	−0.033	−0.009	0.004	0.038	−0.010	0.07	0.99	0.36
	(2.31)	(−4.23)	(−2.22)	(0.47)	(2.18)	(−1.67)	(−0.84)	(0.67)	(3.38)	(−0.87)			
	p-value for the hypothesis of no dynamics = 0.00												
Stage 4													
Beef	−0.012	0.585	0.022	0.384	−0.991	0.164	−0.054	−0.108	−0.002	−0.007	0.40	0.63	0.03
	(−0.07)	(1.94)	(0.07)	(1.29)	(−1.27)	(3.74)	(−2.67)	(−2.72)	(−0.32)	(−0.12)			
Mutton	0.100	−0.073	−0.068	−0.287	0.428	−0.054	0.090	−0.032	−0.042	−0.050	0.12	0.81	0.76
	(1.40)	(−0.63)	(−0.37)	(−2.20)	(1.12)	(−2.67)	(4.15)	(−1.77)	(−0.80)	(−2.22)			
Pork	0.679	−0.312	0.221	0.111	−0.020	−0.108	−0.032	0.131	0.009	0.049	0.46	0.61	0.10
	(3.70)	(−0.97)	(0.79)	(0.38)	(−0.03)	(−2.72)	(−1.77)	(3.10)	(1.20)	(0.78)			
Chicken	0.233	−0.200	−0.175	−0. 208	0.583	−0.002	−0.004	0.009	−0.003	0.008	0.02	0.88	0.74
	(7.45)	(−4.38)	(−2.97)	(−4.30)	(4.41)	(−0.32)	(−0.80)	(1.20)	(−0.58)	(0.98)			
	p-value for the hypothesis of no dynamics = 0.03												

estimates which are invariant with respect to which equation is dropped. The homogeneity and symmetry restrictions are imposed on the various sub-systems.

The hypothesis of no dynamics is tested by a likelihood ratio test. This test has a bias towards rejection in small samples (e.g., Bewley, 1986) and a commonly used correction factor $(T-k)/T$ is used to calculate a corrected likelihood ratio test. Here T is the number of observations and k the average number of estimated parameters per equation.

ESTIMATION RESULTS

The parameter estimates with t-values of the parameters, the budget shares within the various sub-systems, the coefficients of determination (R^2), the p-values (the probabilities of rejecting a null hypothesis given that it is true) of a Breusch–Godfrey test (Godfrey 1978) for first-order autocorrelation (*BG*) and p-values for the hypothesis of no dynamics are shown in Table 1.

The four-stage system appears to have a high explanatory power. The R^2-values are above 0.8 for 13 of the 16 equations. However, the R^2-values can only be considered as indicators of the goodness of fit, since the measure is only truly applicable for a single linear equation. Nearly half the estimated parameters are significant at the 5 percent significance level which is used in this paper.

The Breusch–Godfrey test for autocorrelation is valid in the presence of lagged endogenous variables. Autocorrelation is rejected in each equation, except for beef. This is a major improvement compared with the corresponding static specification. Furthermore, the hypothesis of no dynamics is rejected for each sub-system.

ELASTICITIES

The numerical values of the estimated short-run uncompensated own-price and expenditure elasticities are shown in Table 2. The elasticities are of the expected sign and reasonable magnitudes. The conditional elasticities are calculated at mean and 1991 values of the input variables. There are only minor changes in the numerical values over time, with a possible exception for eggs.

The standard errors are approximated by the ANALYZ statement in TSP which computes the standard errors using the covariance matrix of the estimated parameters but treating the data as fixed constants. The elasticities are statistically significant, except for the own-price elasticity of lamb.

Expenditure data are mainly used in this study. The use of this data set has implications for the interpretation of the elasticities. Given expenditure data, the quantities will include effects of quality changes such as shifts from low to high processed foodstuffs. For example, expenditure data allow for the possibility that an increasing proportion of highly processed meats may increase the expenditure, even though the consumption of meat actually may decrease when measured by weight. This may be viewed as either an advantage or disadvantage depending on what part of the food chain is the primary focus.

The conditional and unconditional elasticities are identical for stage 1. The own-price elasticity of food and beverages is –0.4 and the expenditure elasticity is 0.7. The unconditional elasticities deviate substantially from the conditional for stage 2. These

Table 2 *Expenditure and Short-Run Uncompensated Own-Price Elasticities: Stages 1–4*

	Own-price			Expenditure		
Variable	Conditional		Unconditional	Conditional		Unconditional
Stage 1						
Food and beverages	–0.44	–0.36	–0.44	0.74	0.69	0.74
	(0.10)	(0.12)		(0.04)	(0.05)	
Restaurants	–0.57	–0.52	–0.57	1.09	1.10	1.09
	(0.16)	(0.17)		(0.20)	(0.23)	
Other non-durables	–0.63	–0.65	–0.63	1.32	1.30	1.32
	(0.07)	(0.07)		(0.07)	(0.07)	
Services	–0.97	–0.97	–0.97	1.05	1.04	1.05
	(0.10)	(0.09)		(0.06)	(0.05)	
Stage 2						
Animalia	–0.94	–0.94	–0.76	1.01	1.01	0.75
	(0.15)	(0.15)		(0.15)	(0.15)	
Beverages	–0.88	–0.88	–0.68	1.22	1.22	0.90
	(0.09)	(0.09)		(0.14)	(0.14)	
Vegetablia	–0.83	-0.82	–0.75	0.56	0.53	0.41
	(0.05)	(0.06)		(0.09)	(0.09)	
Other foodstuffs	–0.48	–0.50	–0.38	1.23	1.22	0.91
	(0.12)	(0.11)		(0.22)	(0.21)	
Stage 3						
Meat	–0.90	–0.90	–0.74	0.98	0.98	0.73
	(0.08)	(0.09)		(0.08)	(0.09)	
Fish	–0.93	–0.95	–0.87	1.16	1.13	0.87
	(0.08)	(0.07)		(0.21)	(0.17)	
Cheese	–0.85	–0.88	–0.82	0.95	0.96	0.71
	(0.11)	(0.09)		(0.27)	(0.22)	
Eggs	–0.38	–0.22	–0.37	0.83	0.79	0.62
	(0.19)	(0.22)		(0.20)	(0.24)	
Stage 4						
Beef	–0.59	–0.60	–0.48	0.98	0.98	0.72
	(0.12)	(0.11)		(0.14)	(0.14)	
Mutton and lamb	–0.25	-0.21	–0.23	0.57	0.54	0.42
	(0.18)	(0.19)		(0.20)	(0.20)	
Pork	–0.78	–0.77	–0.66	1.11	1.11	0.81
	(0.13)	(0.13)		(0.14)	(0.14)	
Chicken	–1.15	–1.10	–1.14	1.36	1.25	1.00
	(0.22)	(0.16)		(0.35)	(0.26)	

Note: Standard errors in parentheses

deviations indicate the importance of correcting conditional elasticities used for policy purposes. The deviations are particularly large for the animalia and beverages groups. The unconditional elasticities both with respect to price and expenditure are inelastic at stage 3.

The unconditional own-price elasticities for beef, lamb, pork and chicken are calculated to be –0.48, –0.23, –0.66 and –1.14, respectively. The highly price inelastic demand for lamb may be somewhat surprising. The differences between conditional and unconditional own-price elasticities are of some importance for beef and pork which account for large budget shares within the meat sub-system.

The unconditional expenditure elasticities deviate substantially from the conditional ones. The unconditional expenditure elasticities for beef, lamb, pork and chicken are calculated to be 0.72, 0.42, 0.81 and 1.00, respectively.

CONCLUSIONS

The hypothesis of no dynamics is rejected for each stage. Furthermore, the dynamic specification removes autocorrelation to a large extent. These findings indicate the importance of a dynamic specification.

The estimated elasticities are of the expected sign and reasonable magnitudes. The correction from conditional to unconditional elasticities proved to be empirically important for many goods. This emphasizes the importance of correcting conditional elasticities before results from different studies are compared or before the elasticities are used for policy purposes. This is not the current practice in the literature. The demands for beef, lamb and pork are inelastic with respect to own-price as well as expenditure while the demand for chicken is price elastic.

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DISCUSSION OPENING — Wen S. Chern *(The Ohio State University, USA)*

This paper presents the econometric results of estimating a four-stage dynamic almost ideal demand system in Norway. The study was rigorously done and the paper was well written. The author made two important contributions. One is to demonstrate the differences between the conditional and unconditional demand elasticities. The other is to show that the full AIDS model can be easily estimated with a widely accessible computer package. Rickertsen defines conditional elasticities as those typically obtained from a demand system estimated for a subset of commodities such as beef, lamb, pork, and chicken in his model. The unconditional elasticities are defined as those obtained from a demand model including all non-durable goods and services in the consumer's budget. Estimates of unconditional elasticities are important because they are the elasticities needed in welfare analysis. The second contribution is important because most of applications of the AIDS were based on the linear approximate form. Few empirical applications estimated the full AIDS.

I have several comments on the paper. First, the unconditional elasticities as defined in the paper are not perfectly unconditional. In fact, they are still conditional upon the assumption of weak separability among non-durable goods and services, and the assumption of the independence of non-durables from the demand for durable goods. Specifically, the correction formulae are derived from the specification of various stages of utility maximization. For example, if the author reduces his four stages to three or extends it to five stages, the estimates of unconditional elasticities are likely different. In fact, with the data on hand, one can estimate a truly unconditional one-stage model (with some demand components highly aggregated). It would be very interesting to compare the unconditional elasticities obtained in the paper with those obtained from the one-stage model.

My second comment is on dynamic specification. The author used the lagged budget shares and the demographic translation to incorporate these lagged variables. There is not a single most acceptable way to capture the habit formation. Personally, I would prefer use of the lagged quantity variables to budget shares. Still the general dynamic framework developed by Anderson and Blundell should be explored. In any case, when the lagged variables are included, short-run and long-run elasticities are distinguishable in the model. Unfortunately, in the highly non-linear AIDS model, the long-run elasticities can not be derived analytically. However, they can be estimated by a simulation technique. In the present model, there are no theoretical and statistical criteria available for evaluating the magnitudes or signs of the estimated coefficients of lagged variables. Currently, there are negative and positive coefficients, some smaller than one and others greater than one. There are no clues about what the long-run elasticities would look like. A few notes on the long-run elasticities would be useful in the paper.

The empirical estimates offer interesting insights into consumer behaviour in Norway. First, there appears to be no inferior good in Norway. The demand for food consumed at home is inelastic with respect to both own price and income. All foods appear to be necessities except chicken whose demand is elastic with respect to price and income. It would be useful to report the budget shares of the goods included in all four stages in the model so that one could try to further explain what these estimated elasticities imply when changes in prices or income occur. Overall this is an excellent paper. I congratulate the author on a job well done.