Expenditure Patterns of Smallholder Farm-Households in Tonga: an Application of the Almost Ideal Demand System[1]

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1. INTRODUCTION

Tonga has been experiencing a continuing decline in its balance of trade in recent years, as the value of exports fails to keep pace with increasing imports. In particular, growth in the agricultural sector has not been able to match the increasing domestic demand for food. The ratio of the value of agricultural exports to the value of food imports fell from 3.6 in 1960 to 0.4 in 1986 (Hardaker, Delforce, Fleming and Sefanaia 1988, p. 3).

The increasing reliance on imports is a cause for concern among nutritionists, who see links between changing dietary patterns and the incidence of ailments such as heart disease and diabetes (Parkinson 1982, South Pacific Commission 1982, Thaman 1982). Meanwhile, some economists and development planners are concerned that the expenditure patterns of Tongans might be a hindrance to the goal of achieving [illegible]table economic development. If a strategy based on the development of agriculture and the expansion of rural employment opportunities is to succeed, it is imperative that rural incomes be spent largely on locally-produced, labour-intensive goods and services (Delforce, Hardaker and Fleming 1988).

It has also been suggested that there are inadequate incentives to give up leisure time in order to increase productive output, particularly in the agricultural sector. This is said to be largely because opportunities exist either to migrate oneself or to establish kin networks overseas which supply regular remittances (Bertram and Watters 1985).

The study described in this paper is aimed at addressing some of these issues. The 'farm-household economics' approach is adopted, whereby the village household is recognised to be simultaneously a unit of production and of consumption which allocates its 'full income' so as to maximise utility. As an initial stage in the analysis, a separable model is developed in which production and consumption decisions are assumed to be made independently. In this paper, only the consumption model is discussed. Later, this will be recursively linked to a mathematical programming model of farm-household production activities.

In section 2, average expenditure patterns in four Tongan villages are described. A formal model of consumption behaviour is outlined in section 3. It is based on the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980), and involves six food categories, non-food and leisure. Results of the demand system estimation are discussed in section 4. Some conclusions and implications of the study are outlined in section 5.

2 THE EXPENDITURE OF 'FULL INCOME' AMONG TONGAN SMALLHOLDERS

2.1 The Concept of 'Full Income'

The pioneering work of Becker (1965) established a consistent framework for the simultaneous analysis of both the labour-leisure choice and the allocation of cash and non-cash expenditure at the household level. The essence of Becker's 'new household economics' is that household utility is derived from the consumption of 'Z-goods', which are produced by the household with inputs of time, market goods and household capital services. Many Z-goods are non-tradable and have no market prices, but they have shadow prices determined by the value of the inputs which produced them. Households maximise utility subject to production function, income and time constraints, as follows (Becker 1965, pp. 495-6):

(2.1) $$\text{Max } U = U(Z_i, \ldots Z_m)$$

$$\text{s.t. } Z_i = f_i(x_i, T_i)$$

$$\Sigma_i\, p_i x_i = I = V + T_w w,$$

$$\text{and } \Sigma_i\, T_i = T_c = T - T_w,$$

where Z_i are Z-goods,

x_i are market goods,

T_i is the total time input in the production of Z_i,

p_i are the prices of x_i,

I is total cash income,

V is non-earned income,

T_w is the time spent earning wages,

w is the wage rate per unit of T_w,

T_c is total time spent in consumption, and

T is total time available.

By valuing all household time at the market wage, the three sets of constraints are combined into a single 'full income' constraint (Becker 1965, p. 497):

$$(2.2) \qquad \sum(p_i b_i + t_i w)Z_i = S = V + Tw \; .$$

where t_i is the time input per unit of Z_i and

b_i is the input of market goods per unit of Z_i.

Becker defined 'full income' as 'the maximum money income achievable ... by devoting all the time and other resources of a household to earning income, with no regard for consumption' (pp. 497-8). A household can spend its full income either directly by purchasing market goods (which requires the prior conversion of time into money), or indirectly by choosing to engage in activities which do not produce cash income.

In a semi-subsistence economy, for instance among Tongan smallholder farm-households, Z-goods include farm produce, and the income constraint in (2.1) can be broadened to include farm profits in cash or kind. To maximise utility, the farming household allocates its full income between the consumption of market-purchased goods, home-produced goods and leisure.

2.2 The Household Sample

Data were collected by the South Pacific Smallholder Project[a] from about 30 households in each of four Tongan villages, over a 12-month period commencing in November 1984. Ha'akame-Ha'alalo and Navutoka are on the main island of Tongatapu, Ha'ano is in the central, poorly-

[a] Funded by the Australian Centre for International Agricultural Research (ACIAR).

developed island group of Ha'apai, and Mataika is on the northerly island of Vava'u, where vanilla production has become an important income-earning activity (see Delforce 1986). A Tongan field assistant was stationed in each village to carry out a daily program of interviews.

The Project involved the study of many aspects of farm and household organisation (see Hardaker et al. 1988 for a full summary). Of most relevance to the current paper is the information on household cash expenditure, subsistence consumption and time allocation. According to the interview timetable devised, income and expenditure data were to be recorded weekly for all households, for sample periods of one month per quarter. Household food consumption and individual time allocation diaries were to be completed daily during one week per quarter. For various reasons, the actual number of usable questionnaire responses is somewhat less than implied by the formal timetable. In particular, when the data were examined on a quarterly basis, it was found that some households had escaped recording in one or more of the three data sets in one or more quarters. Since it was essential, for the formal modelling described in sections 3 and 4, to have observations on expenditure <u>and</u> food consumption <u>and</u> time allocation for a given household in a given quarter, households with incomplete records were excluded for that quarter. This left 201 usable observations, distributed as shown in Table 2.1.

2.3 <u>Cash, Subsistence and Leisure Expenditure</u>

For the purposes of this study, total expenditure is divided into eight categories:

(1) LOCSTAP: local staples, including root crops, breadfruit, bananas and plantains;

(2) IMPSTAP: imported staples, including bread, flour and wheat products such as noodles;

(3) LOCFVS: local fruit, vegetables and snacks, including coconuts and peanuts;

Table 2.1

Number of Usable Observations by Village and Quarter

	Ha'akame-Ha'alalo	Ha'ano	Mataika	Navutoka	TOTAL
Quarter 1	15	11	14	14	54
Quarter 2	9	12	22	11	54
Quarter 3	22	4	21	3	50
Quarter 4	21	0	20	2	43
TOTAL	67	27	77	30	201

(4) LOCPROT: local protein, including meat, fish, milk products and eggs;

(5) IMPPROT: imported protein, including tinned and fresh meat, tinned fish and dairy products;

(6) OFBT: other food, beverages and tobacco, nearly all of which are imported;

(7) NONFD: non-food, including household supplies, clothing, domestic durables, fees and gifts, but excluding inputs for farming and other productive activities (which are accounted for on the 'production' side of the full farm-household model); and

(8) LEIS: leisure, as defined later in this section.

Expenditure on IMPSTAP, IMPPROT, OFBT and NONFD is assumed to be of cash only. However, all households in the village sample produced food in their own gardens for consumption and, in some cases, for sale. Therefore, total expenditure on LOCSTAP, LOCFVS and LOCPROT is the sum of cash purchases plus the estimated value of subsistence production (see Hardaker et al. 1988, Appendix 1 for a description of the estimation procedure).

In the time allocation data collected by the South Pacific Smallholder Project, seven categories of activity were demarcated: (a) agriculture, (b) other production, (c) household chores, (d) school and study, (e) village events, (f) religion and (g) medical, legal, etc. All other activities within each 24-hour day (e.g. eating, resting, sleeping, talking with friends, etc.) were defined as 'leisure'.

Using Becker's 'full income' approach, the available leisure time of each household is treated as an 'expenditure', since it represents forgone earnings. Leisure is usually defined as total time less working time (Abbott and Ashenfelter 1976). However, the specification of 'total time' generally involves a recognition that some hours per day are required for sleeping, eating, etc. and are not strictly 'available' for alternative activities.

In order to get a more realistic assessment of 'available' or 'effective' leisure time, the 3880 adult records were examined more closely. It was found that 9.9 per cent of records had less than 12 hours per day of total leisure time, 3.1 per cent had less than 10 hours, and 0.8 per cent had less than 8 hours. When quarterly averages per household were computed, none included less than 10 hours of 'leisure' per person per day, so this figure was chosen as a reasonable approximation of 'unavailable' time. Household expenditure on leisure was therefore calculated as the total observed leisure time of adults, less 10 hours per person per day, valued at the prevailing wage rate for casual agricultural labour. (Children do make some contribution to household production, but the opportunity cost of their time is assumed to be negligible.)

The final data set used for model estimation is summarised on an annual basis in Table 2.2. This shows the budget shares of each of the eight expenditure categories in the four survey villages. Leisure accounts for the largest share in each village, and nonfood is ranked second in all but Ha'ano. Among the food categories, local staples and local proteins are predominant.

3 THE ALMOST IDEAL DEMAND SYSTEM

3.1 Rationale for Selecting the AIDS

Demand systems fall into three general categories (Abbot and Ashenfelter 1976, p. 396). The first is derived, using the first order conditions for constrained utility maximization, from a direct utility function of specific functional form. The linear expenditure system (LES) is an example of such a system, being derived from the Stone-Geary utility function (Stone 1954). The second method of demand system specification is to take an indirect utiltity function of specific functional form, and to use Roy's (1942) identity for the derivation of the corresponding demand equations (Phlips 1974). The quadratic expenditure system (QES) and linear logarithmic expenditure system (LLES) fall into this category (Pollak and Wales 1978, Barnum and Squire 1979). Thirdly, a system of demand equations may be specified which has a

Table 2.2

Weekly Expenditure of Full Income by Village Households*

	Ha'akame-Ha'alalo		Ha'ano		Mataika		Navutoka	
	$	%	$	%	$	%	$	%
1. Local staples	17.34	8.5	10.22	6.6	19.11	7.3	10.18	4.0
2. Imported staples	3.64	1.8	2.06	1.3	4.38	1.7	4.00	1.6
3. Local fruit, vegetables and snacks	9.52	4.7	2.59	1.7	1.77	0.7	3.57	1.4
4. Local protein	11.00	5.4	18.25	11.8	18.18	6.9	18.42	7.2
5. Imported protein	8.26	4.1	0.98	0.6	8.45	3.2	9.09	3.6
6. Other food, beverages and tobacco	5.23	2.6	1.93	1.2	5.17	2.0	5.47	2.1
7. Nonfood	29.36	14.4	7.61	4.9	52.58	20.1	23.75	9.3
8. Leisure	119.19	58.6	110.63	71.7	151.75	58.0	180.16	70.7
TOTAL	203.54	100.0	154.27	100.0	261.39	100.0	254.64	100.0
Food Budget								
Local	18.60	68.8	20.13	86.2	14.94	68.4	12.63	63.4
Imported	8.42	31.2	3.21	13.8	6.89	31.6	7.29	36.6
TOTAL	27.02	100.0	23.34	100.0	21.83	100.0	19.92	100.0

* Figures presented here are averages across all households for the full year of data collection. For model estimation, quarterly averages were computed for each household.

convenient form for estimation but is not related to any particular utility function. In this case, the normal demand theory restrictions (particularly additivity, homogeneity and symmetry) may need to be imposed if they are not automatically satisfied. Examples of this type of specification are the Rotterdam model and the almost ideal demand system (AIDS).

The most commonly used demand system in empirical studies of agricultural households appears to have been the LES (e.g. Barnum and Squire 1979, Ahn, Singh and Squire 1981, Singh and Janakiram 1986). Since preferences in the Stone-Geary utility function are assumed to be directly additive, certain restrictions are thereby imposed on the parameters of the demand system. For instance, there can be no complementarity or substitutability between commodity groups, and Engel curves are constrained to be linear. This means that the impact of income level on consumption behaviour cannot be adequately assessed, and goods cannot be classified as 'necessities' or 'luxuries'. Another implication of direct additivity is that the ratio of own-price to income elasticity is approximately constant (Deaton 1974, p. 338). According to Deaton, such a relationship is '_a priori_ implausible' and without empirical support. In addition, the requirement in LES models that subsistence expenditure must be positive forces own-price elasticities to be less than one in absolute terms (Strauss 1981, Majumder 1986). In short, 'the use of models based upon ... additivity ... seriously distorts the measurement of those responses in which demand analysis has the greatest interest, own-price and income elasticities' (Deaton 1974, p. 338). While the distortion may be reduced by the use of very broad commodity groups within which extreme cases are submerged, Deaton's 'basic point remains; additive models will only work well when the ratio of price to income elasticities is genuinely equal for all commodities and there is no reason to suppose that this is more likely for broad groups than for more differentiated commodities' (p. 344).

The above disadvantages of the LES can be avoided by using the quadratic expenditure system (QES), which is 'a generalisation of LES in which the demand equations are quadratic in total expenditure' (Pollak and Wales 1978, p. 348). The marginal budget shares vary with prices and income and may be negative for some income levels (i.e., goods may be inferior). The QES is generally estimated with a non-linear seemingly unrelated regression algorithm (e.g. Strauss 1981). Demand theory restrictions, with the exception of Slutsky negativity, are automatically satisfied.

The AIDS is another demand system which is not derived from an additive utility function, and consequently avoids the associated restrictions. This system is based not on a specified utility function, but rather, on 'the cost or expenditure function which defines the minimum expenditure necessary to attain a specific utility level at given prices' (Deaton and Muellbauer 1980, p. 313).

The creators of the model, Deaton and Muellbauer (1980), describe it as follows:

> ... [it] gives an arbitrary first-order approximation to any demand system; it satisfies the axioms of choice exactly; it aggregates perfectly over consumers without invoking parallel linear Engel curves; it has a functional form which is consistent with known household-budget data; it is simple to estimate, largely avoiding the need for non-linear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters.

Subsequent users have confirmed the desirable properties of the AIDS. Braverman and Hammer (1986, p. 239), for instance, applauded its flexibility with respect to both price and income elasticities. They were particularly interested in substitution between alternative staple foods at different income levels. The clear distinction between luxuries, necessities and inferior goods (see section 3.2) is also valuable in many studies. Recent applications of the AIDS specification include studies of household expenditure patterns in India (Ray 1980, 1982; Majumder 1986) and Burkina Faso (Savadogo and Brandt 1988); of North American households' demand for convenience and nonconvenience foods (Capps, Tedford and Havlicek 1985) and for food eaten at home and away from home (Goddard 1983); and of tourist expenditures at a Hawaiian resort (Fujii, Khaled and Mak 1985). The AIDS has also been used in trade models (Winters 1984a, 1984b; Murfin 1984; Anderson 1985).

3.2 Estimation Procedures

The AIDS demand equations take the form:

(3.1) $$w_i = a_i + \sum c_{ij} \log p_j + b_i \log(Y/P)$$

where a_i, b_i and c_{ij} are to be estimated;
p_j is the price of commodity j;
Y is total expenditure;
w_i is the budget share, p_iq_i/Y;
q_i is the quantity of commodity i consumed; and
P is a price index, defined as follows:

(3.2) $$\log P = a_0 + \sum a_k \log p_k + 0.5 \sum c_{kj} \log p_k \log p_j.$$

The full estimating equation, with (3.2) substituted into (3.1), is clearly non-linear. However, the usual procedure, justified on the grounds that prices are closely collinear (Deaton and Muellbauer 1980, p. 316), is to define P as approximately proportional to a known index, P^*, the specification of which follows Stone (1953):

(3.3) $$\log P^* = \sum w_k \log p_k.$$

Assuming that $P \simeq gP^*$, the estimating equation becomes:

(3.4) $$w_i = a_i^* + \sum c_{ij} \log p_j + b_i \log(Y/P^*)$$

where $a_i^* = (a_i - b_i \log g)$.

This equation can be estimated with ordinary least squares (OLS). A positive b_i coefficient indicates that the commodity is a luxury, while a negative b_i coefficient indicates either a necessity (if the absolute value of b_i is less than w_i) or an inferior good (if the absolute value of b_i is greater than w_i) (Majumder 1986).

The adding up restrictions, $\sum_i a_i = 1, \sum_i c_{ij} = 0$ and $\sum_i b_i = 0$ together ensure that $\sum w_i = 1$, and are automatically satisfied. The homogeneity restriction, $\sum_j c_{ij} = 0$, can be tested by re-estimating each equation with the restriction substituted in, and then performing F-tests (Deaton and Muellbauer 1980, p. 318). The symmetry condition, $c_{ij} = c_{ji}$, must be tested across the entire system of equations. As explained by Deaton and Muellbauer (1980, p. 318), this affects the variance-covariance matrix of the residuals. They point out that restricted OLS estimates of equation 3.4 'will no longer automatically be maximum likelihood, efficient, or satisfy adding up.' Once restrictions have been tested with OLS, those needing to be imposed should be imposed only on the original system (3.1 and 3.2), which is estimated using a full information maximum likelihood algorithm.

3.3 Application of AIDS to Tongan Data

The linear approximation of the AIDS, as specified in equation 3.4, was modified to include household size (in adult equivalents), education of household head (in years), village and seasonal dummies and dummies for female-headed households, overseas travel (1 if household head had been overseas) and religion (1 for Mormon or Seventh Day Adventist, both of which churches exhort followers to adopt somewhat similar 'appropriate' consumption behaviour). Household income was defined on a per caput basis, and aggregate category prices were expressed as a Theil-Tornqvist index (Tornqvist 1936, Theil 1968) using quarter 1, Ha'akame-Ha'alalo village as the base.

The AIDS estimating equation became:

$$(3.5)\quad w_i = a_i^{*} + \sum c_{ij} \log p_j + b_i(\log Y - \sum w_k \log p_k) + s_i \log SIZE + k_i\, V2 + m_i\, V3 + n_i\, V4 + fma_i\, Q2 + mjj_i\, Q3 + aso_i\, Q4 + os_i\, OS + e_i\, ED + f_i\, FEM + r_i\, REL,$$

$$i,j,k=1,8$$

where a_i, b_i, c_i, p_i, Y, and w_i are as defined in equation 3.1,

SIZE is household size,

V2, V3 and V4 are village dummies,

Q2, Q3 and Q4 are seasonal dummies,

OS is overseas travel,

ED is education,

FEM is for female-headed households,

REL is religion, and

other coefficients are to be estimated.

The above system was initially estimated without imposition of homogeneity and symmetry restrictions. Tests of these restrictions revealed that homogeneity was violated in two of the eight equations (IMPPROT, OFBT), while five of the 21 individual cross-equation symmetry restrictions were violated. Three of the violations involved the LOCSTAP equation, perhaps indicating that price has only a minor influence on this predominantly subsistence category. The system as a whole was also found to violate symmetry. It was therefore re-estimated with restrictions imposed. It will be recalled (section 3.2) that Deaton and Muellbauer advocate non-linear estimation of the exact system (equations 3.1 and 3.2) once restrictions have been imposed. This has been attempted, but computational difficulties have prevented solution of the non-linear model as of the time of writing.

The results presented in the next section pertain to the homogeneity and symmetry-restricted linear approximation of AIDS, estimated using Zellner's seemingly unrelated regression method. To obtain direct estimates of all eight equations without encountering the overidentification problem, the system was run twice, once without the w_8 equation and once without the w_7 equation. (Results for the remaining six equations were, of course, identical in each case.) Estimates were also obtained for a 7-equation model of food and non-food expenditure and a 6-equation model of food groups only. Where the results differ significantly between alternative versions of the model, this is noted in the discussion.

4. RESULTS

Results for the three restricted expenditure systems mentioned above (8-equation, 7-equation and 6-equation) are summarised in Table 4.1.

4.1 Explanatory Power of the Models

In cross-sectional analysis of the type carried out here it is common not to achieve statistically 'good' results as indicated by the coefficient of multiple determination ($\bar{R}^2$). Low $\bar{R}^2$s may certainly be a reflection of poor-quality data, but they may also be due to a high

Table 4.1

Summary of Model Results[a]

		Equation							
		1	2	3	4	5	6	7	8
Coef	Variable	LOCSTAP	IMPSTAP	LOCFVS	LOCPROT	IMPPROT	OFBT	NONFD	LEIS
a_i*	Intercept	0.13**	0.03*	0.10**	0.03	0.11**	0.08**	-0.15*	0.67**
c_{1j}	log p_1	0.06	0.06	0.03	-0.07	0.10	0.09**	-0.17	-0.10
c_{2j}	log p_2	0.06	0.19	-0.08	0.19	0.04	-0.05	-0.37	0.07
c_{3j}	log p_3	0.03	-0.08	-0.13	-0.41	0.02	0.04	0.45*	0.07
c_{4j}	log p_4	-0.07	0.15	-0.41	0.87	0.12	0.30	-1.43	0.46
c_{5j}	log p_5	0.10**	0.04	0.02	0.12	0.03	0.05	-0.36**	0.00
c_{6j}	log p_6	0.09**	-0.05	0.04	0.30	0.05	-0.47	0.18	-0.14
c_{7j}	log p_7	-0.17	-0.37	0.45*	-1.43	-0.36**	0.18	1.64	0.05
c_{8j}	log p_8	-0.10	0.07	0.07	0.46	0.00	-0.14	0.05	-0.41*
b_i	log(Y/P*)	-0.02**	-0.00	-0.01**	0.01	-0.02**	-0.01**	0.06**	-0.02
s_i	log SIZE	-0.01*	-0.01*	-0.01**	-0.00	-0.01*	-0.02	0.06**	0.00
k_i	V2	-0.01	-0.04	-0.12*	-0.12	-0.01	0.07	0.04	0.20**
m_i	V3	0.02	-0.01	-0.04	-0.07	0.03**	0.05**	0.01	-0.00
n_i	V4	-0.05**	-0.00	-0.02**	-0.02	0.00	0.01	-0.04	0.13**
fma_i	Q2	0.02*	0.01	-0.02*	-0.02	0.01	0.04	-0.17**	0.13**
mji_i	Q3	0.02	0.04	-0.04	0.05	0.03*	0.07	-0.27*	0.09*
aso_i	Q4	-0.06**	0.04	-0.05	0.16	-0.02	0.03	-0.23	0.13*
os_i	OS	0.00	0.00	0.00	-0.00	-0.00	-0.01*	0.01	0.00
e_i	ED	0.00	0.00	0.00	0.00	0.00*	0.00**	0.00	-0.01**
f_i	FEM	0.02*	-0.00	0.00	0.01	-0.00	-0.01	-0.01	-0.02
r_i	REL	0.00	-0.01	-0.00	0.01	-0.01**	-0.01	-0.04	0.05
$\bar{R}^2$		0.1313	0.0151	0.3200	0.1403	0.2061	0.1788	0.2093	0.0924

System $\bar{R}^2$ = 0.8608

[a] See equation 3.5 for details of the estimating equation.

* Significant at 90% level.

** Significant at 95% level.

Table 4.1 (continued)

b. <u>7-equation system</u>

		Equation						
		1	2	3	4	5	6	7
Coef	Variable	LOCSTAP	IMPSTAP	LOCFVS	LOCPROT	IMPPROT	OFBT	NONFD
a_j*	Intercept	0.42**	0.07**	0.19**	0.11	0.19**	0.15**	-0.14
c_{1j}	log p_1	0.11	0.12	0.04	-0.32	0.20**	0.22**	-0.38
c_{2j}	log p_2	0.12	0.45	-0.00	0.06	0.07	-0.12	-0.58
c_{3j}	log p_3	0.04	-0.00	-0.21**	-0.33	0.03	-0.05	0.52**
c_{4j}	log p_4	-0.32	0.06	-0.33	5.90**	0.03	-0.95	-4.40*
c_{5j}	log p_5	0.20**	0.07	0.03	0.03	0.12	0.13	-0.58*
c_{6j}	log p_6	0.22**	-0.12	-0.05	-0.95	0.13	0.47	0.31
c_{7j}	log p_7	-0.38	-0.58	0.52**	-4.40	-0.58*	0.31	5.11
b_j	log(Y/P*)	-0.07**	-0.00	-0.02**	0.01	-0.03**	-0.02**	0.13**
s_j	log SIZE	-0[illegible]	-0.02**	-0.02**	0.02	-0.01	-0.04**	0.10**
k_j	V2	-[illegible]	-0.03	-0.19	0.64**	-0.07	-0.13	-0.21
m_j	V3	[illegible].07	0.00	-0.12	-0.06	0.08*	0.08*	-0.06
n_j	V4	-0.11**	0.02	-0.06**	0.02	0.04**	0.04**	0.05
fma_j	Q2	0.06*	0.02	-0.01	0.23**	0.01	-0.02	-0.29**
mjj_j	Q3	0.04	0.06	-0.01	0.55**	0.05	-0.09	-0.61**
aso_j	Q4	-0.14	0.00	-0.00	1.02**	-0.08	-0.26	-0.53
os_j	OS	0.01	0.00	0.00	-0.02	-0.01	0.02**	0.03
e_j	ED	-0.00	0.00	0.00	-0.00	0.00	0.00**	-0.00
f_j	FEM	0.03	0.00	0.01	-0.00	-0.01	-0.02**	-0.00
r_j	REL	-0.01	-0.00	0.00	0.07**	-0.02	-0.01	-0.03
$\bar{R}^2$		0.1575	0.0355	0.3206	0.2160	0.2161	0.1904	0.3548

System $\bar{R}^2$ = 0.8579

* Significant at 90% level.

** Significant at 95% level.

Table 4.1 (continued)

c. <u>6-equation system</u>

		Equation					
		1	2	3	4	5	6
Coef	Variable	LOCSTAP	IMPSTAP	LOCFVS	LOCPROT	IMPPROT	OFBT
a_i	Intercept	0.31**	0.04	0.26**	-0.10	0.27**	0.22**
c_{1j}	log p_1	-0.10	0.12	0.04	-0.24	0.02	0.15
c_{2j}	log p_2	0.12	0.47	0.05	-0.54	0.02	-0.12
c_{3j}	log p_3	0.05	0.05	-0.22*	0.16*	-0.03	-0.01
c_{4j}	log p_4	-0.24	-0.54	0.16	2.11	-0.21	-1.28*
c_{5j}	log p_5	0.02	0.02	-0.03	-0.21	0.34	0.07
c_{6j}	log p_6	0.15	-0.12	-0.01	-1.28*	0.07	1.19
b_i	log(Y/P*)	-0.01	0.01*	-0.02**	0.10**	-0.05**	-0.03**
s_i	log SIZE	0.00	-0.01	-0.02	0.09**	-0.01	-0.06**
k_i	V2	-0.01	-0.06	-0.18**	0.62**	-0.16**	-0.20**
m_i	V3	0.00	0.00	-0.16**	0.11	-0.00	0.05
n_i	V4	-0.13**	0.03*	-0.09**	0.10**	0.03	0.05**
fms_i	Q2	0.07**	-0.01	-0.00	0.03	-0.03	-0.06
mjj_i	Q3	0.05	-0.00	0.03	0.09	-0.01	-0.17
aso_i	Q4	0.01	-0.08	0.08	0.39	-0.06	-0.34
os_i	OS	0.03	0.00	-0.00	-0.01	-0.01	-0.01
e_i	ED	-0.00	-0.00	0.00	-0.00	0.00	0.00
f_i	FEM	0.04	0.00	0.01	-0.02	0.00	-0.03*
r_i	REL	-0.00	-0.01	0.00	0.07*	-0.03	-0.03*
$\bar{R}^2$		0.1115	0.0383	0.3758	0.2483	0.2247	0.1038

System $\bar{R}^2$ = 0.7782

* Significant at 90% level.

** Significant at 95% level.

degree of genuine variability across households caused by a multiplicity of factors which can be only poorly accounted for in a formal model. As is evident from Table 4.1, the $\bar{R}^2$s for the individual equations estimated are extremely low. However, for the systems as a whole the picture is less gloomy, with $\bar{R}^2$s of .8608 for the full 8-equation system, .8579 for the 7-equation system and .7782 for the 6-equation system.

Perhaps of more relevance than the $\bar{R}^2$ results is the extent of significant estimates. Once again, this is somewhat disappointing (particularly for the LOCPROT equation), but it is pleasing that the coefficients for real total expenditure (b_i) and log of household size (s_i) are significant in most equations. The former indicates the distinction between luxuries and necessities, while the latter shows the impact on budget shares of differences in household size. In the 8-equation system, 4 of the total 28 cross-price relationships (or 8 of 56 coefficients, on account of symmetry) and one of the 8 own-prices are significant at the 0.9 level or better. Of the village dummy variables, that for Ha'ano is significant in the LOCFVS and LEIS equations, for Matsika in the IMPPROT and OFBT equations, and for Navutoka, in the LOCSTAP, LOCFVS and LEIS equations. Seasonal factors appear most significant in the second quarter (February-April), although leisure is affected in each season. Education is significant in 3 of the 8 equations, while female-headed households differ from the rest only in their consumption of local staples. Religion and overseas travel are each significant in just one equation: IMPPROT and OFBT respectively.

In the 7- and 6-equation systems, some estimates are statistically superior to those of the full 8-equation system, while others are inferior. For instance, equation 1 has 9 significant coefficients (at the 0.9 level or better) in the full system, 6 in the 7-equation system and just 3 in the 6-equation system. In contrast, equation 4 has no significant coefficients in the 8-equation system and 7 in each of the other two systems. Although the system R^2s are lower in the smaller systems, most of the single-equation R^2s are higher.

The significant results from all three systems are discussed in more detail below.

4.2 Effect of Total Real Expenditure

As mentioned above, the coefficient b_i on the real expenditure term $(\log Y - \sum w_k \log P_k)$ allows a distinction to be drawn between luxury items ($b_i > 0$) and necessities ($b_i < 0$). If total expenditure rises, the share of expenditure on a luxury good increases, while the share on a necessity decreases. On this basis, it can be seen from Table 4.1 that in the 8-equation system, NONFD is classed as a luxury while LOCSTAP, LOCFVS, IMPPROT and OFBT are necessities. This picture is confirmed when leisure is excluded from the analysis. However, when food groups only are considered, the LOCSTAP coefficient is no longer significant, while the IMPSTAP coefficient becomes positive and significant. LOCPROT is now confirmed to be a luxury, whereas in the larger systems its positive coefficient is not significant.

Total expenditure elasticities are obtained by applying the formula:

$$n_i = b_i/\bar{w}_i + 1 \tag{4.1}$$

Elasticity estimates for the three AID systems are presented in Table 4.2. These confirm the situation described above, since elasticities greater than 1.0 indicate luxuries. The results from the three systems estimated are broadly similar, except that the expenditure elasticity for imported staples is slightly less than 1.0 in the two larger systems, but greater than 1.0 when food groups only are considered. In all three systems, there is a higher expenditure elasticity for IMPSTAP than for LOCSTAP, but a lower elasticity for IMPPROT than LOCPROT. This implies that, as overall living standards increase, people will spend relatively more of their budgets on imported staples in preference to local staples, and on local protein in preference to imported protein. Since imported protein currently accounts for a higher share of the average budget than imported staples, this result gives some hope that the overall share of imported foods in the average budget may decline slightly in the future.

While the expenditure elasticity for leisure is not statistically significant, it is worth noting that it is close to unity, implying that

Table 4.2

Expenditure Elasticities

		8-equation system	7-equation system	6-equation system
η_1	LOCSTAP	.79**	.71**	.96
η_2	IMPSTAP	.91	.97	1.22*
η_3	LOCFVS	.60**	.71**	.80**
η_4	LOCPROT	1.17	1.07	1.39**
η_5	IMPPROT	.52**	.66**	.65**
η_6	OFBT	.59**	.70**	.71**
η_7	NONFD	1.55**	1.50**	.
η_8	LEIS	.97	.	.

* b_i significant at 90% level.
** b_i significant at 95% level.

the share of leisure in the 'full income' budget is likely to remain fairly constant as income changes.

4.3 Price Effects

4.3.1 Own-price

As indicated in section 4.1, only one of the eight own-price effects in the full model is significant at the 90 per cent level. This is for leisure, which is negative as would be expected. In the 7- and 6-equation systems, the own price coefficient is significant and negative in the LOCFVS equation and significant but positive in the LOCPROT equation. It will be recalled that this category is classed as a luxury good, meaning that its budget share increases as total expenditure increases. It appears that when its price rises, the quantity consumed either rises or does not fall sufficiently to offset the effect on the budget share of the higher price.

The own-price elasticity formula for the AIDS is:

$$e_{ii} = c_{ii}/\bar{w}_i - (1 + b_i). \tag{4.2}$$

Estimates for each of the systems are shown in Table 4.3, for both significant and non-significant coefficients. Elasticities are of particularly dubious reliability for the fifth and sixth equations (IMPPROT and OFBT), as the signs are different in the different systems. Of the more robust estimates, those for 'luxuries' - IMPSTAP, LOCPROT and NONFD - are positive, while LOCFVS has a negative elasticity. Leisure has an own-price elasticity of -1.64.

4.3.2 Cross-prices

Few of the cross-price coefficients are significant in the models estimated. Cross price effects between LOCSTAP and IMPPROT, LOCSTAP and OFBT and LOCFVS and NONFD are all positive, indicating substitutability, in both the 8- and 7-equation models. There are negative price

Table 4.3

Own-Price Elasticities

		8-equation system	7-equation system	6-equation system
e_{11}	LOCSTAP	-0.16	-0.46	-1.32
e_{22}	IMPSTAP	11.49	9.57	6.93
e_{33}	LOCFVS	-5.97	-3.93**	-3.17*
e_{44}	LOCPROT	11.22	27.97**	6.78*
e_{55}	IMPPROT	-0.12	0.18	-0.03
e_{66}	OFBT	19.15	5.34	10.30
e_{77}	NONFD	12.79	17.88	.
e_{88}	LEIS	-1.64*	.	.

* c_{ii} significant at 90% level.
** c_{ii} significant at 95% level.

coefficients, indicating complementary, between the IMPPROT and NONFD categories and, in the full system, between LOCPROT and NONFD. When food groups only are considered, a negative cross-price relationship is shown to exist between LOCPROT and OFBT.

Table 4.4 shows the cross-price elasticities calculated from these results using the formula:

(4.3) $$e_{ij} = c_{ij}/\bar{W}_i - b_i\bar{W}_j/\bar{W}_i \ .$$

Given the general lack of significance of the c_{ij} estimates on which the calculations were based, few clear relationships emerge. Some degree of asymmetry is evident, however. For example, the effect of IMPPROT and OFBT prices on the budget share of LOCSTAP is less than the effect of LOCSTAP prices on these other two categories.

4.4 Demographic and Seasonal Factors

4.4.1 Household size

Household size influences the allocation of full income to a small, but generally significant, extent. The greatest impact is on nonfoods, which increase with household size. All food group shares decrease slightly, according to the full system results, although the LOCPROT coefficient becomes positive if leisure is excluded. In other words, as household size increases, the budget allocated to food is adjusted slightly to allow for more local protein (and possibly more local staples), but in terms of the overall allocation of full income, there is a reduction in the total food share.

4.4.2 Village

The 'base' village is Ha'akame-Ha'alalo in Tongatapu. Dummy variables are included in the models for the other three villages. For the full 8-equation system, Ha'ano households are found to have a lower budget share of LOCFVS and a higher budget share of LEIS than the base village. Mataika households have proportionately more IMPPROT and OFBT in their budgets, while Navutoka households have more LEIS and less

Table 4.4

Cross-Price Elasticities

		LOCSTAP e_{i1}	IMPSTAP e_{i2}	LOCFVS e_{i3}	LOCPROT e_{i4}	IMPPROT e_{i5}	OFBT e_{i6}	NONFD e_{i7}	LEIS e_{i8}
a. 8-equation system									
e_{1j}	LOCSTAP	-0.16	0.72	0.43	-0.84	1.24**	1.14**	-2.13	-1.18
e_{2j}	IMPSTAP	3.59	11.49	-5.08	9.51	2.40	-3.43	-23.69	4.30
e_{3j}	LOCFVS	1.32	-3.06	-5.97	-15.78	0.86	1.72	17.43*	2.89
e_{4j}	LOCPROT	-0.95	2.08	-5.77	11.22	1.66	4.26	-20.08	6.41
e_{5j}	IMPPROT	2.70**	1.05	0.62	3.34	-0.12	1.33	-9.86	**0.40
e_{6j}	OFBT	3.06**	-2.06	1.72	11.72	1.85	-19.15	6.89	-5.02
e_{7j}	NONFD	-1.46	-3.13	3.79*	-12.08	-3.02**	1.48	12.79	0.09
e_{8j}	LEIS	-0.16	0.11	0.11	0.74	0.01	-0.22	0.09	-1.64*
b. 7-equation system									
e_{1j}	LOCSTAP	-0.46	0.54	0.20	-1.28	0.89**	0.94**	-1.54	
e_{2j}	IMPSTAP	2.93	9.57	-0.05	1.55	1.59	-2.87	-13.70	
e_{3j}	LOCFVS	0.67	-0.02	-3.93**	-4.59	0.52	-0.71	7.35**	
e_{4j}	LOCPROT	-1.57	0.32	-1.65	27.97**	0.14	-4.66	-21.62*	
e_{5j}	IMPPROT	2.06**	0.67	0.37	0.36	0.18	1.29	-5.58	
e_{6j}	OFBT	3.01	-1.63	-0.69	-12.79	1.80	5.34	4.27	
e_{7j}	NONFD	-1.54	-2.18	1.91**	-16.45*	-2.22*	1.11	17.88	
c. 6-equation system									
e_{1j}	LOCSTAP	-1.32	0.39	0.16	-0.75	0.07	0.50		
e_{2j}	IMPSTAP	1.99	6.93	0.86	-9.21	0.23	-2.02		
e_{3j}	LOCFVS	0.54	0.53	-3.17*	1.69	-0.28	-0.12		
e_{4j}	LOCPROT	-1.02	-2.05	0.58	6.78*	-0.85	-4.81*		
e_{5j}	IMPPROT	0.25	0.12	-0.17	-1.30	-0.03	0.48		
e_{6j}	OFBT	1.57	-1.11	-0.10	-12.05	0.69	10.30		

* c_{ij} significant at 90% level.
** c_{ij} significant at 95% level.

LOCSTAP and LOCFVS. Village effects are stronger in the food-only and food-plus-nonfood models.

4.4.3 Season

Data from the Tongan villages covered the 12-month period commencing in November 1984. For modelling, all observations were calculated on a quarterly basis: November-January, February-April, May-July and August-October. These quarters correspond roughly to the summer, autumn, winter and spring seasons which, while not as marked as in temperate climates, do affect agricultural production in Tonga. The main impact of seasonality seems to be on leisure, the budget share of which is lowest in the base period, November-January. This might be partly a result of the relatively high spending on nonfoods over the Christmas period. Climatic factors probably explain the significant decline in LOCFVS consumption in autumn compared to summer, since the tropical fruits such as mangoes and pineapple are most abundant in summer. Similarly, the main yam harvest commences in about March-April, which may account for the significant proportionate increase in local staple consumption in the second quarter.

4.4.4 Other demographic variables

Other demographic variables included in the models are the education level, sex, religion and overseas experience of the household head. Education is a continuous variable measured in years, while the other three are dummy variables. Sex of household head takes the value 1 for female-headed households, religion takes the value 1 for Mormon or Seventh Day Adventist church members, and overseas travel is 1 if the household head has been out of Tonga. From Table 4.1 it can be seen that a higher education level is associated with a budget containing a lower proportion of LEIS and a higher proportion of IMPSTAP and OFBT. Female-headed households allocate a lower share of their budget to OFBT than male-headed households, and the coefficient in the LOCSTAP equation is positive and significant in the 8-equation system. The significance of the religion variable is not constant across the three models presented, but the overall picture is of a higher budget allocation to LOCPROT and a lower allocation to IMPPROT and OFBT by Mormons and Seventh Day

Adventists. In view of the prohibitions of these religions on the taking of alcohol, tobacco and caffeine, a greater impact on OFBT consumption might have been anticipated. Finally, overseas travel appears to exert a negative influence on OFBT consumption, although the reason for this is not clear.

5. DISCUSSION AND CONCLUSIONS

5.1 Imports vs. Local Items

The greater part of the food expenditure of village households is allocated to items produced by the farming household or purchased locally. Table 2.2 shows that the proportion of imports in the food budget ranges from 13.7 per cent in Ha'ano to 36.6 per cent in Navutoka. The nonfood category includes both local and imported goods and services, estimated to be approximately in the proportion two-thirds local to one-third imported ([illegible] al. 1988, Table 3.6).

While locally-produced items clearly dominate the budget, there are indications that the share of imports is increasing. As noted in the Introduction, import growth has far outstripped export performance. To some extent this is probably a reflection of increasing urbanisation. While the study described in this paper does not include an urban sample, it is interesting to compare the average budget allocations in Ha'ano with those of the other three survey villages. Ha'ano is the most remote and least developed village, and only 14 per cent of its food requirements originate overseas. Increasing participation in the cash economy does appear to be associated with a shift towards more imported foods.

However, the total expenditure elasticities calculated from model results (section 4.2) suggest that while imported staples displace local staples as incomes rise, the budget share of imported protein foods is likely to decline and local protein intake to increase. The high positive price elasticity for local protein suggests that factors other than price are of paramount concern in determining consumption. There does appear to be scope for initiatives to increase production of local meats and fish for the domestic market as a means of curbing imports. On the other hand, import.. staples such as bread are clearly becoming increasingly popular. Taste preferences and convenience are such that even the determined efforts of nutrition action groups may be inadequate to curb the trend away from local staples.

In terms of overall development potential, the model results show that there is potential for capturing increases in rural incomes within the local area. In particular, the average budget share of nonfood goods and services was found to increase rapidly as total expenditure increased. Much nonfood expenditure is for school fees and donations to churches and village fundraising activities. Steps need to be taken to ensure that these 'luxury' expenditures are used to generate increased local production and employment. The chances of achieving sustainable economic development along the lines advocated by Mellor (1986) can thereby be enhanced (Delforce et al. 1988).

5.2 Leisure and Work

The proportion of leisure in the 'full income' budget was found to be little affected by changes in income level. There is clearly no evidence here that a sudden increase in remittance income is likely to be associated with increased reluctance to engage in productive activities, as is suggested by Bertram and Watters (1985). Moreover, the fact that the own-price elasticity of leisure is high indicates that people might be more willing to give up excess leisure time if they could be assured of returns higher than those currently available. It is not surprising in these circumstances that many farmers report having to supplement cash wages with food, tobacco and other benefits in order to attract hired labour.

5.3 Conclusions

This study has demonstrated the application of the Almost Ideal Demand System to the cross-sectional analysis of household expenditure patterns in a semi-subsistence economy. Becker's (1965) 'full income' concept was adapted to provide a basis for simultaneous evaluation of subsistence expenditure, cash expenditure and leisure. Seven categories of locally-produced and imported food and nonfood items were distinguished, so as to focus on nutritional and trade balance issues of fundamental concern to Tongan policymakers. The relative importance of leisure in the household budget was also assessed.

While the data used in this analysis cannot be claimed to be fully reliable, and while the models were disappointing in terms of statistical measures such as $\bar{R}^2$, the results are generally plausible and consistent with observed or expected trends. They serve to indicate some potential avenues for future development efforts in Tonga.

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