Food demand in urban and rural Samoa

Kandiah Jegasothy and Yann Duval

In order to meet the food and nutrition needs of its citizens and strengthen its balance of payments, Samoa needs to transform its agricultural production system and to develop sound food policy. This article analyses household consumption patterns and estimates price and expenditure elasticities for seven food groups for urban and rural households in Samoa. A combined food-health policy that leads to improvements in agriculture, nutritional awareness and marketing may be useful both economically and nutritionally.

Kandiah Jegasothy is a Lecturer at the School of Applied Economics, Victoria University of Technology, Melbourne.

Yann Duval is an Adjunct Lecturer in the Department of Agricultural Economics, Washington State University.

The Samoan economy displays two inter-related features—a weak balance of payments and deterioration in nutritional status. Import bills are leaping ahead of foreign exchange earnings and weakening the balance of payments, while an unbalanced nutritional intake is lowering the health status of the population. Both problems are directly related to changes in food import patterns.

Samoa's Sixth Development Plan (Samoa 1987) was the first to acknowledge that the solution to a weak balance of payments lies within agriculture. Three economic realities support this argument: agriculture continues to be the mainstay of the country; agricultural production is concentrated on a few commodities; and food amounts to one-quarter of Samoa's total import bill. Uncertainties with respect to the export sector's performance and ability to address the balance of payments imbalance, suggest that development in Samoa depends heavily on import substitution to conserve foreign exchange and sustain economic growth (Fairbairn 1985). Diversification of agriculture has been recommended as an appropriate strategy to address this issue.

The 1986 Pacific Regional Consultation meeting in Apia focused on integrating nutrition into agriculture training in the South Pacific and identified the commercialisation of agriculture, the westernisation of food habits and a corresponding increase in food imports as the proximate causes of an unbalanced nutritional intake. Over time, such an imbalance could impair the health, and therefore, the productivity of the country's population. Health statistics already demonstrate an increase in nutrition-related health problems. The 1986 meeting, as well as subsequent meetings during the 1990s, suggested that the nutritional imbalance could be effectively and economically corrected by improving domestic food supplies.

In order to resolve Samoa's balance of payments and nutrition-related problems simultaneously, changes in agricultural production—such as diversification—are needed. This would ensure adequate supply of nutritionally well-balanced food products which meet the demand and generate sufficient income for local producers. Despite the fact that Samoa has a narrow resource base, its agricultural and climatic conditions make it possible to produce a significant proportion of the food commodities currently being imported.

Observations of other developing economies suggest that a sound food policy is necessary for innovative changes in agricultural production to occur (Tweeten 1989). In general, food policy objectives have been to provide appropriate incentives to producers while preserving consumers' interests, to ensure a fair distribution of food commodities and to make an appropriate correction to the nutritional intake of the population (Timmer et al. 1983). There is an immediate need in Samoa to address the first and last of these objectives.

Formulation of food policy is a sensitive issue because it simultaneously impacts on production and consumption (Timmer 1980). Policymakers often face the dilemma of ensuring affordable prices for consumers without reducing prices to levels that act as a disincentive for producers. The development of an effective policy thus requires knowledge of household food consumption behaviour (micro input), domestic and international food markets (trade input) and the likely impact of the policy at the national level (macro input). This study provides some of the micro-level input needed for food policy formulation, by examining how household food consumption is affected by price and other factors in three villages of Samoa.

Model and data

Theories involving utility maximising rationality explain real world consumption behaviour remarkably well. The basic assumptions of this rationality approach have been repeatedly confirmed by empirical studies (Deaton and Muellbauer 1980). Accordingly, the demand function derived from a constrained maximisation of utility provides the analytical framework for this study. At the household level, a range of factors can be listed as determinants of quantity demanded, or consumption level, of a commodity. However, in most studies, income, price and household size are found to be the important variables.

Jogaratnam and Poleman (1969) concluded that expenditure is a better variable than income in household consumption studies. Household income data are unsatisfactory as they generally suffer from measurement errors, while expenditure is a reasonably good proxy for permanent income. Expenditure and household size are likely to be collinear variables, and this relationship may lead to insignificant estimates of the parameters. Gray (1982) suggests that this problem can be avoided by using per capita expenditure.

Differences and/or changes in consumer preferences that are caused by exogenous factors also contribute to variations in demand (Eales and Unnevehr 1988; Reynolds and Goddard 1991). Hence, the Marshallian demand function chosen in our analysis includes price and per capita expenditure as explanatory variables as well as exogenous factors, such that

$$Q_{iht} = f(p_{iht}, y_{iht}, Z_{ht}) \quad (1)$$

where Q_{iht} is the quantity of i^{th} commodity consumed by h^{th} household in period t , p_{iht} is the price of i^{th} commodity consumed by h^{th} household in period t, y_{ht} is per capita expenditure of h^{th} household in period t, and Z_{ht} is an exogenous factor that characterises the h^{th} household in period t.

Consumers tend to group commodities according to their consumable characteristics. This phenomenon is known as separability. Separability in consumption implies that a grouped preference structure exists such that choices can be made within a group independently of choices made in other groups. The preference grouping also enables consumers to perform multi-stage budgeting. In empirical analysis, the separability property improves manageability of the data by focusing the analysis through aggregation.

Separability is important in this study because the observed households are semi-subsistence farming units. Therefore, the production and consumption decisions are linked to household finances (Delforce 1994; Gibson 1995). At the first stage a household allocates its budget between non-food (leisure) and food consumption, because household allocations for food and leisure are very dominant in developing economies. In the second stage, expenditure on food is allocated among broad food groups. In the third stage, expenditure for each broad group is allocated to individual food items belonging to that group.

According to the theory, allocation in the first stage requires a complete demand system with leisure as a component. Such a system is empirically difficult to quantify because non-labour income and the cost of leisure are hard to measure accurately (Gibson 1995), particularly in developing economies. An evaluation of farm-household behaviour by Delforce (1994) using linear programming concluded that the approach gives more attention to production than consumption. Further, this study points out that in many (similar) cases, maintaining the separability assumption during analysis has led to only minor distortions. Hence, instead of imposing and testing the separability between food and leisure allocation, it is reasonable to assume it in the analysis. Separability at the third stage is not considered in this study for two reasons. First, the study provides some insight on demand for broad categories of food that are used in food policy formulation. Second, consideration of the variety of food items consumed requires many simultaneous choices. This study assumes weak separability between food and leisure and ignores separability at the level of individual food items. This assumption permits analysis of food consumption at the broad food group level.

Choice of model

In demand models derived from consumption theory, utility maximisation subject to budget constraints is theoretically and empirically preferable. These models offer the advantage of imposing and testing theoretical restrictions, the non-arbitrary choice of the functional form for the demand equations, the ability to postulate non-constant elasticity values and the ability to form a complete demand system that accounts for mutual interdependence of commodities while making a choice (Deaton and Muellbauer 1980). Among these models, the Linear Expenditure System (LES) and the Almost Ideal Demand (AID) system are widely used.

The AID model is empirically more desirable because the demand system generated does not restrict the Engel curve to be linear.

The general specification of the AID model in the form of a Marshallian demand function, structured as an expenditure share-log equation for household h^{th}, is

$$w_{it} = \alpha_i + \sum_j \beta_{ij} \ln p_{jt} + \gamma_i \ln\left(y_t / P_t \right) + \omega_j z_t$$

where P_t is a price index defined as

$$\ln P_t = \alpha_o + \sum_i \alpha_i \ln p_{jt} + \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln p_{it} \ln p_{jt} \qquad (2)$$

(note: $i = j = 1, 2, \ldots n$)
where w_{it} is the food expenditure share of the i^{th} commodity consumed in period t.

Direct substitution of the trans-log price index introduces non-linearity and thus requires a non-linear estimation procedure to estimate the share equation parameters. However, such a complex estimation procedure can be avoided using Stone's geometric price index of $\ln P_t$, approximated as (Deaton and Muellbauer 1980)

$$\ln P_t \cong \ln P_t^* = \sum_i w_{it} \ln p_{it} \qquad (3)$$

Substituting the approximated $\ln P_{ht}$ into the share equation enables a linear approximation of the AID demand model equations. Another empirical advantage of the AID model is that the log-transformed values of the continuous variables tend to be more homothetic and therefore smooth out any erratic variations (Newton 1988).

Data and model specification

The population of Samoa resides in urban and rural village households. A cluster of villages surrounds the capital, Apia. The villages in this cluster are classified as urban in this study, while all the other villages scattered over the islands are identified as rural. Although the spatial difference between the two groups may not be large, the degree of remoteness makes them distinguishable in terms of the availability of consumables and their prices. These factors may contribute to the differences in food consumption between urban and rural dwellers (Ward and Hau'ofa 1980). This study provides an analysis of both urban and rural consumers (households).

A household food expenditure survey was conducted in three Samoan villages over three six-month periods beginning in June 1991, June 1995 and June 1999, respectively. The June–December survey periods were selected to avoid erratic changes in the quantity of consumption and prices during the first part of the year caused by cyclones in late December and January. Two of the villages selected for the study were from Upolu Island—Momoa village near Apia and Poutasi village in the Falealili district. Satupaitaea on Savaii Island was the third village surveyed. The villages all had enumerators with previous experience in conducting survey interviews.

A sample of 30 households was randomly selected in each village, which represented nearly half of all households. Using a structured questionnaire, price and quantity data of various food commodities consumed by the households were collected. The households were semi-subsistence farms, so that food consumption partly consisted of non-monetary consumables. In valuing these consumables, the respective market prices were assumed to be reasonable proxies. Treating the market as complete, especially for self-produced food commodities, is likely to cause correlated errors between expenditure shares and expenditure variables (Sadoulet and de Janvry 1995). Hence, it is important to make the necessary estimation corrections.

Aggregation of individual variables into groups was necessary to improve manageability of the data. For the purpose of this study, household expenditure on food commodities was broadly categorised (aggregated) into seven groups: energy foods, dairy products, protein foods, vegetables, fruits, beverages and miscellaneous foodstuffs. Aggregate price and quantity values for each food group were constructed using a weighted geometric mean procedure. Income data in 1995 and 1999 were adjusted for inflation, treating 1991 as the base year. Income levels were found to be almost consistent across income groups and over time.

Given the nature of the data, it is interesting to assess the structural impacts of location and time differences as exogenous factors affecting demand. These variables are introduced as location effects and year effects and treated as shift variables as they are point indicators across the total observations.

The AID model used for this analysis is a system of demand equations because it contains price and food expenditure shares for six food groups as endogenous variables and two exogenous variables. The exogenous variables are shift variables introduced into the model using binary (0,1) dummy variables. Each shift variable is represented with two dummy variables,

$$\begin{aligned} w_{it} = {} & \alpha_i + \sum_l \eta_{il} D_l + \sum_k \eta_{ik} D_k \\ & + \sum_j \left(\beta_{ij} + \sum_l \theta_{ijl} D_l \sum_k \theta_{ijk} D_k \right) \ln p_{jt} \\ & + \left(\gamma_i + \sum_l \delta_{il} D_l + \sum_k \delta_{ik} D_k \right) \ln\left({y_t}/{P_t} \right) + e_{it} \end{aligned} \quad (4)$$

where location effect, l =1,2 and year effect, k =1,2 are introduced as dummy variables (D_l and D_k), and e_{it} is the error term.

The respective own price elasticity (*Eii*), cross price elasticity (*Eij*) and expenditure elasticity (*Eyi*) equations are

$$\begin{aligned} E_{ii} = {} & \frac{1}{w_i}\left(\beta_{ii} + \sum_l \theta_{ijl} D_l + \sum_k \theta_{jik} D_k \right) \\ & - \left\{ \left(\gamma_i + \sum_l \delta_{il} D_l + \sum_k \delta_{ik} D_k \right) + 1 \right\} \\ E_{ij} = {} & \frac{1}{w_i}\left(\beta_{ij} + \sum_l \theta_{ijl} D_l + \sum_k \theta_{jik} D_k \right) \\ & - \frac{w_j}{w_i}\left(\gamma_i + \sum_l \delta_{il} D_l + \sum_k \delta_{ik} D_k \right) \\ E_{iy} = {} & 1 + \frac{1}{w_i}\left(\gamma_i + \sum_l \delta_{il} D_l + \sum_k \delta_{ik} D_k \right) \end{aligned} \quad (5)$$

Restrictions

The theory of utility maximisation subject to a budget (total expenditure) constraint imposes certain general properties (regularity conditions) on the derived demand system. Hence, it is important to verify whether these properties are embodied and supported by the data. These properties are adding up, homogeneity and symmetry, taking the form of mathematical restrictions on the derivatives of the demand equations. These restrictions are discussed with reference to the empirical demand system.

Adding up. The sum of expenditures on different food groups should equal the total expenditure on food in any time period and for any household. Hence, the parameter restrictions in the model are

$$\sum_i \alpha_i = 1, \sum_i \beta_{ij} = \sum_i \gamma_i = 0 \quad \text{and}$$

$$\sum_i \eta_{il} = \sum_i \eta_{ik} = \sum_i \theta_{ijl} = \sum_i \theta_{ijk} = \sum_i \delta_{il} = \sum_i \delta_{ik} = 0 \quad (6)$$

Homogeneity. Homogeneity implies that every demand equation must be homogeneous of degree zero in income and prices. If all food group prices and income (total expenditure on food) changes by the same percentage the quantity demanded should remain unchanged. Hence, the parameter restrictions in the model are

$$\sum_i \beta_{ij} = 0 \quad \text{and} \quad \sum_l \theta_{il} = \sum_k \theta_{ik} = 0 \quad (7)$$

for $\forall$ *i.*

Symmetry. Symmetry implies that demands should be symmetric to hold utility at a constant level. An increase in the price of one food group should lead to a decrease in the quantity demanded of that food group and an increase in the demand for a substitutable good, and vice versa. Hence, the parameter restrictions in the model are

$$\beta_{ij} = \beta_{ji} \quad (8)$$

for $\forall$ *i* and *j*.

Estimation procedure

Since none of the endogenous variables of the demand system are found on the right hand side of the share equations, the system seems to contain unrelated equations. Hence, a seemingly unrelated regression estimation procedure can be applied (Kementa 1986). Error terms across the equations are correlated for two reasons. First, the sum of the budget shares is one in order to satisfy the budget constraint. Second, the producer and consumer prices are assumed to be equal for self-produced food items. Existence of such correlation leads to singularity in the VAR–COV matrix of the estimated error terms and thereby restrains the generalised least square (GLS) estimation at the second stage. The problem can be overcome by deletion of one of the equations in the system. The parameters of the deleted equation can be obtained using the estimated parameters and the theoretical restriction equations. In this study the demand system covers energy foods, dairy products, protein foods, vegetables, fruits and beverages share equations. As Barten (1969) has suggested, the ITSUR estimation procedure was adopted to obtain consistent estimates that are invariant to the equation deleted.

Deletion of an equation automatically meets the adding-up restriction, and therefore, only imposition of homogeneity and symmetry restrictions is required in the estimation. Pooled data generally suffers from non-spherical disturbances (that is, autocorrelation and heteroskedasticity) and thus the variances of the parameter estimates tend to be biased upward. Hence, using GLS ensures efficiency in the parameter estimates (Greene 1997).

Results and discussion

Consumption patterns

Table 1 reports the distribution of sample households across different income groups and expenditure shares. About 50 per cent of households in Momoa village earned a monthly income of less than SAT$600, whereas in the other two villages nearly 83 per cent of the households reported a monthly income of less than SAT$600. This suggests that in analysing household consumption patterns and deriving demand estimates for food commodities, attention should be given to low-income groups, especially those in rural villages.

Even in a small economy such as Samoa, household expenditure on food is mainly influenced by factors such as availability, price, household income and household size. Indeed, food expenditure (as a share of total household expenditure) rises as income declines (Table 1). This trend is more conspicuous in urban villages than in rural ones, perhaps because more non-food products or services are available in urban areas. Urban village households spend 50 per cent of their total expenditure on food whereas rural village households spend approximately 5 per cent more.

More than 70 per cent of food expenditure is for energy foods, protein foods and beverages, in this order (Table 2). Expenditure on energy foods and protein foods is higher in rural households than in urban households, while beverage expenditure is higher in urban households. Among the other food groups, expenditure on milk and milk products was marginally higher in urban than in rural households, whereas rural households spent relatively more on vegetables and fruits.

Although the shares of various food groups differed among the selected villages, household expenditure on food displays common characteristics. Total expenditure

Table 1 **Distribution of village households among different income groups and food expenditure shares (average of the three time periods)**

Income groups (monthly in tala)	Village	Households (number)	Total households (per cent)	Average expenditure share (per cent)
>650	A	5	16.7	42.0
	B	-	-	-
	C	2	6.7	50.8
650–600	A	8	26.7	46.0
	B	4	13.3	51.2
	C	4	13.3	51.5
600–550	A	10	33.3	52.0
	B	8	26.7	54.6
	C	10	33.3	54.5
550–500	A	5	16.7	53.2
	B	10	33.3	56.5
	C	10	33.3	56.6
<500	A	2	6.7	58.3
	B	8	26.7	58.0
	C	4	13.3	59.0

Note: Village A is the urban village of Momoa. Villages B and C are rural villages of Poutasi and Satupaitea, respectively.
Source: Survey results.

shares of energy foods, beverages and miscellaneous food items fall as income rises in all villages, which suggests that these food items are essential foodstuffs normally consumed at a minimum desired level. In contrast, total expenditure shares of vegetables and fruits increase as income rises in all villages, which suggests that these items are superior food items.

In the case of milk and dairy products, the expenditure shares first tend to rise and then decline. This pattern implies that these items are less preferred when suitable substitutes are available at affordable prices. Protein foods appear to be essential items for urban households and superior items for rural households. However, the increase in protein foods in urban households as income rises is marginal.

Elasticity estimates

Equation 4 was estimated for the set of identified food groups after imposing theoretical restrictions from Equations 6 to 8. Estimates of coefficients of intercept shift, price and expenditure are reported in Tables 3, 4 and 5.

Intercept shift coefficients explain the likely shifts in the mean level of expenditure shares for each food group contributed by location and time variations. The shift in the mean expenditure shares of milk, protein and vegetables are significantly less in rural households than in urban ones. Except for milk, the estimated intercept shift coefficients of time for other food groups are significant. In general, these coefficients together suggest that the mean expenditure shares on all food groups have grown over time.

Table 2 **Average expenditure shares of food groups across income levels** (tala)

Food group	Village A (urban)					
	Overall	> 650	600–650	550–600	500–550	<500
Energy	16.3	13.9	14.0	16.2	17.3	20.0
Milk and dairy products	3.7	2.5	3.8	4.4	4.1	3.9
Protein	9.1	9.0	9.1	9.2	9.2	9.2
Vegetables	2.8	3.3	3.0	2.8	2.3	2.1
Fruits	3.0	3.2	3.1	3.0	3.0	2.9
Beverages	9.8	7.1	8.3	10.5	10.9	12.0
Miscellaneous	5.6	3.0	4.8	6.0	6.4	7.2
Total	50.3	42.0	46.0	52.0	53.2	58.3
Food group	**Village B (rural)**					
	Overall	>650	600–650	550–600	500–550	<500
Energy	19.8	-	16.5	18.4	21.2	23.2
Milk and dairy products	3.4	-	3.1	3.6	3.6	3.4
Protein	11.6	-	12.3	11.8	11.4	10.9
Vegetables	3.6	-	4.2	3.8	3.4	3.2
Fruits	3.5	-	3.8	3.6	3.4	3.2
Beverages	6.2	-	6.0	6.1	6.1	6.5
Miscellaneous	7.0	-	5.5	7.3	7.4	7.6
Total	55.1	-	51.4	54.6	56.5	58.0
Food group	**Village C (rural)**					
	Overall	>650	600–650	550–600	500–550	<500
Energy	20.2	16.5	17.7	20.4	22.3	24.0
Milk and dairy products	3.0	2.9	3.0	3.1	3.0	2.9
Protein	12.4	13.3	12.6	12.4	12.1	12.1
Vegetables	4.2	4.9	4.5	4.2	3.7	3.5
Fruits	4.1	4.0	4.1	4.2	4.2	4.2
Beverages	6.2	5.8	6.0	6.2	6.2	6.6
Miscellaneous	4.4	3.4	3.6	4.0	5.1	5.7
Total	54.5	50.8	51.5	54.5	56.6	59.0

Source: Authors' calculations.

The expenditure coefficients of all food groups are at least significant at the 10 per cent level. The location effect on expenditure is more dominant than the year effect. The effects of the location intercept term on the average expenditure shares are positive but not significant. Year effects are positive and significant at the 10 per cent level. Except for beverages, the own price coefficients of other food groups are significant at least at the 5 per cent level. The majority of the corresponding location effect coefficients are found to be significant at least at the 10 per cent level. In general, the year effect coefficients with respect to own price are not significant. Cross price coefficients are also not significant

Table 3 **Estimates of intercept shift coefficients**

	η_{il}		η_{ik}	
	l =1	*l* =2	*k* =1	*k* =2
Energy	0.01642	–0.02623	0.21652**	0.24382**
Milk	–0.04652*	–0.06345*	0.00021	0.00011
Protein	–0.00921*	–0.01022*	0.02141*	0.02244*
Vegetable	–0.17645**	–0.18492**	0.02672*	0.03182*
Fruits	0.00226	0.00248	0.00034*	0.00006*
Beverages	–0.01124	0.00893	0.00022*	0.00104*

** significant at 5 per cent level, * significant at 10 per cent level.
Notes: Manoa: base location (*l*=0), June 1991: base year (*k*=0), *l*=1: Pontasi and *l*=2: Satupaitea, *k*=1: June 1995 and *k*=2: June 1999.
Source: Authors' calculations.

Table 4 **Estimate of expenditure coefficients**

	γ_I	δ_{il}		δ_{ik}	
		l =1	*l* =2	*k* =1	*k* =2
Energy	–0.294111***	0.044236*	0.035536*	0.000737	0.001894
Milk	–0.012065**	–0.016186*	–0.016697*	0.000088**	0.000070
Protein	0.054725***	–0.015828**	–0.040242**	0.000869	0.000703
Vegetable	–0.014412**	–0.017497**	–0.014981**	0.000146	0.000119*
Fruits	–0.024090*	–0.009010*	–0.010804*	0.000086	0.000073*
Beverages	–0.032896**	–0.020348	–0.018197	0.000486	0.000305

*** significant at 1 per cent level, ** significant at 5 per cent level, * significant at 10 per cent level.
Source: Authors' calculations.

Table 5 **Estimate of price coefficients**

			p_{En}	p_{Mk}	p_P	p_V	p_F	p_B
Energy (En)	β_{ij}		0.18792***	–0.01750*	–0.05994*	–0.00821	–0.01102	–0.03826
	θ_{jl}	l = 1	0.03327**	–0.00937	–0.04679	–0.00121	–0.00732	–0.03128
		l = 2	0.03397*	–0.01750	–0.05146	–0.00505	–0.00814	–0.02747
	θ_{jk}	k = 1	0.00489	–0.01858	–0.05432	–0.00392	–0.00634	–0.03655
		k = 2	0.00347	–0.01296	–0.04653	–0.00058	–0.00697	–0.03368
Milk (Mk)	β_{ij}			0.03075***	–0.00034	–0.00034	0.00024	–0.00162
	θ_{jl}	l = 1		–0.01116*	–0.00355	–0.00123	–0.00069	–0.00378
		l = 2		–0.01612*	–0.00281	–0.00081	–0.00065	–0.00377
	θ_{jk}	k = 1		0.000391	–0.00027	–0.000003	0.00027	–0.00138
		k = 2		0.00001*	–0.00025	–0.00030	0.00028	–0.00159
Protein (P)	β_{ij}				0.16193***	0.00592	0.00387	0.00869
	θ_{jl}	l = 1			–0.03023**	0.00719	0.00311	0.00674
		l = 2			–0.03818**	0.00396	0.00170	0.00356
	θ_{jk}	k = 1			0.00064	0.00627	0.00469	0.00914
		k = 2			0.02508	0.00628	0.00398	0.00898
Vegetable (V)	β_{ij}					0.01605**	–0.00093	–0.00189
	θ_{jl}	l = 1				0.00687**	–0.00209	–0.00422
		l = 2				0.00882*	–0.00189	–0.00396
	θ_{jk}	k = 1				0.00446	–0.00085	–0.00182
		k = 2				0.00280	–0.00090	–0.00179
Fruits (F)	β_{ij}						0.00951**	–0.00319
	θ_{jl}	l = 1					0.022137*	–0.004329
		l = 2					0.026533*	–0.004605
	θ_{jk}	k = 1					0.001548	–0.003140
		k = 2					0.002739	–0.003155
Beverage (B)	β_{ij}							0.09758*
	θ_{jl}	l = 1						–0.02757*
		l = 2						–0.03795*
	θ_{jk}	k = 1						0.00859
		k = 2						0.00079

*** significant at 1 per cent level, ** significant at 5 per cent level, * significant at 10 per cent level.
Source: Authors' calculations.

except for the prices of milk and protein against energy foods.

R-squares of all estimated regressions range from 78 to 81 per cent and the F-ratios are reasonably high. Results of model validation and coefficient significance statistics suggest that the model has significant explanatory power and that price (own) and per capita expenditure are reasonably good determinants of food consumption.

Expenditure and price elasticities are derived from the significant (estimated) coefficients of the regression models and Equation 5. (Elasticities are particularly useful measures because they are independent of the unit of measurement of the variables, thus allowing comparisons across studies.)

Tables 6 and 7 provide expenditure and own and cross price elasticities for the seven food groups for rural and urban areas, respectively.

Expenditure elasticities. Expenditure elasticities demonstrate the change in quantity consumed to a change in disposable household income. Given the location and time effects, the overall expenditure elasticities for food are less than unity, which is consistent with the corollary of Engel's law of consumption behaviour (Table 6). The corollary of Engel's law states that the proportion of personal expenditure devoted to necessities declines as disposable income rises (Phillips 1974).

Except for energy foods, the expenditure elasticities are found to be higher in urban households. This suggests that with economic growth, urban areas would provide a potentially strong market for local produce. Low expenditure elasticities for energy foods and miscellaneous food items reflect the fact that these are necessities and people spend on these food groups irrespective of their income levels. High elasticities for protein foods imply that consumption on these products will increase significantly as incomes rise.

In urban villages, the expenditure elasticities for dairy products, vegetables and beverages are higher than in rural areas, indicating that urban consumers are more likely to diversify their consumption patterns as income levels improve. As Musgrave (1988) explained, this could be due to a 'demonstration effect' that influences the tastes of consumers. The factors underlying the demonstration effect are personal experiences, advertisements or displays and the desire to keep up with others. The demonstration effect is expected to be greater among urban people in Samoa because the variety of food products on display is greater in urban areas, and also because of the frequent interaction with expatriates' living styles and dietary habits.

Expenditure elasticity values for dairy products in rural villages are less than half those in urban villages. In rural areas dairy products are considered an expensive energy and protein supplement and consumers therefore tend to use substitutes. The moderate expenditure elasticity for fruits found in the urban area may also be the result of a demonstration effect. An incremental time effect on the expenditure elasticities for milk, vegetables and fruits further confirms

Table 6 **Expenditure elasticities for food groups**

	γ_i	δ_{il}		δ_{ik}	
		l =1	l =2	k =1	k =2
Energy	0.1616	0.1261	0.0913		
Milk	0.8091	–0.2561	–0.3242	0.0014	
Protein	1.2645	–0.0765	–0.1945		
Vegetable	0.7823	–0.2643	–0.2263		0.0018
Fruits	0.6361	–0.1361	–0.1632		0.0011
Beverages	0.7630				

Notes: Only elasticities corresponding to significant regression coefficients are reported.
Source: Authors' calculations.

Table 7 **Own and cross-price elasticities of food groups**

			p_{En}	p_{Mk}	p_{P}	p_{V}	p_{F}	p_{B}
Energy (En)	β_{ij}		–0.1702	0.0031	0.0026			
	θ_{jl}	l =1	0.0506					
		l =2	0.0613					
	θ_{jk}	k = 1						
		k = 2						
Milk (Mk)	β_{ij}			–0.5014				
	θ_{jl}	l =1		–0.1604				
		l =2		–0.2383				
	θ_{jk}	k = 1						
		k = 2		0.0001				
Protein (P)	β_{ij}				–0.2721			
	θ_{jl}	l =1			–0.1303			
		l =2			–0.1443			
	θ_{jk}	k = 1						
		k = 2						
Vegetable (V)	β_{ij}					–0.7431		
	θ_{jl}	l =1				0.1213		
		l =2				0.1482		
	θ_{jk}	k = 1						
		k = 2						
Fruits (F)	β_{ij}						–0.8323	
	θ_{jl}	l =1					0.3434	
		l =2					0.4116	
	θ_{jk}	k = 1						
		k = 2						
Beverage (B)	β_{ij}							–0.2641
	θ_{jl}	l =1						–0.1783
		l =2						–0.2552
	θ_{jk}	k = 1						
		k = 2						

Source: Authors' calculations.

the presence of demonstration effects in dietary improvement.

Price elasticities. Own-price elasticity is the change in quantity consumed that results from a change in price. Given the location and time effects, the own-price elasticities for all food commodities are negative and, in absolute terms, are moderate (Table 7). The inference to be drawn from these estimates is that food consumption in Samoa is quite responsive to price changes. Except for protein foods and beverages, estimates of urban elasticities are higher than rural estimates. The absolute values of all these estimates are less than one, which indicates that all food groups are essential to both urban and rural consumers.

Energy and protein foods are clearly the most essential food groups with elasticity estimates approaching zero (that is, very inelastic). The price elasticities for energy foods in the rural areas are not significant, which suggests that rural consumers are most unlikely to alter the level of energy food consumption in response to price variations. Similarly, urban consumers' beverage consumption does not change with a change in beverage prices.

Price elasticities for vegetables and fruits are relatively high in urban areas and more moderate in rural areas. These figures suggest that the potential market demand for these products is strong. Differences in the demand elasticity between urban and rural villages may reflect the growing concern among urban consumers for a more balanced diet, and the effectiveness of the recently introduced nutrition awareness programs. A significant substitution effect only seems to exist among energy, protein and milk foods. However, the own price elasticity estimates for dairy products in rural areas are relatively higher because these commodities are regarded as expensive sources of energy and protein that may be readily substituted by locally grown energy foods and seafoods. Although such a substitution provides some flexibility in adult intake, it does not guarantee sufficient nutrition to infants and children.

Implications for food policy

It is important to note that estimated expenditure patterns and responses of households are micro-level (partial) information. Generalisation of the results for the purpose of developing a national food policy implies that the relevant macro-economic relationships can be obtained by multiplying the corresponding micro-economic relationships by the total number of households (or villages) in Samoa.

The results of this study show that the main parameters influencing aggregate food consumption are price and per capita expenditure (equivalently, disposable income). Hence, variation in both price and income can be used as policy instruments to bring about required changes in food consumption and production. The magnitude of the elasticity estimates suggest that income would be effective in both rural and urban areas, and that price policy measures would be most effective on urban households.

A very price-inelastic demand for protein and energy foods combined with an expenditure (income) inelastic demand for energy food and a high income substitution effect for protein foods suggest that demand for these food products will remain strong as the Samoan economy grows. Hence, production of energy foods and protein foods must be maintained and stimulated, respectively. Energy foods are a major component in animal feed and this is being imported in large quantities. Food policymakers, recognising the existence of this derived demand, could encourage production of energy foods for use as feed ingredients to strengthen the balance of payments, and discourage human consumption of energy foods to correct nutritional imbalances.

Attempts to promote animal production to meet protein demand requires careful planning because animal (ruminant) production is a land-extensive activity, especially rearing animals for meat (Food and Agricultural Organization 1996). Fortunately, Samoa has greater access to high-quality protein from sea resources to satisfy adult needs and sufficient input capacity to produce non-ruminants such as poultry and pigs. Hence, animal production should be geared to meet the protein requirements of infants and children in the form of milk production. Utilising the complementarities between crops and animal production has provided ecological and economic farming systems in many countries where the need for food is increasing but the technology and resources are limited (Centre for Agricultural Science andTechnology 1999). Hence, price and production policies must be designed to improve mixed crop-animal (dairy, poultry and pig) production and ensure adequate sustainable-harvest seafoods.

The results also suggest that particular attention needs to be paid to increasing the domestic production of vegetables and fruits. Indeed, both the price and expenditure elasticities are reasonably high, implying that demand for vegetables and fruits are likely to grow relatively faster than for other food items. In addition, these two food groups have substantial amounts of minerals, vitamins and fibres that could help mitigate the nutritional deficiencies in the protein-energy rich diets.

The price elasticity estimates for urban villages suggest that lower consumer prices for fruits and vegetables would result in a significant increase in fruit and vegetable demand in urban areas. The disposable income among rural households may be expected to grow along with the economy, especially when efforts are made to improve agriculture and other rural industries. Improved income levels in turn can allow rural people to diversify their diets and meet nutritional needs. Influencing taste with nutritional awareness programs, combined with improved marketing systems and techniques, can further induce the diversification process.

Concluding remarks

Improving domestic agricultural production to meet expected demand for food and address nutrition problems is a critical issue in many developing economies. This is particularly true in Samoa, where the economy is burdened with heavy food imports and declining workforce health status. It is generally agreed that in a free market environment appropriate food policies are required to initiate changes in food production. Information on consumers' food expenditure dynamics and food price responses provides the basis for food policy design. This study has attempted to provide this information from a household consumption analysis conducted in urban and rural villages between June 1991 and December 1999.

Despite the lack of many cross-price elasticity estimates, this study has provided some insights into urban and rural food consumption behaviour in Samoa. The demonstration effect is a sign of the preparedness of Samoan households to engage in dietary improvement.

The study could be extended by estimating demand systems for specific food items within each of the seven food groups. Samoa has a poor agricultural resource base, and, therefore, importation of food commodities will continue to be a significant activity. A study of consumption of imported and locally-produced food commodities, along with nutritional valuations of food commodities will also be valuable to policymakers. In the meantime, the aggregate price and elasticity estimates provided here should prove useful to food policymakers in Samoa and in other developing economies with a similar resource base.

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