URBAN DEMAND FOR FOOD, BEVERAGES, BETELNUT AND TOBACCO IN PAPUA NEW GUINEA

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ABSTRACT

Data from household surveys conducted between 1985 and 1990 were used in a regression model to estimate the impact that changes in household incomes have on the demand for each of 36 major foods, beverages, betelnut and tobacco within urban areas of Papua New Guinea. Locally produced crops that should be in high demand in future, if urban incomes rise, include betelnut, fresh vegetables, sweet potato, and fresh fruits. All else the same, the higher value of future demand for these crops may justify extra research spending, as opposed to spending on crops whose demand will not respond strongly to rising urban incomes.

***Keywords**: Demand, income elasticity, Papua New Guinea, research priorities, urban consumers.*

INTRODUCTION

In recent years Papua New Guinea (PNG) agriculturalists have begun to pay more attention to market opportunities for supplying food to the local market. This switch in attention has been caused both by low world prices for the traditional export crops and local market growth, especially within urban areas. Although precise data on the value of local food production for the urban market are unavailable, informed estimates suggest that this industry rivals the main tree crop industries as an income source for rural producers (Shaw 1985).

For agricultural planners to allocate scarce research and extension funds amongst the many foods that can be grown for the urban market, information about the demand prospects for those foods is required. In particular, it would be helpful to identify the crops that will be in high local demand in the future, so that farmers can be encouraged to produce these crops. Examining the demand patterns of urban households can help agricultural planners identify market opportunities by showing (i) which foods have large existing markets, and (ii) which foods will be most heavily demanded in future as urban incomes change.

There are several examples of demand analysis being used to inform agricultural research priorities in the international literature. For example, Sarma and Gandhi (1990) used demand analysis to forecast future consumption patterns of food grains in India, under alternative scenarios of economic growth and development. Pinstrup-Andersen *et al.* (1976) used data on demand patterns to see how reallocating the agricultural research budget would affect the nutritional status of the urban poor in Colombia. However, these types of analyses have not previously been possible in PNG because of the lack of information on consumer demand patterns for foods and agricultural crops.

Various concepts can be used to measure existing market demand. Two of these are:

1. The average share of the household budget spent on an item.
2. The proportion of households who consume the item.

Items with a large average share in household budgets will generate more revenue for producers because of the large expenditures that households make. However, the average budget share can be

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inflated when a minority of the population have an intense demand for an item, while the remaining households do not consume it at all. In this case, demand may be vulnerable to what happens to this small group of consumers. Foods consumed heavily by expatriate households would be a relevant example for PNG. Therefore, it is valuable to know what proportion of households consume a particular food, so that the stability of its demand can be assessed.

Two economic concepts for predicting future market demand under changing incomes are:

1. The income elasticity of demand.
2. The marginal budget share.

The income elasticity of demand measures the percentage by which the quantity demanded of an item increases following a one percent increase in household income. When the demand increases by more than one percent, an item is known as a "luxury good", and when the demand increases by between zero and one percent, it is a "normal good", and when the demand goes down as incomes rise, it is an "inferior good" (Sadoulet and de Janvry 1995). The marginal budget share measures how a household allocates any additions to its budget, in contrast to the existing division of the budget. For example, if a household's income rose by K100 per year, the marginal budget share for a particular food shows how many Kina or toea from that K100 would be spent on the food. Hence, the marginal budget share is a good measure of the value of future demand.

The paper provides estimates for PNG urban areas of these four different measures of market demand for 36 major foods, beverages, betelnut and tobacco. The implications of these demand estimates for agricultural research priorities are then discussed.

METHODS AND DATA SOURCES

There are two important requirements for the functional forms that are used to estimate income elasticities of food demand. They should be 'flexible', by allowing income elasticities to differ between rich and poor households, because the usual pattern is for income elasticities of food demand to fall as income rises (Timmer *et al.* 1983). The functional form also should be able to be estimated even when a household has zero consumption of particular foods; otherwise those households have to be dropped from the sample, which can cause sample selection bias (Deaton 1989).

The "share-log" function form, where the budget share of the /th food (w_i) regressed on the logarithm of household income (x) meets these requirements. In addition to income, other variables affecting the budget share of particular foods need to be included in the model. These variables include the size of the household, its age, gender and ethnic composition, and dummy variable for the town the household is located in. This gives the following regression model:

$$w_i = \alpha_i + \beta_i \ln x + \Theta_{ij} z_j + U_i \quad (1)$$

where Z_j is the vector of control variables, α_i, β_i and Θ_{ij} are parameters to be estimated, and U_i is a random error term. The coefficient β_i gives the rate at which the budget share for the *i*th food changes as the logarithm of income changes, $\partial w_i / \partial \ln x$, and this can be transformed into the elasticity of the budget share with respect to income, $\partial w_i / \partial \ln x$ by dividing by w_i (because $\partial \ln w_i = \partial w_i / w_i$). The fact that the budget share is the product of price, p_i and quality, q_i divided by income, x (and hence $\ln w_i = \ln p_i + \ln q_i - \ln x$) allows the income elasticity of the quantity demanded of the *i*th food, ε_i to be derived from the formula:

$$\varepsilon_i = \frac{\beta_i}{w_i} + 1 \quad (2)$$

Because budget shares vary by household, the income elasticity calculated with equation (2) also varies. For example, the estimated rice demand of rich households can be less income elastic than the rice demand of poor households, because rice has a bigger budget share for poor household. This is consistent with the usually occurring empirical pattern (Timmer *et al.* 1983).

The marginal budget share was estimated by multiplying the income elasticity of demand for the food by the average share that food *i* has in household budgets. These marginal budget shares must obey the "adding-up" condition that they sum to one. In other words, the value of all extra demands, following a rise in income, must exactly equal the value of the extra income (Deaton and Muellbauer 1980). This

condition provides a cross-check on the plausibility of the estimates.

Data

Household income and expenditure data were obtained from urban household surveys conducted by the National Statistical Office between 1985 and 1990[2]. These surveys were carried out in nine PNG urban areas: Port Moresby, Goroka, Wewak, Ambunti, Kieta, Arawa, Panguna, Lae, and Rabaul. In all, over 1400 households were surveyed, and complete data were available for 1095 households (Gibson 1995). This is the largest household expenditure survey ever carried in PNG.

The survey collected information on purchases, gifts, production, and sales of food within a two week period, as well as changes in household food stocks. From these components, the value of each household's consumption of 36 food items was estimated. Although the survey collected information on household wage and business income, the actual income variable used in this study is total household expenditure. Total expenditure is less affected by transitory components (e.g. extra overtime pay) and is more closely related to the concept of permanent income, which is what economists believe influences demand (Deaton and Muellbauer 1980). The total expenditure variable includes the value of consumption of all goods and services, including imputed rent. Households were surveyed at different points in time so the effects of inflation were accounted for by using a price index calculated for each town. Full details of the construction of variables and the quality control procedures that the data were subjected to are contained in Gibson (1995).

RESULTS AND DISCUSSION

The four different measures of market demand are reported in Table 1 for 36 foods, beverages, betelnut and tobacco. Measures for the aggregate non-food group (containing all other goods and services) are provided for comparison. The items with the largest average share of household budgets are rice, alcohol, tinned meat, tobacco products, tinned fish, poultry, bread and biscuits. These items make up over one quarter of the total budget for the average household.

The items that are consumed most commonly by households are rice, bread and biscuits, tinned fish, soft drinks, and fresh vegetables. At least 90 percent of households consumed these within the two week period. Hence it is likely that these items have very stable demand. In contrast, alcohol has a high average share of the budget but only 40 percent of the households consumed alcohol. The food item consumed by the smallest proportion of households was pork, with less than 10 percent of households consuming within the two week period. Pork is sometimes regarded as the national meat so this low consumption seems surprising but it may reflect the high price of pork in urban areas and the fact that pork is consumed during celebrations and ceremonial events rather than as an everyday meal.

The income elasticities for demand, and associated standard errors, are reported in the third and fourth column of Table 1. These were estimated using Ordinary Least Squares, with heteroscedastically consistent standard errors being calculated (White 1980). There were only three foods whose income elasticities were not statistically significant (cassava, dried and other fish, and other roots and tubers). The luxury goods, with income elasticities greater than one, were alcohol, eggs, English potatoes, poultry, beef and veal, and fresh fruit (except bananas). For example, if the income of an urban household rose by one percent, its demand for fresh fruit should rise by 1.04 percent (±0.096).

No inferior goods were identified but some important foods had income elasticities that were fairly low, e.g., tinned fish (0.15±0.055); rice (0.30±0.048); and sugar (0.33±0.076). Rising urban incomes will not lead to big percentage increases in the demand for these three basic foods. In contrast, most of the foods produced by rural households and sold in urban areas had income elasticities in the 0.50 to 0.75 range, thus sales of these items should benefit strongly from rising urban incomes.

The final column of Table 1 gives the marginal budget share for each item. This is the amount of extra spending on an item if the household had an extra K100 income available. The "adding-up" condition that the sum of extra expenditures exactly equals K100 holds, and confirms the plausibility of the results.

The marginal budget share gives the best overall

Table 1. **Demand characteristics for foods, beverages, betelnut and tobacco in urban areas of Papua New Guinea (ranked by marginal shares of total expenditure).**

	Average share of total expenditure %	Households who consume%	Income elasticity of demand*	Marginal share of total expenditure %
Alcohol	4.83	40.3	1.48±0.087	7.15
Poultry	2.89	61.5	1.23±0.060	3.54
Takeaways and Meals	2.74	81.8	0.93±0.078	2.55
Tinned Meat	3.11	84.6	0.78±0.048	2.42
Soft Drinks	2.72	90.9	0.87±0.050	2.37
Bread and Biscuits	2.78	93.5	0.75±0.044	2.09
Tobacco	3.09	70.6	0.61±0.052	1.87
Rice	5.62	96.2	0.30±0.048	1.67
Lamb and Mutton	1.66	48.0	0.84±0.082	1.40
Betelnut	2.32	75.1	0.57±0.055	1.32
Fresh/Frozen Fish	1.36	41.1	0.93±0.114	1.26
Fresh Vegetables	1.83	90.1	0.66±0.056	1.21
Other Dairy Fats & Oils	1.26	78.2	0.95±0.056	1.20
Sweet Potatoes	2.06	72.9	0.54±0.080	1.11
Processed Food n.e.s.	0.94	59.9	0.83±0.107	0.78
Bananas	1.29	70.7	0.56±0.083	0.72
Other Fresh Fruit	0.63	57.7	0.04±0.096	0.65
Sugar	1.78	89.1	0.33±0.076	0.60
Beef and Veal	0.50	20.0	1.18±0.144	0.58
Milk (all forms)	0.67	62.3	0.87±0.072	0.58
Coffee, Tea, Hot Beverages	0.85	67.1	0.64±0.070	0.55
Other Cereal Products	0.58	61.8	0.93±0.076	0.54
Spreads & Sugared Foods	0.48	66.4	0.97±0.062	0.47
Processed Meats n.e.s.	0.54	24.7	0.82±0.240	0.44
Tinned Fish	3.04	92.0	0.15±0.055	0.44
Flour	0.66	45.0	0.55±0.097	0.36
Taro	0.69	36.7	0.52±0.117	0.36
Pork	0.31	9.8	0.99±0.297	0.30
Coconuts	0.36	54.1	0.74±0.115	0.27
Eggs	0.15	14.1	1.39±0.140	0.21
Other Nuts and Seeds	0.29	51.8	0.63±0.153	0.18
Sago	0.32	13.9	0.50±0.217	0.16
English Potatoes	0.06	10.0	1.26±0.148	0.08
Cassava	0.20	17.4	0.22±0.285	0.04
Dried and Other Fish	0.19	13.4	0.20±0.224	0.04
Other Roots and Tubers	0.28	12.0	0.03±0.329	0.01
Non-Food	46.92	100.0	1.29±0.018	60.45

n e s = not elsewhere specific.

* Estimated from a regrssion model with 1095 observations and 1077 degrees of freedom. Standard errors are heteroscedastically consistent.

[2] I am grateful to the National Statistical Office for allowing access to these data.

estimate of the future value of a crop because it combines the income elasticity with a measure of the item's monetary importance. For example, English potatoes are a luxury food (e=1.26±0.148), which farmers should grow because their demand will rise with increases in urban incomes. However, English potato is such a minor budget item, a household with an extra K100 to spend would allocate only eight toea to extra purchases of this item. Even though sweet potato has a lower income elasticity, the same household would allocate K1.11 to extra sweet potato purchases. Hence, the research payoff would be greater, *ceteris paribus*, from sweet potato than from English potato.

The items in Table 1 are ranked by the value of their marginal budget share (the final column). The items that would gain the biggest share of increased spending by urban consumers include alcohol, poultry, takeaway meals, tinned meat, soft drinks, and bread and biscuits. Amongst the items produced by rural households and sold in urban markets, betelnut, fresh vegetables, and sweet potato would see the biggest increase in demand if urban household incomes increased.

The marginal budget share for alcohol is twice as large as for any other item and this may be a source of social concern, because of the problems that excessive alcohol consumption can create. Several of the control variables in the vector z_j of equation (1) were important influences on the demand for alcohol, especially the proportion of the household that was male and aged between 15 and 50 years, and whether the household head was from the Highlands. All else the same, the budget share for alcohol would be two percentage points higher in a household where men between the age of 15 and 50 comprised one-half of the dwellers, compared with a household where they were only one-fifth of the dwellers.

DISCUSSION

This ordering of food crops may be helpful in guiding research priorities, because it has been suggested that some crops have gained more research attention that others of greater economic importance (Shaw 1985). The publication of the elasticity and budget share estimates provides one economic criterion for ranking food crop research, although other factors, such as compatibility with existing farming systems and environmental suitability of the crop play a role as well.

One food crop that has received considerable research attention over many years in PNG is rice (Shaw 1985; Fereday 1993). The results in Table 1 show that the marginal budget share for rice is lower than the marginal budget share for foods that are produced from wheat, which is the other major cereal import. Hence, agricultural research that helps local farmers to increase their share of the inputs used in the production of bread and biscuits may give a higher payoff than research into the local production of rice. One example of research that might help local farmers increase their share of the inputs used in bread and biscuit manufacture is the question of blending sweet potato flour with wheat flour (Berrios 1992).

The results also help to disprove the hypothesis that imported cereals are seen by local households as superior foods to the traditional starchy staples (Kannapiran 1993). If this hypothesis were true, the income elasticity of demand for cereals would be greater than for the local root crops, implying that consumers switch to cereals as urban incomes rise. Although bread and biscuits have a greater income elasticity of demand (0.75±0.044) than the major root crops, this is not the case for rice (0.30±0.048), which is the cereal with the largest budget share. To further compare the income elasticities of cereals versus local starchy staples, foods were grouped into (i) cereals, (ii) meats and fish, (iii) fruits, vegetables and nuts, and (iv) root crops and the share-weighted income elasticities of demand for each group were calculated (Table 2).

Table 2. **Income elasticities of demand for major food groups***

Food group	Share-weighted income elasticity of demand
Cereals	0.48
Meats, poultry and fish	0.77
Fruits, vegetables and nuts	0.67
Root crops	0.49

* Derived from data in Table 1.

The income elasticity of demand for the cereals group is 0.48, indicating a ten percent increase in urban household income would cause cereals demand to rise by 4.8 percent. The income elasticity of demand for the root crops is slightly higher, at 0.49, so demand for the root crops benefits slightly more from rising urban incomes than does demand for the cereals. Other locally produced fruits, vegetables, and nuts also have demands that rise by more than those of cereals when urban incomes rise. Thus, rising urban incomes do not signal a dietary transition away from locally produced foods. Instead, the demand profile for food items associated with rising urban incomes indicates an important market opportunity for rural producers to supply food into the local urban market.

CONCLUSIONS

Income elasticities of demand and marginal budget shares were estimated for 36 food items in urban Papua New Guinea markets. The ranking of items according to income elasticities and marginal budget shares gives one economic criteria for the setting of research and extension priorities. Locally produced crops that should be in high demand in future, if urban incomes rise, include betelnut, fresh vegetables, sweet potato, and fresh fruits. All else the same, the higher future demand for these crops may justify increased research spending, as opposed to research spending on crops whose demand will not respond strongly to rising urban incomes. The results also suggest that urban demand for wheat products will eventually exceed demand for rice, if urban incomes rise, so research into the replacement of imported cereals with local crops may give a higher payoff if it is directed at finding substitutes for wheat flour.

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