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# Food consumption patterns and nutrition in urban Java households: the discriminatory power of some socioeconomic variables†

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Food consumption patterns are undergoing substantial change in many countries as economic development proceeds. The trend is a move away from traditional cereals towards higher-value and higher-protein foods. Explaining such changes only in terms of traditional economic variables can lead to biased estimates of income effects and perhaps biased projections of food demand. Household survey data from Indonesia are used to measure the importance of several socioeconomic variables in explaining differences in household food consumption patterns and nutrition. Household expenditure and the level of women's education are shown to be the most influential in this explanation.

## 1. Introduction

The transformation of diets as economic development proceeds, from a reliance on cereals to diets in which non-traditional and value-added products are more dominant, is now well documented (Blandford 1984; Garnaut and Ma 1992; Herrmann and Roder 1995; Mitchell and Ingco 1993; Rae 1997). Typically, consumption of traditional cereals and starchy rootcrops increases in the first phase, followed by a second phase in which consumption of non-traditional staple foods such as wheat-based products increases, cereals consumption reaches a peak and starchy roots consumption declines. In the third phase, consumption of cereals declines as consumption shifts towards higher-value and higher-protein foods such as animal-based products, other processed foods and fruits. Both Blandford

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and Herrmann and Roder demonstrated the tendency for national food consumption patterns in OECD countries to converge over time. Such transformations of food consumption patterns might also be observed in cross-section data, by comparing segments of the population which have reached different stages of development.

As economic development proceeds through time, average per capita incomes and expenditures exhibit a rising trend. But other changes occur through time as well, such as migration from rural to urban regions, changes in the country's and household's demographic structures, and improvements in education, transportation, communications and marketing infrastructure. Some or all of the latter, which may be referred to as structural variables (to distinguish them from income and price variables), could play a role in influencing dietary patterns, although economists have traditionally restricted their attention to the effects of price and income or expenditure variables. Thus omission of structural variables may lead to biased estimates of food demand coefficients and therefore biased projections of future food demands.

Recently there has been a heightened interest in the impact of structural variables on food consumption patterns, particularly because of the rapid growth and dietary transformations that have been taking place in parts of Asia. Huang and David (1993) concluded that urbanisation had significantly reduced demand for rice and coarse grains in several Asian countries, but had consistently increased the demand for wheat. Hence expenditure elasticities of demand when estimated from time-series models that omit changes in urbanisation tend to be biased downwards for traditional grains and biased upwards for wheat. This is because incomes and urbanisation tend to be positively correlated through time, and traditional income elasticity estimates measure both the income and urbanisation effects on demand but attribute them only to the income variable. Rae (1998) examined the effect of expenditure and urbanisation growth on the demand for animal-based products through time in a number of Asian countries, and found that urbanisation often had a significant positive effect on consumption of such products. Thus urbanisation elasticities were positive, and expenditure elasticities whose estimation took no account of urbanisation were usually biased upwards.

Huang and Bouis (1996), using 1991 Chinese cross-section data, estimated that moving a consumer from a rural to an urban area, but leaving expenditure and prices the same as experienced in the rural area, would produce an increase in consumption of meat and fish by between 5 and 9 kg per year. Huang and Bouis also examined cross-section data from Taiwan for 1981 and 1991, disaggregated by urban and rural areas and by occupation. They concluded that the demand for food was substantially influenced not only by growth in incomes and price changes, but also by differences in urban and rural lifestyles, the development of more advanced marketing systems, and occupational changes that were closely linked with increasing GNP per person. Comparing Taiwanese villages between 1981 and 1991, for example, they found that per person consumption of rice had fallen by 35.3 kg: income factors provided an increase in consumption of 31.4 kg but urbanisation had produced a downturn in consumption of 26.6 kg. Both income and urbanisation worked in a similar direction for meat: total per person consumption rose by 24.2 kg, with 18.2 kg contributed from income effects and 3.4 kg from the effect of urbanisation. These results are consistent with the view that income elasticities whose estimation had ignored such non-income effects would be biased downwards for rice and upwards for animal-based products.

The current article is motivated by two issues. The first is to determine which, if any, of a set of socioeconomic variables can be used to classify households at various stages of dietary transformation. For example, knowing some of the differentiating characteristics of households with protein-rich diets can be useful in segmenting the market, allowing marketers to better target their activities. The second motivation is to examine whether the changes in food consumption patterns that may be associated with economic development necessarily induce changes for the better in household nutrition.

The latter has been the subject of considerable debate in the literature. A decade or so ago, the World Bank's (1980) position, for example, was that the most efficient policies to overcome nutritional deficiencies in the developing world were to raise incomes (and food production). Supporting evidence had been provided by Knudson and Scandizzo (1979) with calorie income-elasticities for India in the range 0.33 to 0.85, and by Timmer and Alderman (1979) who reported Indonesian calorie elasticities of 0.26 and 0.47 for urban and rural households, respectively. The studies of Wolfe and Behrman (1983) and Behrman and Wolfe (1984) cast doubt on this position. Using household data from Nicaragua, they found that income effects on nutrition were quite small, and not as critical as was conventionally believed at the time. The wife's education level, on the other hand, was shown to have a significant and positive impact on consumption of several nutrients including protein and vitamin A. Educated women might be better informed on the nutritional content of food, the importance of good nutrition, the product options available, and could hold a stronger decision-making position in the household. Other characteristics of food, such as taste, variety and novelty, were said to influence consumption decisions as incomes increased, but this was not necessarily accompanied by increases in nutrient consumption. Behrman and Deolalikar (1987), Bouis (1990), Bouis and

Haddad (1992), and Ravallion (1990), using data from India, the Philippines and Indonesia, respectively, also concluded that increases in household income may not have much effect on nutritional status of the household. Estimated calorie income-elasticities were close to and/or insignificantly different from zero, and a conclusion was that the additional expenditure was incurred on characteristics of food other than nutritional content. Ravallion (1990) also concluded that calorie demand was positively related to the schooling of the head of the household (over at least the initial ranges of the schooling variable). Bouis (1994) discussed some of the reasons for these varying elasticity estimates, that included differences related to the country chosen, level of aggregation, variable definition, and type of data, model and estimation method. Subramanian and Deaton (1996) brought the argument full circle, by deriving from Indian household data calorie expenditure-elasticities that were described as closer to the conventionally accepted levels (and were within the range 0.3 to 0.5) rather than the near-zero values suggested in what they termed the 'revisionist' literature. Their model did not include demographic or educational variables, however. Dawson and Tiffin (1998) also derived a calorie income elasticity for India of similar magnitude (0.34) from time series data with income and food prices as the explanatory variables.

Several studies have examined aspects of food consumption in Indonesia, often using the Susenas national household survey data. The primary focus of many of these studies has been Indonesian food policy and the influence of changing prices and incomes or expenditures on food consumption and the nutritional status of households. Many studies presented price and income/expenditure elasticities, but only some included or reported the impacts of variables that accounted for demographic or other characteristics of households. Timmer and Alderman (1979) fitted log-linear equations to explain consumption of rice and cassava, and total calories from staple crops, using the 1976 Susenas survey. Explanatory variables were expenditure, prices and a regional dummy. Household characteristics such as size, age/sex distribution or education status were not included. Price and expenditure elasticities were derived for urban and rural households, and for various income classes. Dixon (1982) also used the 1976 Susenas data to fit log-linear functions that explained staple food (rice, fresh cassava, gaplek and corn) demands with expenditure, prices and regional dummies as explanatory variables. No household characteristics were considered. Chernichovsky and Meesook (1982) employed the 1978 Susenas to fit log-linear functions for 13 food groups. In addition to expenditure and price variables, this study also included such household characteristics as size, education of the spouse and sources of income as explanatory variables. They found that increasing household size was associated with decreased consumption of animal products and fruits, and that increased education status of the spouse was associated with increased consumption of the more expensive foods.

Teklu and Johnson (1988) estimated two alternative systems of demand functions using data for urban households from the 1980 Susenas survey. Seven food groups were studied with expenditure, prices and household size as explanatory variables. Increased household size was found to lead to a reallocation of expenditure from luxury foods to staples. Tabor, Altemeier and Adinugroho (1989) used time series data for the 1969–75 period to estimate a system of demand equations for eight food crops. Expenditure and prices were the explanatory variables, and consumption data was obtained from national food balance sheets. Social accounting matrices for 1975 and 1980 were used by Sutomo (1989) to examine links between household income and food consumption. This study included consumption of food away from home and concluded that average energy and protein intake levels were above the minimum requirements in both years. However, there existed some household groups (defined by income level and occupation) which consumed less, including households that were above the poverty line. Both van de Walle (1988) and Deaton (1990) used 1981 Susenas survey data. The former estimated a log-log function to explain rice consumption with expenditure, prices, household size and an urban/rural dummy as explanatory variables. Deaton applied his method for teasing out quality and quantity effects in studying demand for 11 food groups. A number of household characteristics were included as explanatory variables, these being size, 13 age/sex categories and nine education dummies. Price and expenditure elasticities were presented, but results for the household characteristics were not discussed. Elfindri and Dasvarma (1996) studied child malnutrition in Indonesia, using Susenas data for 1986, 1987 and 1989. It was shown that reduction in malnutrition was strongly associated with a decline in the incidence of poverty — a 10 per cent reduction in the population proportion under the poverty line was accompanied by a fall of 4–6 per cent in the number of children suffering from protein-energy malnutrition.

## 2. Methodology

Almost all of the studies referenced above used regression analyses of one type or another to estimate demand or Engel's functions. A similar approach could have been taken here, for example, estimation of a system of equations where the dependent variables were quantities or shares of the various food aggregates. This would have allowed estimation of various elasticities with respect to economic and household characteristic variables, and would have identified those foods with higher (lower) values of the various elasticities.

But that was not the primary objective of the current study, in which the focus is on consumption *patterns*, their identification and the discovery of variables that help explain differences in these patterns.

Therefore a methodology was required that allowed the relationship to be estimated between a multidimensional dependent variable (the household dietary pattern) and a multidimensional independent variable (the explanatory variables). While multiple regression analysis can be used to estimate the relationship between a single dependent variable and a set of independent variables, the question posed here is: 'are there significant socioeconomic differences among households with different dietary *patterns*?' Logistic regression analysis could be used if households were separated into just two groups according to their dietary patterns — for more than two groups, discriminant analysis can be applied.

Discriminant analysis is appropriate when the dependent variable is categorical (i.e. group membership) and independent variables are metric. It has widespread application, for example, in market segmentation research, where an objective is to use a set of independent variables to explain or predict the group membership of objects. In this application a set of explanatory (socioeconomic) variables was used to understand differences between the households, grouped according to their dietary patterns.

A discriminant function[1] may be written:

$$Z_i = \sum_j w_j x_{ij}$$

where:

- $Z_i$ is the score of household $i$;
- $w_j$ is the weighting given to socioeconomic variable $j$; and
- $x_{ij}$ is the value of the $j$th socioeconomic variable for the $i$th household.

The discriminant analysis procedure estimates the weights $w_j$ so as to maximise the variability in the $Z_i$ values between the household groups relative to their variability within the groups (Hair *et al.* 1992). When the sign is ignored, each weight represents the relative contribution of its associated variable to the discriminant score. The sign of the weight indicates whether the variable makes a positive or negative contribution. The simple linear correlations between the independent variables and the discriminant function are known as discriminant loadings. These reflect the variance that the independent variables share with the discriminant function, and can be

[1] The maximum number of discriminant functions is equal to one less than the number of groups.

interpreted to indicate the relative importance of those variables in explaining differences among the groups.

Before discriminant analysis could be applied, households had to be grouped according to the similarity of their diets. Cluster analysis was used for this purpose, by separating households into groups such that households in the same cluster were more like each other than they were like households in other clusters with respect to the predetermined selection criterion. The resulting clusters of households should ideally exhibit high within-cluster homogeneity and high between-cluster heterogeneity with respect to the selection criterion. The selection criterion used was the household's dietary pattern, measured by the shares of various food groups in the household's total caloric intake level.[2] Thus households would be grouped according to the similarity or otherwise of their dietary patterns.

Finally, an econometric model was estimated to derive nutrient elasticities with respect to some of the more important socioeconomic variables to shed further light on the analysis.

## 3. Data

The data source was the 1990 National Socio-economic Survey (Susenas), conducted by the Indonesian Central Bureau of Statistics. While the survey contained data from 49 000 households located in 27 provinces, data for the present study was limited to a sample of 5 703 urban-based households[3] located on Java. This island contains the capital city and major consumer centre (Jakarta), and other fast-growing cities including Surabaya (East Java), Bandung (West Java), and Jogyakarta. The survey collected information on consumption and expenditure relating to a large number of food and non-food items, along with other information such as demographic, income and education data. Household food consumption data were collected over a one-week reference period for more than 150 items in terms of volume, value, and nutritional content. Household food consumption and expenditure data included purchases as well as the imputed value of the household's own production, gifts, and other foods received from outside

[2] Blandford (1984) used the same approach to group countries according to the share of various foods in total calorie intake.

[3] A household was defined as a person who lives in a part or a whole house and manages his/her needs or those of a group of people. If the number of persons living in a house exceeded 10, that house was excluded from the survey (e.g. types of institutional accommodation). For an area to be classified urban, it must have a population density of more than 5 000 persons per square kilometre, less than 25 per cent of employment must be in agriculture, and various urban-related facilities must be located in that area.

the household but excluded goods then transferred to persons outside the household. They did not include food consumed away from home.

Consumption data on the individual foods were aggregated into nine food groups: rice (and other cereals excluding wheat), wheat and flour, roots, pulses, fish, animal products (meats, dairy products and eggs), fruits and vegetables, cooking oil and fat, and sugar. The share of each food aggregate in each household's total food intake (measured in Kcalories), was then computed. The resulting set of variables was used to describe each household's dietary pattern and was therefore the criterion set for the cluster analysis.

Other data collected in the survey allowed the definition of several socioeconomic variables. These were household expenditure per month (TOTEXP), household size (HHSIZE) defined as the number of persons in a household, highest education obtained by the household head's spouse (EDSP), the spouse's age (AGESP), proportion of household members younger than 13 years of age (CH%), the proportion of household members aged 13 to 19 years (TEEN%) and imputed prices of the various food aggregates.

The survey's sampling procedure involved selection of groups of up to fifteen households within districts and regions. This geographical grouping encourages the assumption that households within each group can be assumed to face the same food prices (Deaton 1990). However, no market prices were available in the survey data and unit values had to be estimated, although these are likely to reflect quality as well as price differences. For each food aggregate, the total value of household consumption was divided by the household's total caloric intake of that food to give an implicit price per calorie. Average prices were then computed for each food and household sample group, ignoring households that did not consume that food item.[4] These *average* implicit prices were then applied to *all* households within the sample group. This is an attempt to reduce possible bias due to food quality differences among household choices. Prices were finally expressed relative to the rice price. For some household sample groups and food aggregates, *all* households showed zero consumption and implicit prices did not exist. These households were omitted, which reduced the total sample size to 5 386 households.

Eighteen per cent of households did not report a spouse as a household member. In these cases, the education level of the household head was used although in 75 per cent of such cases the head was female. Overall, the

[4] An implicit price for the wheat and flour aggregate was not used, since a large number of households reported zero consumption of this food.

**Table 1** Food group shares (%) of household calorie intake and total intakes: urban Java

| Food group | Mean share | Standard deviation |
|---|---|---|
| Rice | 65.04 | 12.19 |
| Wheat/flour | 0.36 | 1.23 |
| Roots | 2.43 | 3.61 |
| Pulses | 3.96 | 2.93 |
| Fish | 1.51 | 1.33 |
| Animal products | 3.83 | 3.97 |
| Fruit and vegetables | 4.51 | 2.84 |
| Cooking oil and fat | 12.19 | 5.53 |
| Sugar | 6.16 | 3.54 |
| Total | 100.00 | |
| Kcalories/capita/day | 1694.99 | 449.16 |
| Protein (gms/capita/day) | 41.42 | 13.73 |
| Fat (gms/capita/day) | 34.12 | 17.76 |
| Carbohydrate (gms/capita/day) | 301.66 | 79.20 |

education variable refers to a female in 95 per cent of the cases. Since data on the number of years of completed education was unavailable, the spouse's education variable was coded according to the highest obtained education as follows: 0 if none, 1 if primary school, 2 if junior high school, 3 if senior high school, 4 if polytechnic or similar tertiary college and 5 if university. However, it seems likely that the variable EDSP would be strongly and positively correlated with years of schooling.

Means and standard deviations of the food shares, along with nutrient intake levels, are given in table 1. As a proportion of the total household calorie intake, the mean share of rice was 65 per cent, a not unexpected finding for a developing Asian economy. Cooking oils and fats show a mean share of 12 per cent, but all other food groups contribute on average well under 10 per cent of the total calorie intake. Animal products, for example, accounted on average for only 3.8 per cent of the total household calorie intake. The distribution of the rice share of the diet across households is relatively homogeneous with a coefficient of variation of 19 per cent. For the other food groups, their shares exhibit much more heterogeneity across households, with coefficients of variation ranging from 45 per cent to 342 per cent. The rice share of the diet is negatively correlated with the shares all other food groups, indicating a tendency for the share of *all* non-rice foods to decline as the share of rice increases. This phenomenon was strongest between the rice share and those for animal products, fruits and vegetables, cooking oils and fats and sugar with simple correlations between −0.53 and −0.67. The correlations between the latter four food groups are positive, but no greater than 0.24. Therefore there is a tendency for the shares of these four food groups to increase or decrease together across households.

## 4. Results

### 4.1 Clustering of households by dietary patterns

There is no single objective criterion for choosing the number of household clusters to be formed. Separate analyses were conducted for all cluster sizes from three to nine. Given the objective of maximising the differences between clusters relative to the variation within the clusters, one relevant statistic is the ratio of between-cluster variance to within-cluster variance. This was increased from 1.5 for three clusters, to 2.1 for the five-cluster case, 2.5 for seven clusters and 2.9 for nine clusters. Another statistic is the $R^2$ for predicting each commodity share from the cluster, pooled over all commodities. This value also increased with increasing cluster numbers, from 0.60 (three clusters), to 0.68 (five clusters), 0.72 (seven clusters) and 0.74 (nine clusters). Also of practical relevance to the choice of the appropriate number of clusters is whether increasing the number of clusters produces new insights into the interpretation of the data. In this case, increasing the number of clusters beyond five produced some groups with smaller memberships, which appeared to be 'splits' of groups formed in earlier cluster analyses rather than groups that revealed new dietary patterns. Therefore five clusters were chosen.[5]

Table 2 presents the average commodity shares across households within each cluster, and the number of households included in the clusters. The first cluster of 1 420 households exhibits a 'traditional' developing-country Asian diet. These households obtained on average 80 per cent of total calorific requirements from rice, with all other food groups making a minor contribution. Wheat or wheat flour were on average hardly consumed at all in these households, and little more than 1 per cent of total calories were contributed by animal products. In contrast, the 551 households that were grouped together in cluster #4 would appear to exhibit a 'non-traditional' diet, with the lowest average reliance on rice of all the clusters. For all other food groups except root crops, mean contributions to the total calorie intake were highest compared with the other clusters. Cooking oils and fats contributed 18 per cent of total calories consumed, and both sugar and animal products contributed over 9 per cent.

[5] The SAS FASTCLUS procedure was employed. This uses a nonhierarchical clustering procedure and is particularly useful for large data sets such as that used in this study.

**Table 2** Java household clusters: mean shares by food group

| Cluster | #1 | #2 | #3 | #4 | #5 |
|---|---|---|---|---|---|
| No. of households | 1420 | 1947 | 1362 | 551 | 106 |
| Food group | Share of total calorie intake (%) | | | | |
| Rice | 79.8 | 67.3 | 56.3 | 43.2 | 51.2 |
| Wheat/flour | 0.1 | 0.2 | 0.4 | 1.2 | 0.4 |
| Roots | 1.6 | 2.2 | 2.3 | 2.7 | 18.1 |
| Pulses | 2.4 | 3.8 | 4.9 | 6.4 | 3.8 |
| Fish | 1.2 | 1.5 | 1.8 | 2.0 | 1.2 |
| Animal products | 1.3 | 3.1 | 5.4 | 9.5 | 2.1 |
| Fruit and vegetables | 2.8 | 4.2 | 5.5 | 7.5 | 5.9 |
| Cooking oil and fat | 7.2 | 11.7 | 15.7 | 18.2 | 11.5 |
| Sugar | 3.8 | 5.9 | 7.7 | 9.4 | 5.7 |

Notes: Total standard deviation pooled across variables = 0.051
Pooled within-cluster standard deviation = 0.029
Ratio of between- to within-cluster variance = 2.08
Pseudo $F$ statistic = 2795.8.

Clusters #2 and #3 showed mean dietary shares that suggested a gradual transformation in diets from the first to the fourth cluster. Moving from cluster #1 through to cluster #4, the mean share of rice in the total diet falls, while the reverse applies for all other food groups. Therefore just as the average diet in many developing countries has been shown to move through time from the 'traditional' with its reliance on cereals to the 'non-traditional' in which animal products and other foods play a more important role, and a similar phenomenon can be observed by comparing several countries at different stages of development, a similar transformation appeared to exist across individual households at a single point of time within this specific country.

The fifth cluster revealed a different dietary structure. For this group of 106 households, root crops provided 18 per cent of the total intake of calories, and the share of rice in the diet was at 51 per cent lower only in the 'non-traditional' cluster #4. For all other food groups with the exceptions of fruit and vegetables and wheat/flour, mean dietary shares were about the same as in cluster #2. Fruits and vegetables, while contributing only 6 per cent of the total intake of calories, were important in this cluster relative to some other clusters, and its share was surpassed only in the 'non-traditional' cluster #4. Therefore, on average within this group of households, animal products and other 'non-traditional' foods were not much more significant than within the 'traditional' cluster, but compared with the latter cluster root crops and some other food crops have substituted to some extent for rice in the diet. It could be named the 'traditional–high root crops' cluster.

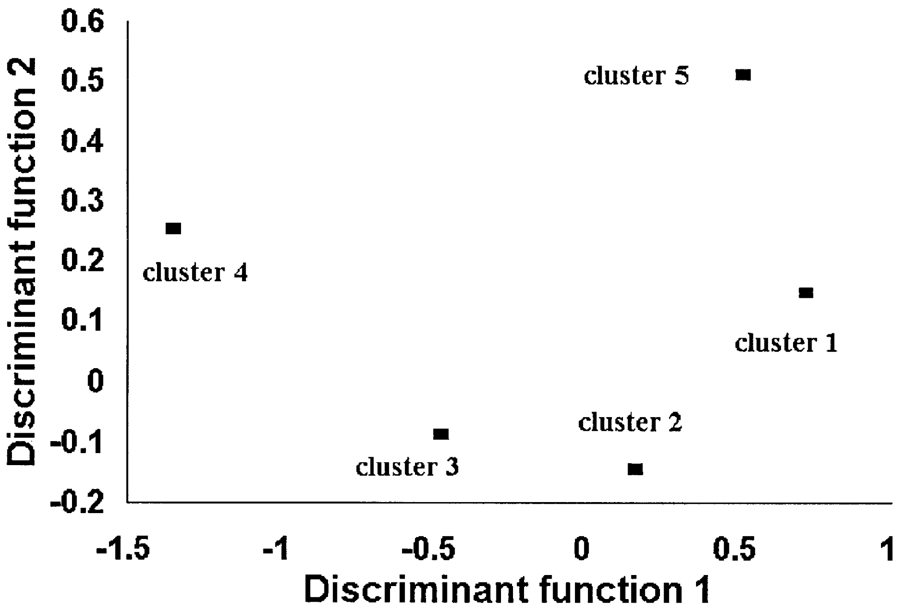


**Figure 1** Mean discriminant scores by cluster

### 4.2 Do the socioeconomic variables explain differences in household dietary patterns?

In order to obtain an overall perspective of the differences in the five household clusters, a plot can be constructed of the mean values of the $Z_i$ household scores for each cluster. Thus with five clusters of households, five mean values of $Z$ may be computed, from each of the first two discriminant functions.[6] These are plotted in figure 1. The graph indicates that the first function appears to discriminate among all five household clusters, with the lowest mean value of $Z$ ($-1.35$) computed for the fourth cluster (defined as the 'non-traditional' diet). The highest mean $Z$ score (0.72) is achieved by cluster #1, or the 'traditional' diet. The second function discriminates less

[6] The SAS CANDISC procedure was employed. With five household groups, the procedure derived four discriminant functions. The canonical correlations and (in parentheses) the proportion of among- to within-group variability accounted for by each function were:

Function 1: 0.532 (0.902)
Function 2: 0.162 (0.062)
Function 3: 0.112 (0.029)
Function 4: 0.057 (0.007)

Hence the following discussion will focus primarily on the first discriminant function.

**Table 3** Summary of multivariate discriminant analysis

| Variable | Discriminant loadings[a] | |
|---|---|---|
| | Function 1[b] | Function 2[c] |
| EDSP | −0.64 | 0.10 |
| TOTEXP | −0.60 | 0.24 |
| HHSIZE | 0.24 | 0.03 |
| TEEN% | 0.18 | 0.14 |
| CH% | 0.11 | 0.02 |
| *Prices relative to rice price:* | | |
| Roots | −0.27 | −0.51 |
| Pulses | 0.19 | 0.37 |
| Fish | −0.34 | −0.23 |
| Animal products | 0.12 | 0.52 |
| Fruit and vegetables | −0.14 | −0.21 |
| Sugar | 0.23 | 0.37 |

Notes: [a] Pooled within canonical structure
[b] Wilks' lambda = 0.687, $p < 0.0001$
Canonical correlation = 0.532 (se = 0.010)
[c] Wilks' lambda = 0.958, $p < 0.0001$
Canonical correlation = 0.162 (se = 0.013).

well, but would appear to discriminate the fifth cluster (the 'traditional–high root crops' cluster) with a $Z$ score of 0.51 from remaining clusters. However, these plots do not provide a basis for *explaining* these differences.

Table 3 gives some results[7] from the first and second discriminant functions. A test for statistical significance of the discriminant functions uses Wilks' lambda. This takes values between zero and one with the latter indicating mean $Z$ values that are identical across groups (no discrimination). Both values in table 3 indicate rejection of this hypothesis. The canonical correlation coefficient from the first function is 0.532, and when squared indicates that 28.3 per cent of the variance in the dependent variable is explained by this function. For the second function, the canonical correlation is 0.162.

The discriminant loadings that measure the simple correlations between the various explanatory variables and the $Z_i$ scores across all households in the sample, are presented in table 3 for the first two discriminant functions.[8] Focusing on the first function, there existed high correlations of −0.64 and

[7] Several cluster and discriminant analyses were conducted, for cluster sizes from three to nine. In each case, the discriminant analyses provided very similar results.

[8] The loading on the relative price of cooking oil and fat was very small, and was excluded from the analysis reported here. The same applied to the variable measuring the spouse's age.

−0.60 between the EDSP and TOTEXP variables, respectively and the $Z_i$ scores, and a correlation of 0.24 between HHSIZE and the $Z_i$ scores. The TEEN% and CH% variables were assigned loadings of 0.18 and 0.11, respectively. Thus, the higher the values of EDSP and TOTEXP, and the lower the values of HHSIZE, TEEN% and CH% for any household, the lower is likely to be that household's $Z$ score. The highest absolute values of loadings amongst the relative price variables were for fish (−0.34), roots (−0.27) and sugar (0.23). The loadings for the pulses and animal products price ratios were also positive while that for the relative price of fruit and vegetables was negative. Thus, the lower the relative prices of roots, fish and fruits and vegetables, and the higher the relative prices of sugar, pulses and animal products for any household, the higher is likely to be that household's $Z$ score.

The variables with the highest loadings (ignoring their signs) are the variables that have the most influence in explaining the differences among households in the various clusters. These variables are the spouse's educational level and total household expenditure, in that order. Further, since the mean $Z$ value for the 'non-traditional' cluster (#4) is lower than for all other clusters, then on average the households that comprise that cluster are likely to have higher values of these two variables than are the households that make up the other clusters. Thus households with diets that feature relatively high shares of 'non-traditional' foods are discriminated from others by higher levels of education and total expenditure. The positive loadings on the HHSIZE, TEEN% and CH% variables, while less powerful than the above in discriminating among the household clusters, suggest that households with the traditional dietary pattern tend to be of larger size and with higher numbers of children and teenagers. Results for the price variables suggest that households in the 'traditional' and 'traditional–high roots' clusters face lower relative prices for fish and roots and higher relative prices for sugar, pulses and animal products, relative to households in the 'non-traditional' cluster, which contributes to explaining differences between their dietary patterns.

The highest loadings in the second function are those of several relative price variables. These loadings are positive for the relative prices of animal products, pulses and sugar, and are negative for the relative prices of roots, fish and fruit and vegetables. The highest $Z$ score for this function (0.51) is for the 'traditional–high roots' cluster. Hence households in this cluster tend to face lower relative prices of roots, fish, and fruits and vegetables — note from table 2 that this cluster has the highest mean dietary share of roots and the second-highest mean share of fruits and vegetables.

Table 4 presents the mean values of the explanatory variables for each household cluster. The clusters are listed in table 4 in decreasing order of their mean $Z$ scores calculated from the first discriminant function.

**Table 4** Mean values of $Z$ (from Function 1) and socioeconomic variables by cluster

| Household cluster | Cluster #1 | Cluster #5 | Cluster #2 | Cluster #3 | Cluster #4 |
|---|---|---|---|---|---|
| Cluster description | 'traditional' | 'traditional–high roots' | 'transitional' | 'transitional' | 'non-traditional' |
| Mean $Z$ score[a] | 0.718 | 0.514 | 0.162 | −0.475 | −1.350 |
| EDSP | 0.97 | 0.84 | 1.23 | 1.68 | 2.26 |
| TOTEXP(Rp'000) | 138.6 | 123.9 | 192.5 | 260.4 | 410.5 |
| HHSIZE | 5.1 | 4.2 | 4.7 | 4.3 | 4.2 |
| TEEN% | 16.7 | 14.7 | 14.3 | 11.6 | 10.9 |
| CH% | 26.7 | 21.3 | 24.8 | 22.9 | 22.0 |
| *Prices relative to rice price:* | | | | | |
| Roots | 1.4 | 1.0 | 1.6 | 1.7 | 1.8 |
| Pulses | 4.4 | 4.5 | 4.2 | 4.1 | 4.1 |
| Fish | 11.9 | 10.8 | 12.8 | 13.6 | 14.7 |
| Animal products | 10.5 | 10.1 | 9.9 | 9.9 | 10.1 |
| Fruit and vegetables | 10.8 | 8.1 | 11.0 | 11.7 | 12.0 |
| Sugar | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 |

Note: [a] From first discriminant function.

Households included in the clusters with low $Z$ mean values had substantially higher mean values of the EDSP and TOTEXP variables, compared with the higher $Z$-score clusters, as expected from the above analysis. The next three explanatory variables listed in table 4 were judged to provide less power in discriminating between the clusters of households, and all were positively correlated with the $Z$ scores. There is some evidence from table 4 that these variables have lower mean values for those clusters with the lower mean $Z$ scores, and that households with more traditional consumption patterns tend to have a larger number of members and higher proportions of children and teenagers. Cluster #5 does not always fit into this pattern, however, with the second highest mean $Z$ score but the lowest proportion of children in the household and the equal-lowest average household size. With reference to figure 1, however, Function 2 appeared to discriminate cluster #5 from the other clusters. The loadings for the relative prices of roots, fish and fruits and vegetables were negatively correlated with the $Z$ score for this discriminant function (table 3) and table 4 shows that cluster #5 faced the lowest mean relative prices for these foods (and in fact a similar effect is evident in the first discriminant function).

## 4.3 Socioeconomic variables and household nutritional status

The above analysis identified a number of household food consumption *patterns*, and then determined that education of the spouse and household expenditure were the most important variables in discriminating among the various household food consumption patterns. But what are the *nutritional consequences* of those consumption patterns, and how do the discriminating variables contribute to nutritional outcomes? This section seeks answers to these questions by measuring average nutrient intake levels for each household cluster, and through estimation of nutrition elasticities from a system of regression equations.

Average daily levels of nutrient consumption per capita for each household cluster are shown in table 5. Nutritional status of household diets was represented by protein, fat and carbohydrate consumption, as well as by total calories. Also shown are standard deviations (in parentheses) and the *F* ratio for the null hypothesis that the mean consumption levels do not differ across the household clusters. In each case, this null hypothesis was rejected.

Daily calorie consumption[9] per capita averaged 1595 Kcals for cluster #1 and increased across the 'transitional' clusters to a value of 1954 Kcals for the 'non-traditional' cluster #4. All pairs of these mean values were significantly different ($p = 0.05$) from each other except for that between clusters #3 and #5. Mean levels of protein and fat consumption per capita were also lowest for the 'traditional' cluster and highest for the 'non-traditional' group. The average levels of fat and protein consumption in the 'traditional–high roots' cluster was not significantly different from those of the 'transitional' cluster #2. For both fat and protein consumption, all other pairs of means differed significantly from each other. Mean consumption of carbohydrates per capita was highest for the 'traditional–high roots' cluster, and declined successively across clusters #1, #4, #2 and #3. However, the mean levels of carbohydrate consumption for clusters #2, #3 and #4 were not significantly different from each other.

Table 5 also shows the percentage of households in each cluster whose dietary intake levels[10] were below the recommended daily requirements. The

[9] These consumption levels appear low when compared with those estimated from food balance sheet data. For example, Phil (1996) quotes daily energy availability per person of 2 701 Kcalories. There are a number of reasons for such discrepancies, for example, estimates from balance sheets refer to food availability rather than consumption, household expenditure data are subject to recall errors, and the Susenas surveys exclude food consumed away from home.

[10] These should be interpreted with caution since they are averages per household member; they say nothing about consumption adequacy of specific individuals or groups (e.g. children) within the household (the original data source did not report consumption levels for the individual household members). Further, they will underestimate total consumption since the data did not include food consumed away from home.

**Table 5** Nutrient status of household clusters

| Household cluster | Cluster #1 | Cluster #5 | Cluster #2 | Cluster #3 | Cluster #4 | $F$ |
|---|---|---|---|---|---|---|
| Cluster description | 'traditional' | 'traditional–high roots' | 'transitional' | 'transitional' | 'non-traditional' | |
| Daily per capita consumption of: | | | | | | |
| Calories (kcal) | 1594.7 | 1795.5 | 1642.7 | 1761.8 | 1953.8 | 83.8 |
| | (386.6) | (433.0) | (394.6) | (487.7) | (546.5) | ($Pr > F = 0.0001$) |
| Protein (gms) | 36.0 | 39.7 | 39.6 | 44.7 | 54.1 | 235.7 |
| | (9.5) | (11.6) | (11.2) | (14.7) | (18.4) | ($Pr > F = 0.0001$) |
| Fat (gms) | 19.2 | 31.5 | 30.7 | 44.0 | 60.7 | 1381.3 |
| | (7.7) | (10.9) | (9.9) | (14.8) | (21.5) | ($Pr > F = 0.0001$) |
| Carbohydrate (gms) | 312.1 | 337.4 | 297.4 | 294.9 | 299.6 | 15.7 |
| | (76.8) | (87.4) | (72.9) | (84.1) | (87.8) | ($Pr > F = 0.0001$) |
| % of cluster with: | | | | | | |
| calories < 2115 Kcals | 93.2 | 75.5 | 87.4 | 81.4 | 64.8 | |
| protein < 48.2 gms | 91.9 | 79.3 | 80.3 | 67.7 | 43.2 | |
| calories < 2115 Kcals and protein < 48.2 gms | 89.9 | 68.9 | 78.4 | 66.1 | 41.4 | |
| < 10% calories from fat | 38.6 | 11.3 | 1.6 | 0.2 | 0.0 | |
| < 25% calories from fat | 0.0 | 0.9 | 0.5 | 26.9 | 69.9 | |
| > 60% calories from carbohydrate | 100 | 100 | 100 | 94.9 | 61.0 | |

latter were obtained by computing levels of household consumption at the recommended daily allowances (Tee 1998) given the age and sex distribution of household members. These were then divided by household size and averaged across all households in each cluster to obtain energy and protein intake levels per person. Since they varied very little across the clusters, average values for the entire sample were used, these values being 2 115 Kcalories and 48.2 gms of protein per day.

The majority of households in all clusters had energy intake levels below the recommended level, although this proportion was lowest (65 per cent) for the 'non-traditional' cluster. Consumption of protein was deficient for the majority of households in all clusters except that with the 'non-traditional' food consumption pattern. The proportion of households with protein consumption below the recommended level declined from 92 per cent in the 'traditional' cluster to 68–80 per cent in the 'transitional' clusters and to 43 per cent in the 'non-traditional' group. The percentages of households in each grouping for which *both* energy and protein intake levels were below the recommended levels declined from 90 per cent in the 'traditional' cluster to 66–78 per cent in clusters #5, #2 and #3, to a low of 41 per cent in the 'non-traditional' cluster.

Other measures of nutritional status are the proportions of total calories provided from fat and carbohydrate. For Indonesia, recommended levels are 25 per cent of calories from fat (with a minimum of 10 per cent) and 50–60 per cent of calories from carbohydrates.[11] Nearly 40 per cent of households with the 'traditional' diet obtained less than the minimum share of calories from fats, whereas 70 per cent of households with 'non-traditional' diets exceeded the recommended level of 25 per cent calories from fat. The majority of households in the total sample obtained more than 60 per cent of their energy intake from carbohydrates, and for those clusters with traditional or transitional diets, the proportions of total households in this category were 95 per cent to 100 per cent.

Do the changes in food consumption patterns associated with higher household expenditure and educational status lead to improved nutritional outcomes? The earlier literature review indicated considerable debate on this point but the current analysis suggests that it does, at least in terms of energy and protein intakes in Javanese urban households. The cluster of households with the non-traditional consumption pattern was shown to be discriminated from other household clusters by its relatively high levels of spouse's

[11] Personal communication, Dr Clare Wall, Institute of Food, Nutrition and Human Health, Massey University.

education and total expenditure. Within this group the proportion of households with dietary intakes of energy and protein below the recommended daily allowances was 41 per cent, much lower than the proportion in all other clusters and lower than the total sample mean value of 74 per cent. However, two-thirds of households within this cluster obtained more than the recommended proportion of calories from fat. At the other end of the dietary spectrum, households with the traditional diet (cluster #1) all exceeded the recommended maximum contribution of carbohydrates to calorie intake levels, and many fell short of the minimum contribution from fats.

Having identified the spouse's education and household expenditure as the most important variables in discriminating among the household consumption *patterns*, how do increases in each variable impact on total household consumption of nutrients? Four nutrient demand equations were estimated, with total household consumption of calories, protein, fat and carbohydrates as the dependent variables. Potential independent variables were the socioeconomic variables used in the discriminant analysis. Following Ravallion (1990) who estimated calorie demand functions from Indonesian Susenas data for 1981, we used a linear functional form with quadratic terms for a number of the explanatory variables, namely household expenditure, education of the spouse and household size. The four equations were estimated as a system, using the seemingly unrelated regression procedure.[12]

Results are given in table 6 (variables whose coefficients were not of the expected sign, or for which the p-values were very high, were omitted). In each equation, household consumption increased with total expenditure, but at a decreasing rate. The nutrient consumption response with respect to the spouse's education was, however, only positive in the case of fat consumption. Total household consumption of each nutrient increased with household size, but at a decreasing rate for three of the four nutrient measures. An increase in the proportion of teenagers in the household had a positive impact on household consumption of carbohydrates and total calories, whereas an increase in the proportion of children produced the opposite effect on total household consumption. The estimated coefficients on the TEEN% and CH% variables in the protein and fat equations were not significant even at the 20 per cent level.

In the equation for total calorie consumption, the majority of the price

[12] The likelihood ratio test indicated rejection of the null hypothesis of a diagonal covariance matrix ($\chi^2 = 38719$ with 6 df).

**Table 6** Household nutrient demand regressions

| Variable | Calories | | Protein | | Fat | | Carbohydrate | |
|---|---|---|---|---|---|---|---|---|
| | coeff | (p-val) | coeff | (p-val) | coeff | (p-val) | coeff | (p-val) |
| TOTEXP | 60.62 | (0.000) | 2.30 | (0.000) | 3.12 | (0.000) | 6.24 | (0.000) |
| TOTEXP$^2$ | −0.104 | (0.000) | −0.003 | (0.000) | −0.005 | (0.000) | −0.012 | (0.000) |
| EDSP | −111.23 | (0.000) | −1.48 | (0.058) | 9.41 | (0.000) | −45.08 | (0.000) |
| EDSP$^2$ | −10.45 | (0.011) | | | −1.18 | (0.015) | | |
| HHSIZE | 1302.4 | (0.000) | 26.28 | (0.000) | 14.06 | (0.000) | 264.23 | (0.000) |
| HHSIZE$^2$ | −8.15 | (0.001) | | | −0.13 | (0.320) | −1.94 | (0.001) |
| TEEN% | 2.77 | (0.083) | 0.05 | (0.303) | −0.04 | (0.494) | 0.66 | (0.031) |
| CH% | −5.07 | (0.000) | −0.04 | (0.329) | −0.05 | (0.272) | −1.16 | (0.000) |
| *Price of:* | | | | | | | | |
| Rice | −15948.0 | (0.000) | −378.5 | (0.000) | | | −3773.6 | (0.000) |
| Roots | −681.3 | (0.000) | | | | | −183.6 | (0.000) |
| Pulses | −115.1 | (0.000) | −46.5 | (0.000) | | | | |
| Fish | −22.1 | (0.000) | −6.9 | (0.000) | | | | |
| Animal products | −103.5 | (0.000) | −2.5 | (0.173) | −12.6 | (0.000) | | |
| Oil and fat | −3688.9 | (0.000) | | | −450.2 | (0.000) | | |
| $R^2$ | 0.748 | | 0.689 | | 0.533 | | 0.731 | |

Note: Values in parentheses are p-values
TOTEXP is in units of $Rp \times 10^{-4}$ per month. Prices are in Rupiah per calorie.

**Table 7** Nutrient elasticities at data means

| Nutrient variable (household consumption per day) | Elasticity with respect to | |
|---|---|---|
| | TOTEXP | EDSP |
| Kcalories | 0.159 | −0.025 |
| | (0.000) | (0.000) |
| Protein | 0.249 | −0.011 |
| | (0.000) | (0.058) |
| Fat | 0.419 | 0.056 |
| | (0.000) | (0.000) |
| Carbohydrate | 0.090 | −0.045 |
| | (0.000) | (0.000) |

Note: p-values in parentheses.

variables had negative and significant coefficients,[13] so that a reduction in the prices of these foods would impact positively on calorie consumption. For the protein, fat and carbohydrate equations, price variables included were restricted to those of foods that were relatively high in the nutrient in question. Thus in the protein equation the prices of rice, pulses and fish had negative and significant coefficients, as did those of animal products and cooking oil and fat in the fat equation and rice and roots in the carbohydrate equation.

Elasticities are given in table 7. Note that the elasticity of total calorie consumption with respect to household expenditure is significantly different from zero but rather low at 0.16, and compares with Ravallion's (1990) estimate for East Java of 0.146. Second, the protein and fat expenditure elasticities are considerably higher at 0.25 and 0.42, respectively, while that for carbohydrates is only 0.09. Thus a given increase in household expenditure will lead to a much larger proportionate rise in consumption of protein and fat than it will for carbohydrate and total calorie intake, consistent with a shift from traditional diets to an increased emphasis on less traditional foods such as animal products.

The only positive education elasticity was that for fat consumption (0.06), while those for carbohydrates, protein and total calories were −0.05, −0.01 and −0.03, respectively. Thus the impact of better education of the spouse, once expenditure effects are accounted for, would appear to be a

[13] Deaton's (1987) warning is recognised, however — that unless the effects of quality are disentangled from the unit values, a spurious negative correlation may exist between unit values and quantities.

substitution of fat consumption for that of carbohydrates, resulting in a reduction in total household calorie consumption and little change in protein intake. The latter may be explained by the substitution of high-protein non-traditional foods for rice, since the latter has traditionally been a major source of protein in Indonesian diets. This result with respect to the education elasticities is perhaps surprising, given the top ranking of the education variable in discriminating among the household dietary patterns. Yet comparing the consumption patterns between clusters #1 and #4, two of the largest increases in shares (ignoring wheat) were for animal products and cooking oil and fat which had by far the largest fat content per unit of all the food aggregates studied. Also, of the *F* ratios shown in table 5, the largest is for fat.

## 5. Conclusion

The discriminant analysis indicated that the spouse's education and household expenditure were the most important variables in explaining differences among the 'traditional', 'transitional' and 'non-traditional' dietary household groups. On average, households clustered in the 'non-traditional' dietary group exhibited higher values of these variables than households in the remaining clusters. There was weaker evidence that the dietary groupings may also be discriminated according to total household size, with households in the 'non-traditional' cluster tending to be of smaller size than those in the other clusters, and according to the implicit prices of some of the food aggregates relative to the rice price. Results for the latter variables suggested that households in the 'traditional' and 'traditional–high roots' clusters faced lower relative prices for fish and roots and higher relative prices for sugar, pulses and animal products, relative to households in the 'non-traditional' cluster. The proportion of children and teenagers in total household membership had little influence in discriminating among the various household clusters, although these proportions tended to be higher for households in the 'traditional' cluster.

The calorie and protein status of households in the 'non-traditional' grouping that was associated with higher expenditure and education levels was superior to other groupings. In this cluster just 41 per cent of the households consumed less than the recommended levels of both calories and proteins compared with 74 per cent in the total sample. While increases in household expenditure may lead to increased consumption of carbohydrates, protein, fat and total calories, increases in the spouse's education appeared to be associated with the substitution of fat consumption for that of carbohydrates, leaving total protein consumption unchanged.

It might have been expected that households with higher proportions of children and teenagers may have exhibited higher shares of animal products in their diets, given the apparent popularity of dairy products and some kinds of meat with young people, and hence that these variables could have had more influence in explaining differences between traditional and non-traditional dietary patterns. However, the analyses did not support this supposition, perhaps because these purchases may be made primarily away from the household, e.g. in fast-food outlets, which purchases were not included in the survey data.

The high relative importance attached to education of the spouse in describing differences between traditional and non-traditional food-consuming households is an interesting result, and adds to previous findings that women's education opportunities could be important components of a national food policy. This variable appeared to exert its influence through encouraging the substitution of fat for carbohydrates, however, with little impact on protein and total calorie consumption, so that the majority of households with the 'non-traditional' diet exceeded the recommended share of calories derived from fats. Thus, in addition to the research results reviewed in the introduction to this article, the evidence produced in the present study would suggest that estimation of changes in food consumption patterns as economic development proceeds may also be biased if the influence of changes in educational levels of household decision-makers is ignored. Given that this variable is likely to be positively correlated with household incomes and expenditures,[14] exclusion of the education variable from demand studies could lead to upwardly-biased expenditure elasticities.

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[14] This correlation was 0.45 in the present study.

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