Quantity Aggregation and Quality Price Adjustment;

Problems with Measuring Indonesian Food Demand

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ABSTRACT

One Asian country which is predicted to provide excellent opportunities for New Zealand exporters is Indonesia.

To measure Indonesian demand responses requires the use of cross-sectional survey data. However, the use of such data produces aggregation errors, caused by quality effects, in the measurement of commodity price and quantity elasticities. Such aggregation errors produce biased elasticity estimates. The bias in the estimation of price elasticities is compounded by errors of measurement in measured quantities and expenditures.

Adapting the theoretical model of Houthakker (1952) and Theil (1952), Deaton (1988) developed a methodology which accounts for both aggregation and measurement error. Using Deaton's methodology, the demand for five commodities - rice, meat, fruit, vegetables, and milk products - were computed.

The expenditure elasticities are ordered much as would be expected, with rice and vegetables close to zero, and meat, fruit and milk products all having elasticities greater than one. Comparing the expenditure elasticities with respect to total expenditure with those of previous studies, the quantity elasticities are decreasing with time as expected. Thus while meat, fruit, and milk products are still considered luxury items, they will increasingly be within the average Indonesian consumer's reach in the near future. Also, the quality of foodstuffs consumed is increasing with incomes. The effects of quality, and measurement error especially, produced dubious price elasticity estimates. After adjusting for these influences, the price elasticity estimates are, with the exception of milk products, negative, although the rice price elasticity is larger than predicted. Meanwhile. the effects of quality in the estimation of quantity elasticities is relatively minor.

While the model produced satisfactory results, it was considered that further exploration of the methodology was required, particularly with regard to the use of food expenditure.

In the absence of data on total expenditure, Deaton (1988) assumed that food expenditure was a theoretically acceptable alternative explanatory variable. To measure if this was so, elasticities using both food and total expenditure were calculated. Although no formal non-nested tests were used, differences in the price elasticities between the two models casts doubt on the use of food expenditure in place of total expenditure.

Nevertheless, estimation of a 'food share' elasticity provides a method for moving from food expenditure elasticities to total expenditure elasticities, with a proxy value for this elasticity providing encouraging results. Yet the estimation of such an elasticity requires information on total expenditure, providing limited empirical value for the researcher with just food expenditure data, and only a theoretical curiosity for the researcher with information on both.

Other methodological problems included a larger than expected rice price elasticity and the estimation of biased OLS parameter estimates through the use of zero expenditures in the model. Consequently, without further exploration of these issues, the procedure should only be applied cautiously.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND.

In 1992 the World Bank reported that countries in East and South East Asia, such as China, Japan, South Korea, Singapore and Thailand, were distinguished as countries with remarkable GNP growth per capita. Between 1965 and 1973, the growth of GNP per capita in these countries averaged 4.8 percent. In 1990 this rose to 5.3 percent, the highest growth rate in the world. In comparison, most OECD countries averaged a per capita growth rate of between 1.5 to 1.6 percent. The rapid industrial growth in these Asian countries is the major contributing factor to this per capita GNP growth.

A consequence of this rise in incomes is its effect on diet. Food demand patterns change with the nation's level of economic development. Asian income growth over the past three decades has resulted in dramatic transformations in diet (Mitchell and Ingco, 1993). As incomes increased, consumers in these countries had access to a wider variety of food.

Urbanisation has also been an important development within Asia, with large cities experiencing tremendous physical and population growth. Huang and David (1993) noted that this population movement to urban centres increases the demand for 'convenience' foods.

As such, these changes have resulted in a shift away from the traditional rice diet to a more western diet of bread, red meat, and dairy products. These changes in consumption patterns provide an opportunity for New Zealand agricultural exporters.

However, Tradenz (1993) predicted the economic performance of China to slow, while forecasts for Japan were not promising either. Consequently, there is an emphasis on New Zealand exporters to find new markets within Asia.

Another country which is predicted to follow in the footsteps of Singapore and South Korea is Indonesia. Agricultural and manufacturing development has led to an average per capita GNP growth rate[1] of about 4.1 percent for the period 1976-1990. The high annual growth of GNP per capita, a large population base and a relatively rapid population growth, especially in its urban centres, makes Indonesia a desirable destination for agricultural products. In addition, with the exception of cereal goods, the growth in agricultural production is still low (Hakim, 1994). As a result, Indonesian agricultural producers, in the short run at least, will not be able to respond to the predicted changes in consumption patterns.

There is already some evidence that food consumption is changing in Indonesia. A study of Asian food consumption patterns by Mitchell and Ingco (1993) demonstrated how Indonesian food consumption had changed. The study examined changes in consumption patterns for six food groups - rice, maize, root crops, livestock products, and, fruit and vegetables, using three types of data: time series, international comparison project and household survey data. Although rice had maintained its dominant position, wheat consumption was increasing (per capita consumption of wheat increased from 1.3 kg/yr during 1961-65 to about 11 kg/yr during 1986-1990), with consumers shifting away from rice to wheat as income grew. Per capita consumption of root crops had also been declining steadily for some time (100 kg/yr in 1961-65 to 60.3 kg/yr during 1986-90). Total meat consumption was found to have risen sharply over the last two decades. Per capita meat consumption during 1961-65 was 3.7 kg/yr while between 1986-90 it was 6.2 kg/yr. Across income groups, total meat consumption increased with income, with the greatest increase in the highest income group. The same pattern was true of fruit and vegetable consumption, with increases in consumption from 42 kg/yr during 1961-65 to 55 kg/yr during 1986-90.

Data from household surveys confirm these findings. Indonesian budget shares of staple foods - rice, maize, and root crops - declined with income, while budget shares for wheat, livestock products, and fruit and vegetables increased with income. Households in urban areas were found to have lower average budget shares for rice, and higher shares for

[1] World Development Reports 1976-1990, World Bank.

livestock products. Consequently, per capita consumption of traditional foods is declining as Indonesians eat higher-valued foods. Such consumption patterns are similar to those which have occurred in more economically advanced Asian countries.

Aside from the changes in the quantity of food consumed, a rise in income will also change the quality of purchases. Theil (1976) said that consumers will react to income increases by not only buying more, but also by buying better quality. It was hypothesised that rising per capita income will lead to an upgrade in the quality of purchases as richer consumers buy higher-valued and more highly-processed food products. As a result, expenditure may increase while the quantity purchased remains the same. It can be assumed, therefore, that differences in price between various brands of coffee, types of meat, kinds of cheeses, etc., are indicative of differences in quality (Theil, 1976). Moreover, this quality choice may itself reflect the influence of prices as consumers respond to price changes by altering both the quantity and quality, or more precisely the composition of their purchases within the group.

The estimation of demand using cross-sectional survey data reflects these quality considerations through the heterogeneous aggregation of household demand level data. Consumers buy 'goods', which, for instance, are different meat products, not the composite commodity itself. Because consumers choose both the quantity and quality of their purchases, grouping such goods into commodities produces aggregation errors, which are basically the consumer choice for quality. Thus, in conducting a commodity demand analysis, this aggregation, or quality choice, will affect a commodity's price and quantity measurements and could produce deceptive results. Because Indonesian demand responses can only be estimated using cross-sectional survey data, aggregation errors present an important research issue.

Some way must be found to aggregate measures of demand for these goods into meaningful composite commodities with corresponding meaningful price measures. But in addition, the proposed methodology should also provide the means to measure changes in the quality of purchases so as to provide a richer analysis.

Deaton (1987; 1988; 1990) recognised the problems associated with quality choice in estimating price elasticities from household survey data. In his papers, Deaton addressed some of the theoretical and econometric problems which can arise in the estimation of price and income elasticities data when the researcher is given data on expenditures and physical quantities of purchases of non-homogenous commodities. The methodology also measures quality choice. However, Deaton did not recognise the problems associated with quantity aggregation. Nevertheless, Deaton's methodology does allows for a theoretically rigorous definition of aggregate composite commodities. Nelson (1990, 1991) showed that Deaton's assumption of constant relative prices serves as a natural extension to the Hick's composite commodity definition, thereby solving the quantity aggregation problem.

1.2 OBJECTIVES.

This research will attempt to provide information on Indonesian food consumption patterns by estimating a set of theoretically robust price and income elasticities. The 1990 SUSENAS expenditure survey will be used to estimate elasticities for a group of commodities whose consumption patterns have changed in recent times and which are likely to be of interest to New Zealand agricultural exporters. However, the study will also provide a more penetrating analysis of demand by trying to ascertain what proportion of a rise in income is allocated to increasing the quality of food purchases.

1.3 THESIS OUTLINE.

The structure of this study is as follows. In chapter two, the theory of demand is outlined, including the *a priori* restrictions which can be imposed or tested for on a system of demand equations. Chapter three introduces the ideas behind the methodology used in the study. Further, we introduce potential problems in the use of food expenditure in the methodology and introduce Hicks' composite commodity theorem to control for aggregation errors in the model. The chapter also provides a brief literature review of Indonesian food demand. Chapter four describes the data used in the empirical analysis; 5,708 observations on urban households in urban Java from the 1990 SUSENAS National Economic Survey. Chapter five presents regression results and elasticities. In this chapter, the effects of measurement error and aggregation error will be analysed. The use of food expenditure in place of total expenditure will also be examined, as will the bias caused by the use of a simple regression of quantity on unit value conditioned by households making purchases. To investigate changes in Indonesian food demand over the past decade, the results of this study will be compared to those of previous Indonesian food demand studies. The implications for New Zealand agricultural exporters will also be reported. Chapter six concludes the study with suggested refinements to the methodology to resolve some of the problems encountered.

CHAPTER TWO

DEMAND THEORY

2.1 INTRODUCTION.

This chapter will derive a set of demand functions from a set of axioms and show that if they satisfy the homogeneity, aggregation, symmetry and negativity restrictions, then the theory allows one to go to preferences from a given set of demand functions. The dual approach to demand theory will be utilised. Its simplicity and elegance allows for a more direct insight into the comparative statics of demand. The basis for the existence of demand functions is provided in the next section through the consideration of individual preferences as described by the preference relation. Based on these preferences, the axioms of choice allow for the construction of a utility function which represents a consumer's preference ordering, leading to the system of choice described by utility maximisation.

2.2 THE PREFERENCE ORDERING RELATION AND THE UTILITY FUNCTION.

Utility functions are the consequence of assumptions, or axioms, imposed on an individual's ranking of commodity bundles. A rational consumer exhibits a certain logical ranking of various alternative commodity bundles. The choice of a particular commodity bundle depends on the tastes of an individual consumer. These tastes are described by the preference relation. Commodity space is defined to introduce the notion of a commodity bundle and the consumer preference relation.

2.2.1 Commodity Space.

Following Intriligator (1971) and Barten and Bohm (1980), it is assumed that there exists a finite number of l commodities. Quantities of each commodity are measured by real numbers. A commodity bundle, i.e. a list of real numbers (q_h) $h = 1,...,l$ indicates the quantity of each commodity, and can be described as an l dimensional vector $\mathbf{q} = (q_1,...,q_l)$ and as a point in l dimensional Euclidean space R^l, the commodity space. Under perfect divisibility of all commodities, any real number is possible as a quantity for each commodity, so that any point within commodity space R^l is a possible commodity bundle.

The price p_h of a commodity h, h = 1,...,l is a real number which is the amount paid in exchange for one unit of the commodity. A price vector $\mathbf{p} = (p_1,...,p_l)$ can be represented by a point in Euclidean space R^l. Subsequently the value of a commodity bundle given a price vector **p** is

$$\sum_{h=1}^{l} p_h q_h = \mathbf{pq}.$$

2.2.2 Consumer Preferences and the Preference Relation.

The weak preference relation - is preferred to or indifferent to - describes the tastes of a consumer based on the choice of a particular commodity bundle and is written $\geq$ (Intriligator, 1971). Given two different commodity bundles x and y, the consumer under consideration either prefers x to y, or prefers y to x, or is indifferent between x and y. Indifference could also be defined in terms of the weak preference relation. A consumer is indifferent between x and y;

$$x \sim y \text{ if and only if } x \geq y \text{ and } y \geq x$$

and a consumer prefers bundle x to y;

$$x > y \text{ if and only if } x \geq y \text{ and not } y \geq x.$$

A consumer's weak preference relation between alternative commodity bundles is assumed to be consistent with a set of axioms. The axioms used in this section are similar to those used by Deaton and Muellbauer (1980, p23 - 26). These axioms are reflexivity, completeness, transitivity, continuity, non-satiation, and convexity. The first four axioms are fundamental in defining a utility function, such that the statement "the consumer chooses the most preferred bundle from their constraint set" is translated to "the consumer acts so as to maximise utility subject to remaining in his constraint set" (Cornes 1992, p32). The remaining axioms put extra structure into preferences and subsequently, into the utility function that represents them. The set of axioms are:

Axiom 1: Reflexivity. For any bundle x, $x \geq x$.

Each bundle is as good as itself. It ensures that every bundle belongs to at least one indifference set, namely that containing itself, if nothing else.

Axiom 2: Completeness. For any two bundles x and y, either $x \geq y$ or $y \geq x$ or both.

This axiom says that the consumer can express a preference or indifference between any pair of consumption bundles. This ensures that there are no holes in the preference ordering.

Axiom 3: Transitivity. If $x \geq y$ and $y \geq z$, then $x \geq z$.

This is a consumer consistency requirement. The transitivity axiom implies that indifference sets have no intersection.

These three properties of the preference relation allow us to conclude that every bundle (completeness) can be put into one indifference set (reflexivity) and no more than one indifference set (transitivity) (Gravelle and Rees, 1992). Axioms 1 - 3 define a complete pre-ordering of the choice set, with the relation being complete, in that given any two bundles x and y, either $x \geq y$ or $y \geq x$ (or both), so that there are no gaps in the choice set over which preferences do not exist.

Axiom 4: Continuity. For every bundle x, the no worse than x set $A = \{y \in X \mid x \leq y\}$ and the no better than x set $B = \{y \in X \mid x \geq y\}$ are closed sets in commodity space for any bundle y. The intersection of the upper contour set A and the lower contour set B for a given point x, defines the indifference class $I(x^0) = \{x \in X \mid x \sim x^0\}$ which is a closed set. If $y > x$, then the bundles that are sufficiently close to y will also be preferred to x and vice versa. In terms of consumer choice, given two goods, the amount of one good can be reduced and be exactly compensated by an increase in the other good.

Axioms 1 - 4 are necessary conditions for the existence of a continuous utility function. Cornes (1992) says that the central result is that a function U(**q**), where **q** is a vector of quantities, exists that associates each bundle of commodities with a real number. More succinctly,

$$q \geq q^0 \Leftrightarrow U(\mathbf{q}) \geq U(\mathbf{q}^0).$$

Deaton and Muellbauer (1980) also point out that Axioms 1-4 allow us to treat preferences by constrained maximisation tools via the function U(**q**) since the best choice yields the highest value of U(**q**).

<u>Axiom 5</u>: Non-satiation. Suppose the bundle y has at least as much of every commodity as x, and strictly more of at least one commodity. That is $y \geq x$ and x does not equal y, then $y > x$.

The implication is that each commodity is indeed regarded as a good - the more of one good there is the better. The consumption of any commodity, holding the consumption of all other commodities constant, increases utility. This completes the transition from axioms to utility. Axioms 1 - 5 reduce the consumer's choice problem to a constrained maximisation of utility.

<u>Axiom 6</u>: Convexity. A preference ordering on $x \in R^l$ is called convex if the set $\{y \in X \mid x \leq y\}$ is convex for all $y \in X$.

This definition states that all upper contour sets are convex. The associated concept for a utility function is that of quasi-concavity. If $y \geq x$, then for any scalar α such that $0 \leq \alpha \leq 1$, $\alpha y + (1-\alpha)x \geq x$. The upper level sets of a quasi-concave function are convex. A utility function for a preference order $\geq$ is quasi-concave if and only if the preference order is convex. Thus, quasi-concavity is a property which relates directly to the ordering.

Therefore, it is preserved under increasing transformations. The utility function is consequently ordinal (Barten, 1982).

A strengthened version of the convexity axiom was defined by Cornes (1992) as:

Axiom 6a: Strict convexity. If $y \geq x$, then for any scalar α such that $0<\alpha<1$, $\alpha y + (1-\alpha)x > x$.

Equivalently, U(**q**) is strictly concave. This rules out linear segments of indifference surfaces. This Axiom allows the use of straightforward differential calculus in characterising a consumer optimum and a comparative static analysis.

In addition to the axioms defined by Deaton and Muellbauer (1980), Cornes (1992) included a seventh axiom:

Axiom 7: Differentiability. U(**q**) is everywhere twice continuously differentiable.

This axiom means that the indifference curve has a unique tangent at each point. At a more intuitive level, Cornes (1992) says that the axiom imposes a certain smoothness on indifference surfaces, ruling out kinks or corners. Intriligator (1971) also remarks on the usefulness of this property in showing how the marginal utility of any good decreases as more and more of that good is consumed.

The neo-classical consumer problem now becomes one of choosing a bundle x^a in the opportunity set X that is 'most preferred', in that for any other bundle x in X, $x^a \geq x$. In terms of the utility function, the problem is

$$\text{Max } U(\mathbf{q}) \text{ subject to } \mathbf{pq} = M \qquad 2.2.1$$

where **p** is the vector of prices associated with each quantity bundle **q**, and M is the consumer's money income. Using the Lagrangian technique to solve this utility maximisation problem, there are the following n+1 first order conditions,

$$\frac{\delta U}{\delta q_i} = \lambda p_i \qquad 2.2.2$$

$$M = \mathbf{pq} \qquad 2.2.3$$

where λ is the Lagrangian multiplier. These equations will give solutions for the n+1 unknowns **q** and λ which will depend on the values of **p** and M. Therefore the solutions are the system of Marshallian demand functions

$$q_i = x_i(\mathbf{p}, M). \qquad 2.2.4$$

2.3 DUALITY.

In the previous section we formalised the consumer's problem as one of maximising utility for a given outlay or cost. The solution to this problem produces some utility level, say u, which is defined over quantities as the object of choice. However, we can reformulate this problem so that utility can just as well be a function of prices and money income, or inversely, money income can be regarded as a function of u and prices. Thus, the information about preferences contained in the direct form U(**q**) can be transferred into the indirect forms known as the indirect utility function V(**p**,M) and the expenditure function E(**p**,u). This change in variables is the essential feature of the duality approach, which is the topic of this section.

2.3.1 The Indirect Utility Function.

The direct utility function U(**q**) expresses utility in terms of quantity consumed. In contrast, the Marshallian demand functions derived from this utility function take the form x(**p**,M). In this form the optimal quantities, **q**, depend on prices and money income. Subsequently, so does the associated maximum attainable utility level. Therefore, it becomes possible to express utility in terms of prices and money income. The resulting function is called the indirect utility function V(**p**,M) (Cornes, 1992). Substituting the Marshallian demand functions back into the direct utility function gives the maximum attainable utility given **p** and M, where

$$U = (q_1,q_2,...,q_n) = v(g_1(\mathbf{p},M),...,g_n(\mathbf{p},M)) = V(\mathbf{p},M).$$

The function $V(\mathbf{p},M)$ presupposes that the consumer chooses the best bundle from those that the budget constraint makes available.

Using normalized prices, Henderson and Quandt (1980, pp42-3) described a set of duality theorems which formalised the relationship between $U(\mathbf{q})$ and $V(\mathbf{p},M)$. No proofs were provided, but they can be found in Diewert (1974) and Diewert (1982).

Theorem 1: Let U be a finite regular strictly quasi-concave increasing function in which the utility function for a commodity combination, where one or more quantities is zero, is lower than the utility for any combination in which all quantities are positive. Then the indirect utility function determined by

$$\text{Max } \{U(\mathbf{q}) \mid \mathbf{pq} \leq 1\} = F[x(\mathbf{p})] = V(\mathbf{p})$$

is a finite strictly quasi-convex decreasing function for positive prices.

Theorem 2: Let V be a finite regular strictly quasi-convex decreasing function in positive prices. The direct utility function determined by

$$\text{Min } \{V(\mathbf{p}) \mid \mathbf{pq} \leq 1\} = G[h(\mathbf{q})] = U(\mathbf{q})$$

is a finite strictly quasi-concave increasing function.

Theorem 3: Under these assumptions

$$U(\mathbf{q}) = F[x(\mathbf{p})] \text{ and } V(\mathbf{p}) = G[h(\mathbf{q})].$$

The direct utility function determined by the indirect utility function is the same as the indirect utility function determined by the direct utility function. Consequently, $U(\mathbf{q})$ and

V(**p**) contain precisely the same information and offer alternative but equivalent representations of individual preferences.

To generate demand functions from an indirect utility function requires the introduction of Roy's identity. Roy's identity demonstrates that demand functions of the form x(**p**,M) can be generated from expressions involving partial derivatives of the indirect utility function. To derive Roy's Identity, Layard and Walters (1978) totally differentiated the utility function $u = V(p_1,..,p_n,M)$, holding u and $p_2,...,p_n$ constant, so that

$$0 = \frac{\delta V}{\delta p_1}\delta p_1 = \frac{\delta V}{\delta M}\delta M. \qquad 2.3.1$$

If u and all p_j ($i \neq j$) are constant, then p_i must vary in such a way that compensation is affected, i.e. $dM = q_i dp_i$. Income must be increased by q_i times the change in its price (p_i). Substituting this result back into equation 2.3.1

$$q_i = -\frac{\delta V(\mathbf{p},M)}{\delta p_i} / \frac{\delta V(\mathbf{p},M)}{\delta M}. \qquad 2.3.2$$

Roy's identity says that optimal commodity demands are related to the derivatives of the indirect utility function and the optimal value of the marginal utility of income. Intuitively, an increase in p_i is a reduction in the purchasing power of the consumer's money income, M, and their purchasing power falls at the rate $-q_i$ as p_i varies. Roy's Identity shows that an increase in price of a good a consumer purchases reduces their maximised utility. Subsequently, Roy's identity generates an implied set of demands as functions of **p** and M.

The restrictions that can be imposed on $x_i(\mathbf{p},M)$ follow in a straightforward way from the budget constraint. These restrictions are

1. Adding up. The total value of demands is total expenditure, that is **px**(**p**,M) = M.

2. Homogeneity. Demands in total expenditure and prices are homogenous of degree zero, that is, for a scalar $\theta > 0$, $x(\theta\mathbf{p},\theta M) = x(\mathbf{p},M)$.

3. Engels aggregation: $\Sigma p_j(dq_j/dM) = 1$. Differentiating with respect to M results in the sum of the marginal propensities to consume being equal to unity.

4. Cournot aggregation: $\Sigma p_j(dq_j/dp_k) = -q_k$. This follows from the budget constraint by differentiating with respect to p_k

However, nothing in these results tells us much about individual price responses. Hicksian demand functions must be introduced to do so. Just as Marshallian demand functions are themselves partial derivatives of the indirect utility function, the Hicksian demand functions are partial derivatives of an expenditure function. The expenditure function and its properties are discussed in the next section.

2.3.2 Expenditure Function.

As discussed previously, the classical approach to demand theory was to formulate the consumer's problem as one of maximising utility subject to a budget constraint to produce some level of utility. An alternative approach would be to use the dual of this problem. The problem is reformulated as one of selecting goods to minimise the outlay necessary to reach some utility level (Deaton and Muellbauer, 1980). Clearly, the vector of commodities chosen must be the same in both cases. Thus, the cost minimisation problem is given by

$$\text{Min } M = \mathbf{pq} \text{ subject to } U(\mathbf{q}) = u. \qquad 2.3.3$$

Both the maximisation and minimisation problems are seeking the optimal values of **q**. In the original problem the solution was $x(\mathbf{p},M)$, or the Marshallian demand functions. In the dual, the determining variables are u and **p**. Using the Lagrangian to solve this problem, the n+1 first order derivatives for the cost minimisation problem are

$$\mu\frac{\delta U}{\delta q_i} = p_i \qquad 2.3.4$$

$$u = U(\mathbf{q}) \qquad 2.3.5$$

where μ is the Lagrangian multiplier. The solution for the n+1 unknowns depends on **p** and u. Hence, the cost minimisation demand functions, or Hicksian demand functions are given by

$$q_i = c_i(\mathbf{p},u) \qquad 2.3.6$$

and tells us how quantity is affected by prices with utility held constant. As with the derivation of the indirect utility function, substitution of the solution back into the original problem gives:

$$M = \Sigma\mathbf{pq} = \Sigma\mathbf{p}c(\mathbf{p},u) = E(\mathbf{p},u). \qquad 2.3.7$$

The function $E(\mathbf{p},u)$ is the minimum cost of attaining u at prices **p** and is known as the expenditure function. It is also the solution to the dual problem. The expenditure function and indirect utility function are intimately related. Since $E(\mathbf{p},u) = M$, the inversion of $E(\mathbf{p},u)$ gives u as a function of M and **p**, or $u = V(\mathbf{p},M)$. Similarly, inversion of $u = V(\mathbf{p},M)$ gives $M = E(\mathbf{p},u)$.

The expenditure function's properties were expressed as follows by Deaton and Muellbauer (1980):

1. The expenditure function is an increasing function of prices. An increase in any individual price will decrease utility. To maintain the original level of utility, expenditure must be increased.

2. If all prices change by the same proportion, the level of expenditure required to attain a fixed utility target must also change by the same proportion. In other words, $E(\mathbf{p},u)$ is homogenous of degree one in all prices.

3. $E(\mathbf{p},u)$ is concave in all prices. Concavity implies that as prices rise, cost rises no more than linearly. This is essentially because the consumer minimises costs by rearranging purchases in order to take advantage of changes in the structure of prices.

It is also assumed that the expenditure function is continuous in prices, and that the first and second derivatives with respect to price exist everywhere (Cornes, 1992).

With this information we can prove another expenditure function property known as Shephard's Lemma. Consider what happens to the expenditure function if p_i changes. Smith (1987) showed that as p_i changes, the consumer continues to minimise their expenditure so that q_i and M change to keep equations 2.3.4 and 2.3.5 satisfied. Given equation 2.3.7, differentiating with respect to p_i

$$\frac{\delta E(\mathbf{p},u)}{\delta p_i} = c_i(\mathbf{p},u) + \Sigma p_j \frac{\delta c_j(\mathbf{p},u)}{\delta p_i}. \qquad 2.3.8$$

But for all j

$$p_j = \mu \frac{\delta U(\mathbf{q})}{\delta q_i}$$

so that

$$\Sigma p_j \frac{\delta c_j(\mathbf{p},u)}{\delta p_i} = \mu \Sigma \frac{\delta U(q)}{\delta q_j} \cdot \frac{\delta c_j(\mathbf{p},u)}{\delta p_i} \qquad 2.3.9$$

and the fact that $U(\mathbf{q}) = u$ is constant implies that the right hand side of this equation is zero. Thus, $dE(\mathbf{p},u)/dp_i = c_i(\mathbf{p},u)$. The derivative of the expenditure function with respect to the price of a good is equal to the quantity demanded of that good. This property is known as Shephard's Lemma. It demonstrates how the expenditure function derivative with respect to price p_j is a Hicksian demand curve. Shephard's Lemma allows the derivation of those Hicksian demand properties which result from optimising behaviour as a consequence of the expenditure function properties.

One important Hicksian demand function property can be obtained on the basis of economic logic (Barten, 1982). For a fixed utility level, u, consider two price vectors p_1 and p_2, and the associated demand vectors $q_1 = c(\mathbf{p},u)$ and $q_2 = c(\mathbf{p},u)$. Using the property that q_1 and q_2 are expenditure minimisers, we obtain

$$p_1q_1 \leq p_2q_1 \text{ and } p_2q_2 \leq p_2q_1.$$

Adding and rearranging gives

$$(p_1 - p_2)(q_1 - q_2) \leq 0.$$

Now suppose that every entry of q_1 is the same as the corresponding entry of q_2 except that p_i has changed from p_1 to p_2. Then

$$(p_{i1} - p_{i2})(q_{i1} - q_{i2}) \leq 0$$

and for all i

$$\frac{\delta E_i(\mathbf{p},u)}{\delta p_1} \leq 0.$$

These equations show that if p_i rises with all other p_j constant and u constant, q_i falls or stays constant. Therefore, the demand function of an expenditure minimising consumer for any good is a function of the price of that good. This is the most simple of the properties of Hicksian demand functions and is known as the negativity of the own price substitution effect.

As well as the negativity of the own price substitution effect, Cornes (1992) specified the following additional properties of the Hicksian demand functions. These were:

1. Homogeneity of degree zero in all prices. This can be seen by recalling that the expenditure function is homogenous of degree one, so that its partial derivatives are homogenous of degree zero. The homogeneity condition implies that

$$\Sigma\left(\frac{\delta c_i(\mathbf{p},u)}{\delta p_j}\right)p_j = \Sigma c_{ij}p_j$$

for all i.

Thus, the price weighted sum of compensated price responses of x_j is zero. This means that if n-1 of these responses is known, so is the nth.

2. Symmetry of compensated cross price responses. This is a consequence of Shephard's Lemma and of the continuity property of the expenditure function. Assuming that the second derivative of the expenditure function with respect to prices is continuous, application of Young's theorem tells us that

$$c_i(p,u) = \frac{\delta E(\mathbf{p},u)}{\delta p_i}$$

$$c_{ij} = \frac{\delta^2 E(\mathbf{p},u)}{\delta p_i \delta p_j} = \frac{\delta^2 E(\mathbf{p},u)}{\delta p_j \delta p_i} = c_{ji}$$

This provides a further set of *a priori* restrictions because it means that once c_{ji} is known, so is c_{ij}. The symmetry and homogeneity restrictions can be combined to yield the further restriction

$$\Sigma\left(\frac{\delta c_i}{\delta p_j}\right)p_j = \Sigma c_{ij}p_i$$

3. Negativity. The fact that the own price response is non-positive is a reflection of the concavity of the expenditure function. Concavity of $E(\mathbf{p},u)$ in prices implies that the matrix of second derivatives $\delta^2E/\delta p_ip_j$ or c_{ij} is negative semi-definite. This implies the following set of inequalities;

$$c_{ii} \leq = 0$$

$$\begin{vmatrix} c_{ii} & c_{ij} \\ c_{ji} & c_{jj} \end{vmatrix} \geq 0$$

$$\begin{vmatrix} c_{ii} & c_{ij} & c_{ik} \\ c_{ji} & c_{jj} & c_{jk} \\ c_{ki} & c_{kj} & c_{kk} \end{vmatrix} \leq 0$$

$$\begin{vmatrix} \{c_{ij}\} \end{vmatrix} = 0$$

The last of these conditions refers to the NxN determinant formed by all the price responses. It is zero because of the homogeneity of the demand system (Cornes, 1992).

4. Adding up. The total value of demands is total expenditure, that is $\Sigma p_jc_j(\mathbf{p},u) = M$.

Hicksian demand functions reflect the *a priori* restrictions implied by rationality, whereas the Marshallian demand functions are the most natural and commonly used form in the estimation of demand systems. Clearly, it is important to relate the two types of functions so that the analysis that uses the Marshallian formulation can still exploit these restrictions.

2.4 THE SLUTSKY EQUATION AND COMPARATIVE STATICS.

We can now look at the relationship between the demand functions x(**p**,M) and x(**p**,u). Clearly, if the consumer is solving the expenditure minimisation problem with utility u and actually spending M, the same bundle of goods maximises utility subject to a budget of M and gives a value of utility u. Hence, $x_i(\mathbf{p},u) = x_i(\mathbf{p},M)$ if $M = E(\mathbf{p},u)$; that is

$$x_i(\mathbf{p},u) = x_i(\mathbf{p}.E(\mathbf{p},u)). \qquad 2.4.1$$

Differentiating with respect to p_i gives

$$\frac{\delta x_i(\mathbf{p},u)}{\delta p_i} = \frac{\delta x_i(\mathbf{p},M)}{\delta p_i} + \frac{\delta x_i(\mathbf{p},M)}{\delta M} \cdot \frac{\delta x_i(\mathbf{p},u)}{\delta p_i} \qquad 2.4.2$$

and given that $\frac{\delta E(\mathbf{p},u)}{\delta p_i} = x_i(\mathbf{p},u)$, rearranging yields

$$\frac{\delta x_i(\mathbf{p},M)}{\delta p_i} = \frac{\delta x_i(\mathbf{p},u)}{\delta p_i} - q_i \frac{\delta x_i(\mathbf{p},M)}{\delta M} \qquad 2.4.3$$

which is the Slutsky equation. It divides the price effect into a substitution effect and an income effect. It can be seen that the parameters of the Hicksian demand functions are related to those of the Marshallian demand functions, so that the results imply useful restrictions on the observable values of Marshallian price response of demand to price changes.

Application of Slutsky's equation reveals the values of the remaining Hicksian price response values. Although c_{ij}'s are not directly observed, the relationships between them enter the system of Hicksian demands and imply substantial and potentially useful *a priori* restrictions on the observable behaviour of a rational consumer. Alternatively, independent estimation of demand parameters can be used to provide tests of the theory.

2.5 EXTENSIONS OF THE THEORY.

Many theoretical and empirical applications of consumer behaviour models make use of significant modifications or extensions of the consumer preferences we have thus far analysed. This section deals with one such modification.

2.5.1 Separability.

For many purposes it is necessary to impose additional structure on preferences. In the case of the estimation of a demand system, rather inadequate data sets are used to estimate the parameters. Thus, the degrees of freedom are low, resulting in a reduction in the explanatory power of the estimation procedures used (Brown and Deaton, 1973). By imposing a more *a priori* structure on a model, additional degrees of freedom can be obtained. Separability is a solution to this problem. Separability is based on the reasonable assumption that goods fall naturally into groups in such a way that there is more independence in some forms of decision making than in others.

Barten (1977) describes preference ordering as being separable into mutually exclusive groups if the preference ordering of a certain group is independent of what goods one consumes outside the group. Deaton and Muellbauer (1980) defined separability as being characterised in terms of preference ordering. Let q_1 be some sub-vector of the commodity vector q, so that $q = (q_1,q_2)$. When the conditional ordering on goods in q_1 is independent of consumption outside the group, q_2, then q_1 is said to be weakly separable if the direct utility function takes the form

$$U = v(v_1(q_1), q_2) \qquad 2.5.1$$

where $v_1(q_1)$ is the sub utility function associated with q_1. This equation is equivalent to the existence of a preference ordering over q_1 alone: choices over the q_1 bundles are consistent, independent of the vector q_2. If all q can be separated into n groups, $(q_1, q_2,..., q_n)$, these preferences can be represented through the utility function

$$U = f[v_1(q_1), v_2(q_2), ... , v_n(q_n)] \qquad 2.5.2$$

for sub-vectors $q_1,..., q_n$ and some function f which is increasing in all arguments. Because v is increasing in the sub-utility levels, maximisation of overall utility implies maximisation of sub-utilities subject to optimal expenditure on each sub group, or that the marginal rate of substitution between two goods is independent of expenditure on goods outside the sub-group (Sono, 1961).

If this is the case, there are two levels in the decision process. At the first level it is decided what to spend on each group in total. At the second level, the actual choice of quantities of the goods in each group is made, given the total expenditure for the group. This second level allocation problem is formally analogous to the overall choice problem (Barten, 1982). As a result, if a utility function takes the form of equation 2.5.2, the implication is the existence of sub-group demands, or conditional demands of the form

$$q_i = x_i(p_i, M_i) \qquad 2.5.3$$

where $M_i = \Sigma p_i q_i$ is total expenditure on group x_i.

These conditional demand functions share all the properties of the usual demand functions except that their domain range is limited to M_i and p_i. Given $v_i(q_i)$, p_i and M_i, then δq_i is known.

However, M_i is not given exogenously, but as part of the overall optimisation problem. Barten and Bohm (1980) deal with this complication by letting $x_i(\mathbf{p},M)$ be the ith sub-vector of the demand function $x(\mathbf{p},M)$. Then, M_i is given by

$$M^*_i(\mathbf{p},M) = p_i x_i(\mathbf{p},M) \qquad 2.5.4$$

In general, the full price vector **p** is needed to determine M^*_i. When using M^*_i generated by $M_i(\mathbf{p},M)$ in the conditional demand functions, they obtain the same demand vector as one given by $x_i(\mathbf{p},M)$, that is

$$x_i(p_i, M^*_i(\mathbf{p},M)) = x_i(\mathbf{p},M) \text{ for all i.} \qquad 2.5.5$$

This equation shows how other prices affect the demand for q_i only by way of the scalar function $M^{*}_{i}(\mathbf{p},M)$. This implies a considerable restriction on the scope of impact of p_i. If one can observe M_i empirically one can concentrate on conditional demand functions for which only the p_i were needed. Therefore, if the utility function is separable, then once the M_i's have been correctly chosen, the allocation of each between the commodities in that group can be determined without reference to any other group.

2.5.2 Separability and the Slutsky Matrix.

Separability of the utility function implies restrictions on the Slutsky matrix because of the structural impact of p_i on demand for commodities in sub-groups other than the one i belongs to. Following Layard and Walters (1978, pp165-7), if good i belongs to group r, the demand for good i can be expressed as a function of M and the whole price vector,

$$q_i = x(\mathbf{p},M). \qquad 2.5.6$$

However, weak separability implies that it can be expressed as a function of expenditure on its own group r (M_r) and of the price vector of the goods in group r only (p_r). Therefore,

$$q_i = x(p_r,M_r). \qquad 2.5.7$$

The cross price effects, $\delta q_i/\delta p_j$, can be inferred where $i \in r$ and $j \in s$, $r \neq s$. If prices in r are constant and price j in group s changes, then the uncompensated price effect is

$$\frac{\delta q_i}{\delta p_j} = \frac{\delta q_i}{\delta M_r} \cdot \frac{\delta M_r}{\delta p_j} \qquad 2.5.8$$

$$= \frac{\delta q_i}{\delta M_r} \chi_{rj}, \qquad 2.5.9$$

where

$$\chi_{rj} = \frac{\delta M_r}{\delta p_j}.$$

A change in p_j will affect all goods in group r in a way that is proportional to their response to expenditure in group r, where χ_{rj} is the factor of proportionality. The compensated price effects were given as

$$\left(\frac{\delta q_i}{\delta p_j}\right)_u = \frac{\delta q_i}{\delta M_r}\frac{\delta q_j}{\delta M_s}\lambda_{rs} \qquad 2.5.10$$

where λ_{rs} is a common term applying to all goods in r and s. The compensated cross substitution effect is thus a given substitution term between r and s times the response of each good to expenditures on its own group. Subsequently, weak separability gives a two tier structure on the substitution matrices. Within each group no restrictions are placed on substitution and we have n completely general inter-group Slutsky matrices because $\delta/\delta x_k(u_i/u_j) = 0$, for all $k \neq i, j$. Between groups, the only means of contact is through total expenditure. Thus, inter-group substitution is done through the total expenditure for that group.

CHAPTER THREE

QUALITY, PRICE AND COMMODITY AGGREGATION

3.1 PRICES, EXPENDITURE, QUALITY EFFECTS AND DEMAND ANALYSIS.

Because cross-section data is collected over a short time period, it is often assumed that households face the same prices. Hence, household expenditure surveys are used extensively to estimate Engel functions. By definition, an Engel's function is a relationship between income and expenditure on a particular commodity, all other things being equal (Phlips, 1974). This definition implies that the Engel function is a demand function derived from a constant (constrained) utility function with all prices assumed constant. However, this assumption of constant prices is based on temporal variation only. If prices vary spatially between regions, then traditional Engel analysis may be inappropriate. Consequently, the results of the previous chapter hold, and cross-sectional demand becomes a function of income and *prices*.

Attempts have been made to calculate prices from survey data by dividing reported expenditures by reported quantities to obtain implicit prices[2], or unit values (Deaton, 1990). Because implicit prices are easy to calculate and are not based upon restrictive assumptions, they are widely used by researchers to estimate prices from budget survey data (see Pitt, 1982; Capps et al, 1985; and Gao et al, 1994). Studies using unit values have shown substantial variation in these implicit prices. This finding made sense in light of high transport costs. But Deaton (1988) said that it was not possible to use unit values as direct substitutes for true market prices. Because commodity expenditure contains information on prices, quantity and *quality*, unit values will contain information on price and quality. Quality choice may itself reflect the influence of prices as consumers respond to price changes by altering both quantity and quality, resulting in a substitution as an increase in price generates a less than proportionate increase in unit value.

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[2] Attempts to measure prices from cross-section data have also included the Household Equivalence Hypothesis and Additive preferences. However, both these methods have been empirically rejected (see Muellbauer, 1977; and Deaton, 1974).

In response to quality effects, Cox and Wohlgenant (1986) developed a model which separated out quality from quantity decisions using a hedonic pricing function. Like Deaton (1988), they felt that failure to adequately specify cross-sectional price effects could result in biased and misleading demand elasticities, making traditional Engels analysis in which prices are assumed to be constant, inappropriate. This was based on the assumption that rich households bought more expensive food commodities than poor households, so that unit values were systematically and positively related to household income. Also, there was the likelihood that quality would be negatively related to price so that in times of high price, or areas of high price, quality would tend to be lower (Cox and Wohlgenant, 1986).

Cox and Wohlgenant felt that both price and quality variation could be attributed to regional and seasonal variation, but was largely due to heterogeneous commodity aggregation. When separate goods are aggregated into a single commodity, variations in average price paid for the aggregated commodity would result. The importance of adjusting for quality effects was shown by using the result of Cramer (1973) who made the distinction between income and expenditure elasticities. Cramer's commodity/goods distinction and the generalisation of his quality elasticity was found to be a special case of the Houthakker-Theil model of quality choice.

Using the separability assumption to reduce the model's general framework, Cox and Wohlgenant assumed that a household decides whether or not to consume a commodity aggregate whose quality has been determined by prior decisions concerning the component goods' quantity shares. Conditional on this choice, a decision as to the composite commodity's quantity is then made. In other words, one can assume that a household first determines commodity quality through the selection of component goods, and then the composite commodity's quantity. This meant that the household quality decision can be modelled independently of the quantity decision. To account for difficulties encountered where prices were not observed for non-consuming households when estimating quantity demanded, a first order missing regressor procedure was used.

The two-stage approach developed by Cox and Wohlgenant provided both quality adjusted prices and an estimate of the Prais-Houthakker quality elasticity when estimating the price/quality functions during the first stage.

However, aside from the quality choice problem, there are errors of measurement in expenditures and quantities. Unit values are calculated by dividing expenditures by quantities, so that errors of measurement in either will not only cause the unit value to be measured with error, but is also likely to generate a spurious negative correlation between quantity and unit value, leading to a biased estimate which is either larger or smaller than the true value (Deaton, 1988). Deaton (1988) considered this problem more important than adjusting for quality effects. Therefore, even though the prices and price elasticities calculated using the approach of Cox and Wohlgenant will not be contaminated by quality effects, they could still be contaminated by measurement error, and the estimated price elasticities could still be biased.

3.2 THE WITHIN-CLUSTER MODEL.

Deaton (1987, 1988, 1990) developed a methodology for eliminating both quality and measurement error to produce unbiased price elasticity estimates. Given the possibility of biased estimates resulting from spurious correlations, the approach of Deaton will be used to estimate Indonesian food consumption in this study.

Like Cox and Wohlgenant, the model used by Deaton was adapted from the Houthakker-Theil model and assumed quality effects were also caused by aggregation errors. Quantity and quality were specified to be functions of household income, price, and household characteristics. However, instead of assuming that quantity/quality choice was dichotomous, Deaton viewed the quantity/quality choice as being a simultaneous decision, and his methodology reflected this. Deaton assumes that households which live in the same village and which were interviewed at the approximately the same time, would produce no variation in market price within each cluster. Within-cluster variation in purchases and unit values could therefore be used to estimate the influence of incomes and household characteristics on quantities and qualities without data on prices.

Variation in unit values within the clusters could also indicate the importance of measurement error. In contrast, variation in behaviour between clusters was at least partly due to cluster-to-cluster variation in prices, and this effect could be isolated by allowing for the quality effects and measurement errors that are estimated at the first, within-cluster, stage.

Deaton's published version of his first his first paper, Deaton (1988), used the logarithmic formulation where the analysis was confined to the single-commodity case, and thus the measurement of own-price responses. Deaton (1987) developed a unified statement of the methodology for the system case, but was confined to the estimation of demands conditioned on market purchases. Deaton (1990) was intended to supersede both these earlier treatments by estimating a system of unconditional demand equations. Computing limitations, however, restricts this study to the use of the double-logarithm demand functions of Deaton (1988). Despite being inconsistent with demand theory, this model still provides a means of estimating unconditional demands and quality adjusted price and expenditure elasticities, as well as the Prais-Houthakker quality elasticity. The double-logarithm specification only allows for the calculation of own-price elasticities, although the method used for the calculation of the expenditure elasticities is equivalent to Deaton (1990). Consequently, what follows is an exposition of Deaton (1988).

3.2.1 Conceptual Framework.

The data to be analysed come from surveys in which the unit of observation are households which are geographically clustered. The basic assumption is that all households in the same cluster face the same market prices for goods and that market prices may vary between clusters.

The quantity of a commodity (e.g. meat) purchased (or consumed) by a household at location c is written

$$Q_c = k^0 q_c$$

where q_c is the vector of quantities of goods which make up the commodity and k^0 is an aggregating vector (e.g. kilograms, calories, etc.).

Deaton postulates that at cluster c, the price vector for the goods comprising the commodity is λ_c[3].

Deaton assumes there exists a positive linearly homogenous function of λ_c, $p_c\lambda_c$, where the value p_c is to be thought of as the commodity price level index in cluster c. Given p_c, Deaton writes

$$\lambda_c = p_c.\lambda^{*}_{c}$$

where λ^{*}_{c} is a vector of relative prices of goods making up the commodity.

Expenditure on the commodity is denoted by E_c, which is $\lambda_c q_c$. Hence, unit value of the commodity, V_c, is given by

$$V_c = \frac{E_c}{Q_c}$$

$$= p_c\left(\frac{\lambda^{*}_{c}q_c}{k^0 q_c}\right)$$

$$= p_c v_c$$

where v_c is Deaton's measure of commodity quality. It is unlikely that all goods making up a commodity will have the same income (or price) elasticity, so that not only will richer households consume more of a commodity than poorer households (on a per capita basis), the commodity they consume will consist of goods in different proportions to the commodity consumed by poorer households. The price (p_c) of the commodity, and

[3] The notation used here differs from that used by Deaton 1988 for reasons of consistency.

household characteristics (demographics), may also be expected to influence the proportion of goods comprising the commodity consumed.

The measure of commodity quality is captured by Deaton's quality index v_c. It is in this sense then, that unless there are no quality effects, the unit value of a commodity is not the price of a commodity. And, measured in logarithms, unit value is the sum of price and quality. Also, since quality depends on the proportion of goods making up the commodity, unit value is a choice variable affected by the same variables that influence the quantities of goods consumed.

Consequent on the above, Deaton's 1988 model consists of explanatory equations for both the budget share and unit value of a commodity:

$$w_{ic} = \alpha_1 + \beta_1 \ln X_{ic} + \gamma_1 z_{ic} + \theta_1 \ln p_c + f_c + u_{1ic} \quad 3.2.1$$

$$\ln V_{ic} = \alpha_2 + \beta_2 \ln X_{ic} + \gamma_2 z_{ic} + \theta_2 \ln p_c + u_{2ic} \quad 3.2.2$$

where,

w_{ic} : budget share (E_c/X) for the commodity in the ith household budget - includes actual purchases and imputed expenditures;

V_{ic} : the commodity unit value - computed from market purchases only;

X_{ic} : total household expenditure on all commodities and services - commonly expressed per capita;

p_c : the unobserved unit price of the commodity in the cth cluster;

z_{ic} : a vector of household characteristics; γ_1 and γ_2 are corresponding vectors of model coefficients; and

f_c : a set of cluster fixed effects (one for each cluster). These represent unobservable taste variation (due to religion, ethnic origin etc.) from cluster to cluster, and can be thought of as residuals in a cross-cluster explanation of purchases.

u_{1ic} and u_{2ic} are model residuals that may in part be due to measurement errors in w and lnV and hence may be correlated.

The errors u_{1ic} have variance σ_{11} and, conditional on households making purchases in the market, the errors u_{2ic} have variances σ_{22}, and covariance σ_{12} with u_{1ic}.

Both model equations are functions of the same explanatory variables, with the exception of the f_c variables which do not occur in the unit value equation; as explained in Appendix B, their inclusion in equation 3.2.2 would preclude any inference about price from unit values and the model would not be identified. The cluster fixed effects are taken to be orthogonal to the unobserved price term.

3.2.2 Elasticities.[4]

Three elasticities are recovered directly from Deaton's model coefficients; others can be acquired from these. The three elasticities obtained directly are

(i) Prais and Houthakker Quality Elasticity:

$$\eta_X = \frac{d\ln v}{d\ln X} = \beta_2. \qquad \text{A.5}$$

(ii) Expenditure Elasticity:

$$\psi_X = \frac{d\ln E}{d\ln X} = w^{-1}\beta_1 + 1. \qquad \text{A.6}$$

[4] **Refer to Appendix A for derivation of these results. Equation numbers in this section refer to those in Appendix A.**

(iii) Quantity Elasticity:

$$\varepsilon_p = \frac{d\ln Q}{d\ln p} = w^{-1}\theta_1 - \theta_2 \qquad \text{A.9}$$

$$= \theta_1(w^{-1} - \phi^{-1}) \text{ where } \phi = \frac{\theta_1}{\theta_2}.$$

The relationship between these and other elasticities of potential interest are given below.

$$\varepsilon_X = \frac{d\ln Q}{d\ln X} = \psi_X - \eta_X \text{ (Demand elasticity)} \qquad \text{A.7}$$

$$\varepsilon_V = \frac{d\ln Q}{d\ln V} = \frac{\varepsilon_p}{1 + (\eta_X\varepsilon_p/\varepsilon_X)} \qquad \text{A.14}$$

$$\eta_E = \frac{d\ln v}{d\ln E} = \frac{\eta_X}{(\varepsilon_X + \eta_X)} \qquad \text{A.8}$$

$$\eta_p = \frac{d\ln v}{d\ln p} = \frac{\eta_X\varepsilon_p}{\varepsilon_X} \qquad \text{A.10}$$

$$\psi_p = \frac{d\ln E}{d\ln p} = 1 + \eta_p + \varepsilon_p\,. \qquad \text{A.12}$$

All of these elasticities, apart from η_X, are conditional on budget share for the commodity of interest. From equation 3.2.1, taking the average over all clusters and at the overall mean for $\ln p_c$, we have

$$w = \overline{w} + \beta_1(\ln X - \overline{\ln X}) + \gamma_1(z - \overline{z})$$

where $\overline{w}$ is the overall mean budget share for the commodity. It is therefore possible to explore changes in relevant elasticity values relative to deviations in total expenditure and household demographic characteristics from their respective sample means.

In the absence of quality effects we have dlnV = dlnp and relevant elasticities are computed from the parameters of equation 3.2.1, with observed commodity unit value replacing the 'unobservable' price. We would then have

$$\psi_X = \varepsilon_X = w^{-1}\beta_1 + 1$$

$$\varepsilon_V = \varepsilon_p = w^{-1}\theta_1 - 1$$

$$\psi_p = \varepsilon_V + 1.$$

3.2.3 Model Estimation.

Zero budget share observations are included in the estimation of equation 3.2.1, so that the conditional expectation of w is taken over consuming and non-consuming households alike. Budget share (at least for some commodities) is clearly a censored variable (w > 0 or w = 0). Instead of following the traditional methodology of postulating a structural model and then dealing with the censoring (e.g. via the Tobit model), Deaton postulates that the conditional expectation of budget share directly takes the form of equation 3.2.1. While Deaton recognises that given the inclusion of zero sample observations in OLS estimation, the question of the proposed model's plausibility for the conditional expectation of budget share remains unresolved, he states that it is far from clear whether it would be possible to disentangle the effects of the censoring from the underlying structural form without essentially arbitrary and untestable underlying assumptions.

As was mentioned in the previous section, a model for population expected budget share is needed if the objective is to explore how elasticities change relative to changes in explanatory variables. Consistent residual estimates from the budget share model for households making commodity market purchases are also required for some parameter estimates. It would appear therefore that, in spite of Deaton's comments, exploration of censored dependent variable estimation methods might be worthwhile. However, computing limitations precluded such an exploration in this study.

Following Deaton, estimation takes place in two stages. In the first stage, the parameters β_1, β_2, γ_1 and γ_2 are estimated by OLS applied to data with cluster means removed. This subtraction eliminates both the cluster fixed effects from the budget share equation and the unobserved cluster invariant prices from both equations.

For the ith household in the cth cluster we have

$$w_{ic} - \overline{w_c} = \beta_1(\ln X_{ic} - \overline{\ln X_c}) + \gamma_1(z_{ic} - \overline{z_c}) + (u_{1ic} - \overline{u_c}) \qquad 3.2.3$$

$$\ln V_{ic} - \overline{\ln V_c} = \beta_2(\ln X_{ic} - \overline{\ln X_c}) + \gamma_2(z_{ic} - \overline{z_c}) + (u_{1ic} - \overline{u_{2c}}) \qquad 3.2.4$$

Generating the data with cluster means removed can be easily accomplished by regressing w_{ic}, $\ln V_{ic}$, $\ln X_{ic}$ and (the set of household characteristics variables) z_{ic}, on the set of cluster dummy variables (either with zero origin, or with the intercept term and excluding one cluster dummy), and requesting the resulting residuals. These residuals are the data required for estimating equations 3.2.3 and 3.2.4.

It may be worth noting that the resulting equation 3.2.3 and 3.2.4 parameter estimates and residuals could also be obtained by regressing the dependent variables w_{ic} and $\ln V_{ic}$ on the set of explanatory variables, $\ln X_{ic}$ and z_{ic}, plus dummy variables for all (but one of the) clusters. If the full set of cluster dummies is used (and hence the models are fitted with zero origin), in equation 3.2.1 the coefficient for the cth cluster dummy variable is $d_{1c} = f_c + \theta_1 \ln p_c$, and in equation 3.2.2 the corresponding coefficient is $d_{2c} = \theta_2 \ln p_c$. In comparison with this dummy variables approach, and where the total number of clusters is large (as is usually the case with household surveys), Deaton's intra-cluster regressions are parsimonious of computer space. But it should be clear that both approaches will lead to exactly the same parameter estimates and residual error values. However, it should also be clear that the OLS regression output for the intra-cluster regressions will use (n-k) and (n^+-k) as the respective error degrees of freedom; rather than (n-C-k) and (n^+-C-k) as is appropriate. Hence the reported standard errors and associated significance levels will be incorrect, and equation R^2 values will also be misleading relative to those for the 'full model' i.e. equations 3.2.1 and 3.2.2. The necessary corrections to the computer output for equations 3.2.3 and 3.2.4 are straightforward, but since this research has not focused unduly on these aspects of the model, these adjustments have not been made here.

Denoting the residual vectors of the first stage estimates as e_1 and e_2, and given there are C clusters and k explanatory variables (lnX and the set of z variables), then[5]

$$\sigma_{11} = (n\text{-}C\text{-}k)^{-1}e_1'e_1 \qquad 3.2.5$$

$$\sigma_{22} = (n^{+}\text{-}C\text{-}k)e_2'e_2 \qquad 3.2.6$$

where n is the total number of households over C clusters (used to estimate equation 3.2.3) and n^+ the total number of households that record market purchases of the commodity (used to estimate equation 3.2.4). Denoting e^+_1 as the elements of e_1 corresponding to households that do record market purchases of the commodity, we have

$$\sigma_{12} = (n^{+}\text{-}C\text{-}k)e_2'e_1^{+}. \qquad 3.2.7$$

The first stage parameter estimates are consistent as the sample size increases to infinity. Consistency here requires that cluster size is held constant, while the number of clusters increases, and that the model parameters (including the error variances and covariances, but excluding the f_c parameters) are the same for all clusters, so that within-cluster information can be pooled over a large number of clusters.

Second stage estimation requires the use of the first stage OLS estimates to 'correct' the observed budget shares and ln(unit values) to obtain

$$y_{1ic} = w_{ic} - \beta_1 \ln X_{ic} - \gamma_1 z_{ic} \qquad 3.2.8$$

$$y_{2ic} = \ln V_{ic} - \beta_2 \ln X_{ic} - \gamma_2 z_{ic}. \qquad 3.2.9$$

[5] Coefficients in italics represent sample estimates.

Interest from here centres on the between cluster means of these values for the n^+_c households in each cluster making market purchases of the commodity. As can be seen from equations 3.2.1 and 3.2.2, the population models for these cluster means may be written as

$$y_{1.c} = \alpha_1 + \theta_1 \ln p_c + f_c + u_{1.c} \qquad 3.2.10$$

$$y_{2.c} = \alpha_2 + \theta_2 \ln p_c + u_{2.c}\,. \qquad 3.2.11$$

It is shown in Appendix B that, over C clusters, where the f_c variables are orthogonal to $\ln p_c$

$$\mathrm{Var}(y_{2.c}) = \theta^2_2 \mathrm{Var}(x) + \sigma_{22}/\tau^+ \qquad 3.2.12$$

$$\mathrm{Cov}(y_{1.c}, y_{2.c}) = \theta_1\theta_2 \mathrm{Var}(x) + \sigma_{12}/\tau^+ \qquad 3.2.13$$

where Var(x) is the inter-cluster variance of $\ln p_c$ and where

$$\tau^+ = \frac{C}{\Sigma(1/n^+_c)}\,.$$

Rearranging equations 3.2.12 and 3.2.13 we obtain

$$\frac{\theta_1}{\theta_2} = \phi = \frac{\mathrm{Cov}(y_{1.c}, y_{2.c}) - \sigma_{12}/\tau^+}{\mathrm{Var}(y_{2.c}) - \sigma_{22}/\tau^+}\,. \qquad 3.2.14$$

As is shown in Appendix A, we then have

$$\theta_1 = \phi\{\beta_1 + w(1 - \beta_2)\}.\{\beta_1 + w - \phi\beta_2\}^{-1}. \qquad 3.2.15$$

Substituting empirical values (sample estimates) for population values in equations 3.2.14 and 3.2.15 yields consistent estimates for ϕ and θ_1, and hence a consistent estimate for ε_p.

This derivation deviates from the procedure used by Deaton in one respect. In his estimation of $Cov(y_{1.c}, y_{2.c})$, Deaton estimates $y_{1.c}$ from equation 3.2.10 using all households in a cluster, regardless of whether or not they have made market purchases of the commodity under study. In equation 3.2.13, therefore, Deaton replaces τ^{+} by τ where

$$\tau = \frac{C}{\Sigma(1/n_c)}.$$

However, the estimation of $y_{2.c}$ from equation 3.2.11 involves only households in a cluster which have made market purchases of the commodity under study. Hence, in this study, $Cov(y_{1.c}, y_{2.c})$ has been estimated using $y_{1.c}$ computed only from those households in a cluster which have made positive purchases in the market. As a result, τ^{+} appears in equation 3.2.13 rather than τ.

3.2.4 Measurement Errors and Quality Effects.

The cluster mean values $y_{1.c}$ and $y_{2.c}$ obtained from equations 3.2.8 and 3.2.9 are cluster mean budget shares and ln(unit values) after netting out the effects of total expenditure and household characteristics. Since from equations 3.2.10 and 3.2.11 $\frac{dy_{1.c}}{d\ln p_c} = \theta_1$ and $\frac{dy_{2.c}}{d\ln p_c} = \theta_2$ we have $\frac{dy_{1.c}}{dy_{2.c}} = \frac{\theta_1}{\theta_2}$ and OLS regression of $y_{1.c}$ on $y_{2.c}$ would therefore yield an estimate of $\frac{\theta_1}{\theta_2} = \phi$

$$\phi = \frac{Cov(y_{1.c}, y_{2.c})}{Var(y_{2.c})}. \qquad 3.2.16.$$

This is the sample counterpart to equation 3.2.14 without corrections to the numerator and denominator.

According to Deaton (1988), it is most likely that expenditure on a commodity (E) and commodity quantity consumed (Q) are measured with error. Hence budget share (w = E/X) and unit value (V = E/Q), and hence, $y_{1.c}$ and $y_{2.c}$ are both likely to be subject to measurement error. In addition, measurement errors in V would result in an inflated estimate of the variance for lnV, based on $y_{2.c}$.

Direct regression of $y_{1.c}$ on $y_{2.c}$ will therefore lead to a biased estimate of ϕ. Using cluster means will reduce, but not eliminate the bias induced by measurement errors in E and Q. On the other hand, the estimate of ϕ obtained by using equation 3.2.14 is a standard errors in variables estimator (Fuller, 1987 cited by Deaton, 1988).

Now, recalling that in the absence of quality effects dlnV = dlnp, hence $\theta_2 = 1$, we have the following results.

(i) In the presence of measurement errors and quality effects

$$\varepsilon_p = \theta_1(w^{-1} - \phi^{-1})$$

where ϕ is estimated via equation 3.2.14, and θ_1 is estimated via equation 3.2.15.

(ii) In the presence of measurement errors, but no quality effects

$$\varepsilon_p = w^{-1}\phi - 1$$

(since $\theta_2 = 1$ and θ_1 is directly estimated by ϕ via equation 3.2.14).

(iii) In the absence of measurement errors, but given there are quality effects

$$\varepsilon_p = \theta_1(w^{-1} - \phi^{-1})$$

where now ϕ is estimated by the direct regression of adjusted budget shares on adjusted ln(unit values), i.e. via equation 3.2.16, and θ_1 is estimated via equation 3.2.15.

(iv) In the absence of measurement errors and quality effects

$$\varepsilon_p = w^{-1}\phi - 1$$

where ϕ (i.e. θ_1) is estimated via equation 3.2.16.

3.3 Comparison of Price and Expenditure Elasticities.

Using the results of Deaton (1990), comparisons of his price elasticities with those estimated from other Indonesian food demand studies can be used to investigate whether the differences in estimates are in the direction Deaton's theory predicts.

Price Elasticities

In Deaton (1990), there were no goods with large estimated own price elasticities. There was also some tendency for the goods which had the lowest total expenditure elasticities to have absolutely low price elasticities, something that Deaton said might be expected for goods which were genuinely necessary. The rice price elasticity (-0.424) and cassava price elasticity (-0.325) can be compared with the estimates of Timmer and Alderman (1979), and Timmer (1981) who reported an average rice price elasticity of -1.105 and cassava elasticity of -0.814, and Chernichovsky and Meesook (1984) with price elasticities of -1.48 and -1.36 for rice and cassava respectively. Deaton felt that these discrepancies could result from the specification of the logarithm of quantity on the logarithm of unit value.

However, the difference in estimates when compared with van de Walle (1988) is not very large, although it was in the direction the theory predicts. Therefore if Deaton (1990) is correct, van de Walle's argument that the rice price may be relatively well measured has some credibility. The results of Teklu and Johnson (1988), with an estimated rice elasticity of -0.58, provides some evidence that even when unit values were not adjusted, a system of demand equations offered a better estimate than a single equation estimate.

Large differences between price elasticities for staples were also found when comparing the potato elasticity of Chernichovsky and Meesook (-3.35) with Deaton's (-0.953). Deaton found it implausible that such basic staples should display such high price elasticities, if only because there were few obvious substitutes. Of the remaining comparable products between these two studies - wheat, vegetables, legumes, and fruit - only the vegetable elasticity calculated by Chernichovsky and Meesook was found to have an absolute value less than that reported by Deaton. However, the magnitude of the difference for wheat, legumes and fruit was not as great when compared to the staples.

These results tend to confirm the hypothesis of Deaton (1988) who said that if price elasticities were measured using unit values instead of prices, a larger price elasticity would be estimated because of measurement error and the quality effects.

Expenditure Elasticities

In less developed countries, where information on income is not easily obtained, data on household expenditures are used to approximate income. As a result, the 'income elasticities' are estimated from observations on expenditures. However, these elasticities will be larger than those based on physical quantities because the income change includes a price effect due to quality as well as the quantity effect. Because Deaton's methodology accounts for quality effects in both expenditure and prices, a comparison of his results with comparable estimates from previous studies seems to confirm that income elasticities calculated from expenditures include quality effects.

However, this is a rather tentative assumption. The estimates in Table 3.1 suggest that rice was a luxury good between 1976 and 1980, and a necessary good after this period. The probable explanation for this is the achievement of self-sufficiency in rice production, combined with increased per capita GNP. Therefore, leading up to this period the main staple is likely to have been cassava.

In general, the rural expenditure elasticities for rice were relatively larger than those calculated for the urban areas. Huang and David (1993) said that this pattern may have two explanations. First, demand for more conveniently consumed food is greater in urban areas where both spouses typically work outside the home, travel times between work and home are large, and cost of household help is higher than in rural areas. Because wheat is typically consumed in the form of commercially supplied bread and instant noodles which can be easily purchased and consumed, it offers substantial time savings for the household. Secondly, agricultural labour requires more physical energy and thus calorie inputs than industrial work. At a given income, rural consumers will have a greater demand for the cheaper food per calorie, such as rice, or even roots and tubers, to maintain the calorie requirements for subsistence.

Table 3.1: Estimated Indonesian Rice Expenditure Elasticities

Study/Data base year	Location/Group[1]	Elasticity
Timmer and Alderman (1976)	urban(1)	0.997
	rural(1)	1.168
	urban(2)	0.759
	rural(2)	0.924
	urban(3)	0.533
	rural(3)	0.704
	urban(4)	0.700
	rural(4)	0.364
Timmer (1976)	low	1.617
	low-middle	1.248
	high-middle	0.939
	high	0.372
Chernichovsky and Meesook (1978)	(1)	3.022
	(2)	0.914
	(3)	0.034
Teklu and Johnson (1988)	urban	0.33
	urban	0.24
van de Walle (1981)	urban/rural[a]	0.48
	urban/rural[a]	0.54
	urban/rural[b]	0.43
	urban/rural[b]	0.48
Deaton (1981)	rural	0.490

[1]Group refers to expenditure group and location refers to urban/rural.
[a]Log-Log model.
[b]Tobit model.

With the exception of Deaton (1990), the expenditure elasticities reported for vegetables in Table 3.2 were similar. Vegetables, like rice, are a staple commodity in the Indonesian diet. Although the fruit elasticities in Table 3.2 seem to be declining, households in rural areas were expected to allocate smaller amounts of expenditure to fruit, and this could be the reason for the smaller elasticity estimated by Deaton. However, fruit is still a luxury good which can only be purchased by richer households. This is also true of meat and dairy products (found in Table 3.3), where with the exception of Teklu and Johnson (1988), the elasticity estimates were larger than two.

Table 3.2: Estimated Indonesian Expenditure Elasticities for Fruit and Vegetables

Study/Data base year	Location/Group[1]	Elasticity
Chernichovsky and Meesook (1978)[a]	(1)	0.953
	(2)	0.990
	(3)	0.559
Chernichovsky and Meesook (1978)[b]	(1)	1.901
	(2)	3.708
	(3)	2.617
Teklu and Johnson (1988)[c]	urban	0.85
	urban	0.86
Deaton (1981)[a]	rural	0.670
Deaton (1981)[b]	rural	1.385

[1]Group refers to expenditure group and location refers to urban/rural.
[a]Vegetables.
[b]Fruit.
[c]Fruit and Vegetables.

Table 3.3: Estimated Indonesian Expenditure Elasticities for Meat and Dairy Products

Study/Data base year	Location/Group[1]	Elasticity
Chernichovsky and Meesook (1978)[a]	(1)	3.948
	(2)	2.162
	(3)	2.534
Chernichovsky and Meesook (1978)[b]	(1)	0.076
	(2)	0.783
	(3)	2.203
Teklu and Johnson (1988)[c]	urban	1.40
Teklu and Johnson (1988)[c]	urban	1.40
Deaton (1981)[a]	rural	2.296

[1]Group refers to expenditure group and location refers to urban/rural.
[a]Meat.
[b]Dairy products.
[c]Meat and Dairy products.

Although the staple products consumption is increasing over time, there is evidence to suggest that it is doing so at a declining rate (Ito *et al*, 1989; Huang and David, 1993). In terms of meat, fruit and dairy products, no firm conclusions can be drawn as to changes in consumption patterns, but it is also likely that consumption is also increasing with income. Although, Deaton (1990) separated out the quality effects, the differing estimates may be explained more fully by changing consumption patterns resulting from rising incomes.

3.4 CONSISTENCY WITHIN THE DEATON MODEL: FOOD EXPENDITURE VERSUS TOTAL EXPENDITURE.

In the first published version of his model, Deaton (1988) used a 1979 household survey from the Cote d'Ivoire to estimate own price elasticities. Food expenditure was used to calculate the annualised per capita household expenditure and budget share variables. Expenditure on food was necessitated by the absence of data on total expenditure. However, Deaton felt that food expenditure would be theoretically acceptable if food was separable in preferences. In his 1990 paper, which extends and improves on his earlier work, Deaton used total expenditure.

Access to both food and total expenditure in the data set used in this study allows us to study what effect each definition has on price elasticities. Theoretically, however, there are problems in using both food expenditure and total expenditure to estimate the budget share equation for a commodity. This can be easily shown. If food expenditure is used to calculate budget shares, then we have

$$w_x = \frac{E}{x}$$

where E is expenditure on a commodity, x is food expenditure and w_x is budget share with respect to food expenditure. Alternatively, using total expenditure to calculate budget shares gives

$$w_X = \frac{E}{X}$$

where E is once again commodity expenditure, X is total expenditure and w_X is budget share with respect to total expenditure. However,

$$w_x = w_X\left(\frac{X}{x}\right) \text{ or, } w_X = w_x\left(\frac{x}{X}\right).$$

Thus, if equation 3.2.1 holds for w_x, then the same general form for 3.2.1 cannot hold for w_X and vice versa. The main point is that equation 3.2.1 cannot be applied to both w_x and w_X to make meaningful comparisons. If one model is correct, then the other is not.

Attention in this study has focused on estimating food commodity elasticities with respect to total expenditure. This was done for three reasons. Firstly, neo-classical demand theory indicates that it is more correct to use total expenditure in the calculation of budget shares. Secondly, using total expenditure is consistent with Deaton (1990). Thirdly, and most importantly, there is a problem in using commodity budget share with respect to food expenditure as the dependent variable in equation 3.2.1, along with ln(food expenditure) as a regressor, in the computation of price elasticities.

Derivation of elasticity formulae associated with Deaton's model specification are given in Appendix A. In several of the elasticity derivations it is necessary to assume dln(commodity expenditure)/dln(commodity price) = 0. This assumption may or may not be appropriate for food expenditure with respect to the prices of individual food prices. This assumption would seem unlikely to hold where p is an index of all food prices since x (total food expenditure) = ΣE_j, where E_j is expenditure on the jth commodity. Thus, $\frac{d\ln x}{d\ln p}$ will depend on the individual food commodity price elasticities plus budget shares. There is no corresponding doubt in the case of total expenditure.

Despite the rationale for the use of total expenditure given above, it remains unclear as to which model is more correct, w_x or w_X. This dilemma, however, can be overcome to some extent. While not necessarily solving the problem of which model is more correct, it is theoretically possible to go from an elasticity with respect to total expenditure to the corresponding elasticity with respect to food expenditure. Since

$$\frac{d\ln Q}{d\ln x} = \frac{d\ln Q}{d\ln X}\left(\frac{d\ln x}{d\ln X}\right)^{-1}$$

we only require an estimate of $\frac{d\ln x}{d\ln X}$ to make the transition. The obvious way to estimate $\frac{d\ln x}{d\ln X}$ would be to use $\frac{x}{X}$ (food expenditure budget share) as the dependent variable in equation 3.2.1 and, following Deaton, to estimate β_1 from the inter-cluster data. Because of the inherent uncertainty, such a transformation allows for the possibility of estimating a correct set of elasticities from an incorrect model.

Thus, the estimation of price elasticities using food expenditure and the possibility of estimating food expenditure elasticities from total expenditure elasticities (and vice versa) will be investigated to determine whether further empirical analysis is required.

3.5 Quality Variation and Theoretically Valid Quantity Aggregation.

Quality, in addition to complicating the definition of price, also complicates the definition of quantity. Deaton neglected these aggregation issues by using the simple sum of physical quantity to measure demand. If the goods in a group are heterogeneous, there exist as many physical quantity elasticities as there are dimensions in which to measure the good. In other words, if goods are heterogeneous, simple physical sums of quantities measure demand only for a single physical characteristic of the commodity, not for the commodity itself.

Nelson (1990) showed how this aggregation problem could be overcome. By applying Hick's composite commodity theorem, Nelson showed how a single, theoretically rigorous demand elasticity could be obtained using Deaton's estimation methodology. If one particular dimension is chosen to measure physical quantity, then a precise measure of commodity quality can also be defined, which subsumes a consumer's evaluation of all other aspects of the goods contained in the bundle purchased. In addition, the Hicksian composite commodity theorem can be used to reinterpret the earlier literature on quality choice in terms of a more general expression of preferences.

3.5.1 Theil-Houthakker Quality Model.

Both Deaton (1988), and Cox and Wohlgenant (1986), accepted and adapted the models of Theil (1952) and Houthakker (1952). Theil and Houthakker defined heterogeneous commodity quantities as the sum of physical quantities of elementary goods in the group (assumed to be measured in a common physical unit), while adding "quality" choice as a separate set of elements in the utility function

$$\text{Max } U(\mathbf{q},\mathbf{v}) \text{ subject to } \Sigma\mathbf{pvq} = M \qquad 3.5.1$$

where

$$\mathbf{q} = \Sigma x_i \qquad 3.5.2$$

is the physical quantity consumed of a commodity made up of elementary goods x, **v** represents quality (defined as a vector of characteristics), **p** is a composite price dependent on composite quality and M is income.

Nelson (1991) identified a number of difficulties with the model. First and foremost was the inherent ambiguity about how the quantities **q** related to the quantity demanded of consumer demand theory. Quantity demanded is a function of exogenous prices and income, and endogenous quality choice. Second, the use of such physical quantities involves a selection of one dimension of physical measurement from a range of possibilities. Nelson said that measurement in different physical quantity dimensions could suggest contradictory answers. Third, it was unclear, without further assumptions, how the **q**'s relate to any item of special interest. Finally, the model is difficult to solve in its general form. Additional assumptions are required to make the model both theoretically and empirically tractable. To get theoretical results, Theil made the assumption that intra-group prices moved proportionally. Meanwhile, Houthakker assumed that the functions $p_i(v_i)$ were linear in v_i, but also required that only one purchase could be made from each group.

Nelson was able to solve these problems by putting the quality issues into an aggregation theory context. Nelson (1991) showed how the Hicksian composite commodity assumption leads to interesting implications for quality choice and provides a theoretically valid quantity aggregate.

3.5.2 The Hicksian Composite Commodity.

Defining elementary goods as goods which are strictly homogenous (as opposed to heterogeneous commodities), the general model of preferences defined directly over elementary goods is

$$\text{Max } U(x_1,..., x_n) \text{ s.t. } \Sigma\lambda_i x_i = M \qquad 3.5.3$$

where x_i are physical quantities of the elementary goods and the λ_i are the corresponding exogenous prices.

Reformulation of this problem gives the dual equation discussed in chapter two:

$$\text{Min } M = \Sigma\lambda_i x_i \text{ s.t } U(x_1,....,x_n) = u \qquad 3.5.4$$

with the resulting expenditure function

$$E(\lambda_1,...,\lambda_n, u). \qquad 3.5.5$$

The composite commodity theorem asserts that if a group of prices move in parallel, then the corresponding group of commodities can be treated as a single good. For a composite commodity to exist, it must be a positive linear homogenous function of its elementary goods if price and quantity indices are to equal group expenditure. By assuming that prices $\lambda_1,...,\lambda_n$ bear some fixed ratio p to some base period prices $\lambda^0_1,...,\lambda^0_n$; that is $\lambda_i = p\lambda^0_i$, where p varies temporally or geographically but is common to all prices, the ratio λ_i/λ_j remains fixed at λ^0_i/λ^0_j. Deaton and Muellbauer (1980) said that p acts as a 'price' for a new combined group with a 'quantity' defined by weighting the individual quantities using the base period prices λ^0_i. Subsequently, the expenditure function can be written

$$E(p\lambda^0_1,...,p\lambda^0_n, u) \qquad 3.5.6$$

which, since λ^0_i are fixed, can be thought of as a function of u and p alone and is the grouped expenditure function. Therefore, the grouped expenditure function is

$$E^{*}(p,u) = E(p\lambda^{0}_{1},...,p\lambda^{0}_{n}, u). \quad 3.5.7$$

Differentiating $E^{*}(p,u)$ with respect to p gives

$$\frac{dE^{*}(p,u)}{dp} = \frac{dE(p,u)}{d\lambda_1}\frac{d\lambda_1}{dp} + ... + \frac{dE(p,u)}{d\lambda_n}\frac{d\lambda_n}{dp} = x_1.\lambda^{0}_{1} + ... + x_n.\lambda^{0}_{n}. \quad 3.5.8$$

Subsequently, the composite commodity is a base-price weighted sum of physical quantities. This can expressed alternatively as

$$Q_g = \Sigma\lambda^{0}_{i}x_i \quad 3.5.9$$

where Q_g is the composite commodity.

To summarise, if the relative price of a group of commodities, $x_1,...,x_n$, are fixed at $\lambda^{0}_{1},...,\lambda^{0}_{n}$, then for the purposes of demand analysis they can be treated as a single commodity, Q_g, with the price given by the appropriate index of goods prices, p_g. As such, the composite commodities can be treated as if they are elementary goods and the model collapses to the one given by equation 3.5.4.

3.5.3 Quality and Quantity Aggregation: An Extension of Deaton's Methodology.

In principle, the Hicksian composite commodity theorem does not require that goods be related in any other way than through their constant relative prices, which is not entirely implausible when dealing with food products. Because Theil (1952) also assumed proportional intra-group prices to make his model tractable, Nelson said that the Hicksian approach adds no additional assumptions relative to the older literature. Instead, the model represents a return to a more general expression of preferences. Consequently, Nelson showed that with restrictions on relative prices one can get both a strict justification for the use of a composite commodity and a clear and non trivial model of quality.

Using the Hicksian approach, Nelson (1991) expressed group expenditures as

$$E = \Sigma\lambda x = p\Sigma\lambda^{0}x = pQ \tag{3.5.10}$$

and unit values as

$$V \equiv \frac{E}{q} = \frac{pQ}{q}. \tag{3.5.11}$$

Nelson also defined quality, v, as

$$v \equiv \Sigma(\frac{x}{q})\lambda^{0} = \frac{\Sigma\lambda^{0}x}{q} \tag{3.5.12}$$

where as before $q \equiv \Sigma x_i$. This definition follows on from Theil (1952) and Cramer (1973) who characterised a quantity weighted sum of elementary goods base prices as being a measure of quality within a group.

If one adopts a Hicksian composite commodity model, the earlier literature on quality choice can be reinterpreted in a particularly clear way. The larger the proportion of higher priced goods in the consumer's purchased bundle, the higher the measure of quality.

The definition of relative quality depends on the dimension in which physical quantity is measured. That is, by choosing one of the dimensions in which the characteristics can be measured as reflecting quantity, the researcher's measure of quality is a scalar indicator of the consumer's valuation of all the omitted characteristics in the purchased bundle. Thus, if goods are heterogeneous, simple sums of physical quantities measure demand for a single physical characteristic of the commodity only, not demand for the commodity itself.

Using the definitions derived above, and for some specified dimension, Nelson (1991) obtained the following identities:

$$Q = vq \qquad 3.5.13$$

$$E = vpq \qquad 3.5.14$$

$$V = pv. \qquad 3.5.15$$

Composite quantity is a quality-adjusted quantity measure; expenditure on a composite can be broken down into exogenous price, and endogenous quality and physical quantity components; unit value has both exogenous price and endogenous quality components.

Nelson (1991) obtained the respective price and income elasticities by taking natural logarithms of these equations and differentiating with respect to the natural logarithms of p or X, where

$$\frac{d\ln Q}{d\ln p} = \frac{d\ln v}{d\ln p} + \frac{d\ln q}{d\ln p} \qquad 3.5.16$$

$$\frac{d\ln Q}{d\ln X} = \frac{d\ln v}{d\ln X} + \frac{d\ln q}{d\ln X} \qquad 3.5.17$$

and because $\frac{d\ln p}{d\ln X} = 0$ and $\frac{d\ln p}{d\ln p} = 1$

$$\frac{d\ln E}{d\ln X} = \frac{d\ln Q}{d\ln p} \qquad 3.5.18$$

$$\frac{d\ln E}{d\ln p} = 1 + \frac{d\ln Q}{d\ln p} \qquad 3.5.19$$

$$\frac{d\ln V}{d\ln X} = \frac{d\ln v}{d\ln X} \qquad 3.5.20$$

and

$$\frac{d\ln V}{d\ln p} = 1 + \frac{d\ln v}{d\ln p}. \qquad 3.5.21$$

The first two equations can be interpreted as the sum of the physical quantity elasticity and the quality elasticity. The next two equations imply that the quantity and quality measures are not necessarily a derivation of price and income elasticities, but could be derived directly from the corresponding expenditure elasticities.

Deaton's use of the constant relative price assumption provides a natural extension to the definition of the Hicksian composite commodity when dealing with quality effects in prices. The assumption that the relative price structure is fixed within each commodity group and geographical cluster of households and the application of Hick's composite commodity theorem provides a theoretically rigorous means of obtaining a single well defined price elasticity of demand using his estimation methodology.

Nelson (1990) showed, using results derived from the U.S. Consumer Expenditure Survey and Deaton's methodology, that ignoring this result could lead to severely misleading results. If estimated quality income elasticities were larger in absolute value than the physical quantity elasticities, negative income elasticities of physical quantity could be counterbalanced by sizeable positive income elasticities of quality, so that the income elasticities of demand (the sum of quantity and quality elasticities) were less negative than those for physical quantity.

CHAPTER FOUR

DATA DESCRIPTION AND EMPIRICAL SPECIFICATION

4.1 THE SUSENAS SURVEY[6].

This study uses data from the 1990 National Socio-economic Survey (SUSENAS), conducted by the Indonesian Central Bureau of Statistics. The survey's objective is to obtain data on the Indonesian population's food consumption patterns. The SUSENAS includes consumption data, and demographic information on household members. The SUSENAS is conducted every year and contains three modules: (1) consumption and income; (2) health, education, and housing and; (3) socio-culture, criminality, and domestic travel. The original data set contains approximately 49,000 households, located in 27 provinces. The data used in this study is a sub-sample drawn from the SUSENAS.

4.1.1 Data Collection.

Information on food item consumption was collected by the Central Bureau of Statistics using two methods. Illiterate respondents were interviewed directly, while literate respondents were given a form on which to record details of food consumed over the week. Information on non-food consumption or expenditure was obtained by direct interview.

The design of the survey involves a three stage sampling procedure applied to both rural and urban households. The procedure used is as follows: (i) villages were selected with probability proportional to the number of census blocks in the village; (ii) census blocks were randomly selected; and (iii) 15 homogenous households were randomly drawn to represent each selected segment group.

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[6] Because the SUSENAS language is Indonesian, this section is a reproduction of the data chapter in Hakim, D.B (1994) Household Food Expenditure Patterns in Urban Java, Indonesia. Unpublished Thesis, Massey University, pp39-45.

4.1.2 Sampling Method and Survey Period.

Sample selection involved dividing every province into urban and rural areas according to the classification established for the 1990 population census (SP90). The SUSENAS is a household sample survey in which the samples were selected to statistically represent all parts of the country. With 49,000 households in the total sample, the SUSENAS can provide both national and provincial estimates, as well as urban and rural estimates.

The survey period was one week prior to the enumeration date for food consumption. Non-food expenditure information (housing, clothing, miscellaneous goods and services, consumption on taxes and insurance premiums, and parties and ceremonies), was collected either at the end of the month, or end of the year. The data used is drawn from the first round of the 1990 SUSENAS conducted during January-February 1990.

4.1.3 Commodity Coverage.

There are more than 200 food items listed in the SUSENAS questionnaire which are classified into 11 food groups. These groups are cereal, pulse vegetables, fruit, fish, meat, milk and eggs, spices, sugar, beverages, and prepared food and tobacco. Data collected on food items included the quantity and value of each food consumed, with the exception of the prepared food group, in which only the value was recorded.

4.1.4 Regional Coverage.

The sub-sample used in this study covers only urban households on the main island of Java, which is divided into five provinces - D.K.I Jakarta, West Java, Central Java, Jogyakarta, and East Java. Consequently, this study uses only 5708 of the original 49,000 households. The household distribution by province is shown in Table 4.1.

Table 4.1: Household Distribution by Province

Province	Household Distribution	Proportion of Sample
Jakarta	1389	24 %
West Java	1308	23 %
Central Java	1148	20 %
Jogyakarta	370	6 %
East Java	1493	27 %
Total	**5708**	**100 %**

4.1.5 Urban and Household Definition.

Because the study uses only urban data, a definition of urban as it pertains to Indonesian conditions must be specified. A region is classified as urban based on the following conditions:

(1) having a population density of more than 5,000 persons per square kilometre;

(2) less than 25% of employment is in the agricultural sector; and,

(3) at least 8 urban related facilities are available in that area, e.g. post office, bank, cinema, hospital, and school.

The unit of tabulation is the household. A household is defined as a person or group of persons who occupy a part or the whole of a building and generally eat together from one kitchen. A household generally consists of a husband, his wife, and their children, but can include any relatives or domestic servants who live with them. Persons who have room and board are also included in the household. Groups of students or employees (less than 10 persons) who occupy a building/house, although they eat individually are classified as a private household. But, if they number more than 10, they are considered as living in an institutional household and are excluded from the survey.

4.1.6 Definition of Expenditure.

Expenditures for consumption are defined as expenditures for food, beverages, clothing, parties, durable goods, etc. by every household member, either in or out of the home, either for individual needs or household needs. Expenditures for household enterprises, e.g. sugar or rice which are used for sale, are excluded from household expenditures. Consumption of own production is valued and registered as expenditure for consumption. The value of the food consumed during the reference period (during the week ending on the day before the survey data) constitutes expenditures for consumption during that period. Foodstuffs purchased during the reference period but not consumed are not considered as expenditures for that period.

4.2 EMPIRICAL SPECIFICATION.

The study of Mitchell and Ingco (1993) produced evidence of the trends in Indonesian food consumption of six food groups. It would be of interest to investigate the changes in the elasticities of these groups. Subsequently, five commodities were selected from the six food groups identified by Mitchell and Ingco. Rice and vegetables were chosen because of their importance in the Indonesian diet. Milk products, fruit, and meat were selected because of the opportunities changes in the consumption of these commodities provide for New Zealand agricultural exporters.

For consistency, the variables used in the model are similar to those used by Deaton (1988). The variables are defined as follows. Given the discussion in section 3.2, and following demand theory, the income or expenditure variable used is total annualised household expenditure on all goods and services divided by the number of people in the household (LTPCX). Total household expenditure was also used to calculate budget shares. The z variables are household demographics. Although an explanation of the calculation of the fourteen age ratio variables is given in Deaton (1990), no definition for the seven age groups is provided. It is assumed, however, that the age groups from Deaton (1987) were used, where the seven categories are specified as follows: 65 and over, 55-64, 35-54, 18-34, 12-17, 6-11, and 0-5. Using data on household members by sex, each member is classified into one of fourteen sex by age groups and then each group is divided by household size. The youngest age group is denoted by INFANT. In ascending order the other age categories are specified as follows: CHILD; TEEN; ADULT; MIDDLE; MATURE; and PENSIONER. To denote the sex of the occupant, each category has either an M for male or F for female immediately following the category. For example, males aged 65 and over are denoted by PENSIONERM. When estimating the budget share and unit value equations, to avoid multicollinearity among these ratios, the females aged 18-34 category was omitted. Deaton (1988) also omitted a category and said that the effect of the fourteenth could be inferred from the intercept[7]. However, because the regressions are estimated on a within-cluster basis, there is no intercept term, and the effect of this omitted category on unit value and budget share is lost. The logarithm of household size (LHS) was also used to allow for the possibility that demands are not linearly homogenous in household numbers and total expenditure taken together.

Expenditures and quantities are recorded at the purchase level, and aggregated so that unit values for each household were derived by dividing total expenditures for the household by total quantity in kilograms. Taking logarithms produces the dependent variable LNV. Non-purchased quantities (own-produced) and the corresponding imputed expenditure are then added to market expenditures to give the total from which the budget shares (w) are formed.

Because all households in each cluster were interviewed at approximately the same time, the assumption of no price variation within each cluster is a reasonable one. The number of households in each cluster varied from 1 to 15. Clusters in which no households made a purchase of the good concerned had to be excluded since no unit value could be calculated. In addition, because of the nature of equations 3.2.3 and 3.2.4, a minimum of 5 houses making purchases in the market was decided upon. Although such exclusions may generate some selection bias, the situation is better than would be the case if all households that made no market purchases are excluded. Finally, households with unit values and logarithms of per capita total household expenditure values greater than three standard deviations from the means are also eliminated. It is expected that the LTPCX coefficient will have a negative (positive) coefficient in the budget share equation for the staple (luxury) commodities as households reduce (increase) their consumption of these goods as their total household expenditure increases. In the unit value equation, the LTPCX variable is expected to be positive for all commodities as the quality of purchases increases with income. Household size is expected to have a negative impact on both

[7] Deaton, 1988 p427.

share and unit value. The impacts of the remaining household characteristic variables are likely to be offsetting, so the signs on these categories is indeterminate.

Although the clusters may not be widely spaced in an urban setting, the assumption of households in the same cluster facing the same price still holds. Nevertheless, households which consume in one cluster, may have purchased food in another.

CHAPTER FIVE

REGRESSION RESULTS AND ELASTICITIES

5.1 INTRODUCTION.

This chapter is arranged as follows. The next section presents the first stage results of the model described in chapter three. The third section moves from within- to between-cluster analysis. The inter-cluster covariance between shares and unit values is presented, with and without corrections for quality effects and measurement error. The fourth section analyses the demand elasticities. For comparative purposes, the elasticities from a naive OLS regression of quantity on unit value and Deaton's model using food expenditure in place of total expenditure in budget share and household expenditure are also presented. The differences in these estimates and those of the model estimated in this study are reviewed in the following section. Hick's composite commodity estimates are presented thereafter so as to estimate 'the' demand elasticities, and to provide some indication of Indonesia's economic development. Finally, the implications for New Zealand exports to Indonesia are presented by contrasting the expenditure elasticities calculated in this study with those from Deaton (1990). This is done to explore changes in Indonesian food consumption patterns over the past decade.

5.2 FIRST STAGE REGRESSION RESULTS.

This section describes the results obtained from the first stage within-cluster regression models for the five commodities selected.

Table 5.1 summarises first stage regression estimates and t statistics for each commodity[8]. The results provide estimates of the effects of income and household characteristics for the budget share and unit value equations. While unit value is not exactly the same as Deaton's quality index, for a given commodity price dV = dv, so it is possible to interpret the regression coefficients in the ln(unit value) equation as relating to a change in

[8] Note the cautionary comments relating to standard error and R^2 values on pp. 34-35.

commodity quality. Similarly, for a given commodity price, a change in budget share relates to a change in quantity (per capita), so that with respect to the budget share equation, the regression coefficients can be interpreted as effects on budget share (amounts of expenditure) or on commodity quantity.

Table 5.1: Regression Coefficients for Budget Share and Unit Value Equations

	Rice	Meat	Fruit	Vegetables	Milk Products
SHARE					
LTPCX	-0.1168	0.0276	0.0151	-0.0226	0.0313
	(-66.8973)	(26.8843)	(17.8014)	(-33.6878)	(16.1645)
LHS	-0.0016	0.0096	0.0029	-0.0105	0.0022
	(-0.8771)	(8.9044)	(3.3088)	(-15.0549)	(2.5927)
INFANTF	-0.0261	0.0058	0.0076	5.24e-5	0.0457
	(-3.1627)	(1.1893)	(1.9090)	(0.0163)	(11.9320)
CHILDF	-0.0068	0.0029	0.0068	-0.0040	0.0053
	(-0.8896)	(0.6350)	(1.8283)	(-1.3664)	(1.4861)
TEENF	0.0013	-0.0045	0.0018	-0.0070	-0.0034
	(0.1729)	(-1.0241)	(0.4967)	(-2.4554)	(-0.9693)
MIDDLEF	0.0199	-0.0057	-0.0099	0.0047	-0.0032
	(3.4634)	(-1.6620)	(-3.5297)	(2.1042)	(-1.2123)
MATUREF	0.0135	-0.0054	-0.0063	0.0004	-0.0033
	(2.1280)	(-1.4477)	(-2.0483)	(2.1042)	(-1.1278)
PENSIONERF	-0.0054	-0.0054	-0.0060	-0.0074	-0.0017
	(-0.7542)	(-1.2642)	(-1.7226)	(-2.6828)	(-0.5235)
INFANTM	-0.0333	0.0110	0.0128	-0.0032	0.0424
	(-4.0648)	(2.2710)	(3.2309)	(-1.0142)	(11.1788)
CHILDM	-0.0013	0.0076	0.0096	-0.0074	0.0050
	(-0.1729)	(1.6812)	(2.5930)	(-2.6828)	(1.4304)
TEENM	0.0128	-0.0065	2.77e-5	-0.0026	-0.0016
	(1.7274)	(-1.4852)	(0.0077)	(-0.9192)	(-0.4669)
ADULTM	0.0079	-0.0140	-0.0035	-0.0056	-0.0065
	(1.2739)	(-3.8370)	(-1.1625)	(-2.3297)	(-2.2613)
MIDDLEM	0.0076	-0.0074	-0.0032	-0.0118	-0.0083
	(1.0299)	(-1.6889)	(-0.8906)	(-4.1509)	(-2.4400)
MATUREM	0.0173	-0.0055	-0.0061	-0.0092	-0.0065
	(2.0088)	(-1.0884)	(-1.4555)	(-2.7682)	(-0.1636)
PENSIONERM	-0.0036	0.0020	-0.0112	-0.0128	-0.0014
	(-0.4285)	(0.4083)	(-2.7708)	(-3.8880)	(-0.3526)
R^2	0.4958	0.1330	0.0729	0.2074	0.1188
F	370.286	57.676	29.621	95.653	50.643
Prob>F	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
UNIT VALUE					
LTPCX	0.0488	0.1897	0.3037	0.0700	0.2490
	(16.6062)	(10.6836)	(16.86950	(4.1941)	(3.9616)
LHS	0.0111	0.0451	0.0586	-0.0161	0.2348
	(3.5912)	(2.4728)	(3.1637)	(-0.8981)	(3.5610)
INFANTF	0.0036	-0.0367	0.0820	-0.1373	0.5936
	(0.2613)	(-0.4727)	(1.0203)	(-1.7454)	(2.3170)
CHILDF	0.0113	0.0638	0.1721	-0.0955	0.2486
	(0.8887)	(0.8694)	(2.2779)	(-1.2992)	(0.9866)
TEENF	-0.0092	-0.2020	0.0279	-0.2165	-0.1858
	(-0.7340)	(-2.9550)	(0.3814)	(-3.0196)	(-0.7512)
MIDDLEF	-0.0089	-0.0051	-0.0597	-0.0559	-0.3118
	(-0.9281)	(-0.0855)	(-1.0049)	(-1.0104)	(-1.4429)
MATUREF	-0.0009	0.0241	-0.0984	-0.0559	-0.4215

	(-0.0807)	(0.3478)	(-1.4084)	(-1.2599)	(-1.4217)
PENSIONERF	-0.0036	0.0805	-0.1177	-0.0861	-0.4545
	(-0.5130)	(0.9299)	(-1.4536)	(-1.2157)	(-1.5898)
INFANTM	-8.07e-5	-0.0238	0.0200	-0.0855	1.0167
	(-0.0057)	(-0.3151)	(0.2527)	(-1.0977)	(3.7455)
CHILDM	-0.0036	-0.0438	0.0280	-0.0942	-0.2978
	(-0.2805)	(-0.6081)	(1.7111)	(-1.2915)	(-1.1585)
TEENM	-0.0217	-0.1469	0.0053	-0.1118	-0.3413
	(-1.737)	(-2.0040)	(0.0701)	(-1.5554)	(-1.2066)
ADULTM	-0.0257	-0.1078	-0.0263	-0.1003	-0.5595
	(-2.4662)	(-1.7700)	(-0.4266)	(-1.6082)	(-2.4621)
MIDDLEM	-0.0086	-0.0036	-0.0421	-0.0781	-0.6408
	(-0.6994)	(-0.0480)	(-0.5726)	(-1.0584)	(-2.3680)
MATUREM	0.0066	-0.0423	-0.2364	-0.1318	-0.7062
	(0.4496)	(-0.4381)	(-2.4441)	(-1.5324)	(-1.7051)
PENSIONERM	-0.0217	-0.0366	-0.2303	-0.1724	-0.4081
	(-1.7370)	(-0.3747)	(-2.3740)	(-2.0198)	(-1.2267)
R^2	0.0592	0.0522	0.0763	0.0092	0.0909
F	21.800	10.666	23.210	3.339	6.926
Prob>F	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)

5.2.1 Rice.

The logarithm of per capita total household expenditure has significant negative effects on the budget share for rice. The unit value equation demonstrated that increased per capita total household expenditure results in significantly better quality rice being purchased. Increased household size also has significant positive effects in terms of the quality purchased.

The significant household age structure variables influence the quantity consumed, and the quality purchased differently. An increase in the proportion of infants[9] (male and female) in the household significantly decreases rice commodity expenditure. A larger proportion of middle and mature aged women have significant consequences for rice commodity share. Increases in the numbers of teenage and mature males relative to the base variable have significant impacts on rice commodity share. However, these age structure variables are less influential in terms of quality. Only an increase in the proportion of teen aged and adult males significantly affects the quality of rice purchased.

[9] An increase relative to the base household demographic: the proportion of adult aged females in households.

5.2.2 Meat.

The results for meat show that household expenditure and household size have important positive effects in both the budget share and unit value equations. Changes in many household age structure variables do not significantly affect the quality of purchases. A higher proportion of teenagers of both sexes and adult males in a household leads to less commodity heterogeneity. Meanwhile, a larger proportion of adult males, mature males, female children and middle aged women have significant consequences on meat expenditure as a proportion of total expenditure.

5.2.3 Fruit.

The per capita household expenditure variable has a significant influence on the fruit budget share and unit value equations. In terms of household demographics, increases in household size results in a significantly larger share of expenditure being allocated to fruit. Household size also has an important influence on the quality of fruit purchases. Of the age ratio variables, only children and older than adult women significantly affect the quantity of fruit purchases. Relative increases in the proportion of children and pensioners also significantly affect fruit budget share. In the unit value equation, the better quality fruit purchased by households with larger numbers of children is offset by those households with proportionately more males aged fifty-five and older, which purchased lower quality fruit.

5.2.4 Vegetables.

Increased per capita household expenditure significantly decreases the share of total expenditure allocated to vegetables consumption. But, this variable has significant positive effects in the unit value equation. Household size is significant and negative in the budget share equation, but insignificant in the unit value equation. The household age structure variables have different impacts on the quantity consumed and the quality purchased. Changes in the proportion of females aged 12-17 or 55 and older, and males aged 6-11 or older than seventeen, are significant vegetable budget share variables. Meanwhile, alteration in the proportion of female infants and teenagers, and young male adults and pensioners, have a significant negative influence on vegetable commodity quality.

5.2.5 Milk Products.

Increases in per capita household expenditure significantly increases the budget share allocated on milk products expenditure. Increasing household size also results in significantly larger milk products consumption. The remaining demographics and their effects on milk products share indicate that, relative to the base variable, households with proportionally more infants consume significantly more milk products. In addition, households with a greater proportion of males aged 19-64 allocate significantly less to expenditure on milk products. The unit value equation results are similar to those obtained from the budget share equation. Increased per capita household expenditure and household size results in the purchase of more expensive milk products. Households with a larger proportion of males aged 19-64 and female pensioners purchase significantly lower quality milk products. In contrast, an increased proportion of infants of either sex has positive and significant impacts on milk products quality.

5.2.6 Discussion.

A scan of the summary statistics reveals that the model variables are in general jointly significant (F-test) in the budget share and unit value equations for each commodity, although each equation had a very low unadjusted R^2 value. It should be noted that the regression R^2 values may be misleading since these intra-cluster models have been fitted without an intercept. In addition, since the variation in the dependent variables of the intra-cluster (first stage) models reflects residual variation in the original dependent variables of equations 3.2.1 and 3.2.2 **after** removal of the fixed cluster and price effects, relatively low R^2 values for the intra-cluster regressions might not be unexpected. Low R^2 values for the intra-cluster models does not imply that regressions corresponding to equations 3.2.1 and 3.2.2 would also have low R^2 values. In fact, the R^2 values for the models specified by equations 3.2.1 and 3.2.2 can be obtained from the sample variances of the budget share and ln(unit value) variables and the sample estimates of σ^2_{u1} and σ^2_{u2}.

The expenditure estimates measure the absolute change in share for a given proportional change in per capita household expenditure. Consequently, the expenditure coefficient measures the marginal increase in commodity expenditure if total expenditure increases by a dollar. It is hypothesised that when total household expenditure is low, cheaper (staple) commodities will be consumed. As household expenditure increases, additional expenditure on these cheaper commodities will not be as high, and may decline. This occurs when household income grows, and households substitute these staple foods for more expensive luxury items, suggesting a diminishing marginal propensity to consume for food products as incomes rise. The results indicate that expenditure on rice and vegetables is declining as incomes increase, while for the remaining commodities, expenditure is increasing. The expenditure coefficients of the unit value equation are the quality elasticities, which are examined later in the chapter.

Like the expenditure estimate, the household size coefficient in the unit value equation is the elasticity of quality with respect to household size. These household size elasticities, with the exception of the vegetable estimate, are positive and inelastic. Thus, as household size increases, the quality of rice, meat, fruit, and milk products increases, although at a rate smaller than the corresponding increase in household size.

The budget share equation household size coefficient is equivalent to its expenditure estimate. The parameter measures the marginal propensity to consume resulting from the addition of another person to a household. The parameter estimates are small and negative (positive) for the staple (luxury) commodities. These results are not consistent with the hypothesis of household economies of scale. Larger households are expected to consume greater quantities of the relatively cheaper staple commodities. In addition, each commodity is expected to contain relatively more inexpensive goods. However, increased per capita expenditure, combined with nutrition requirements, may account for these results. If household size increases because more children are born, it can be assumed that the parents of these children will be relatively young and more likely to consume a more western diet. Therefore, the advent of more children is likely to result in households consuming more milk products, which are given up when the average household age increases. In addition, the expenditure estimates indicate that households substitute less traditional food commodities for traditional staples as household income rises. Fruit and vegetables are an important source of vitamins, while rice and meat are valuable sources of protein. Thus, as the per capita level of income rises, vegetables are replaced by fruit, while meat is substituted for rice

The household composition variables seem to confirm this supposition. For the staple products, a higher proportion of adult males relative to adult females in a household will induce larger amounts of rice to be consumed. Households with a higher proportion of older females are also found to consume larger quantities of rice. For vegetables, only households with a relatively larger proportion of females will consume more vegetables. Households with proportionally more children, on the other hand, will consume significantly smaller quantities of rice and vegetables. Despite the decline in consumption caused by increased household income and the addition of children, rice is still the most popular commodity amongst adult consumers. The same cannot be said for vegetable consumption. Increased income reduces both the quantity and quality consumed, while the demographic variables indicate that very few household members prefer to eat vegetables.

Households with a greater proportion of older males and females will consume smaller quantities of meat and fruit, while households dominated by children will consume larger quantities of fruit. As expected, the younger the average age of a household the more milk products are consumed, while the opposite is true of older households, which probably substitute rice and meat, for milk products. The pattern that emerges is the dominance of older household members, especially males, in household consumption decisions, with the exception of fruit and milk products. Those households with children, and presumably younger parents, are more likely to eat a less traditional diet, while those households with a proportionately older population, will consume more traditional foods. These results are consistent with Hakim (1994) who found that households with more children had a higher probability of consuming milk products, while those households with a lower average age would consume more meat.

In addition to consumption patterns, these household structure coefficients tell us what effect the addition of a household member, of a certain age relative to the omitted group, has on the average price paid for a commodity. However, because the regression results relate to intra-cluster variation in ln(unit value), $\ln p_c$ disappears. Thus, when we are talking about the commodity price index for cluster c, we are referring to the way Deaton's quality index interacts with commodity price. As Deaton's quality index increases, the commodity purchased consists of higher priced goods, and hence, the 'average price' paid for a commodity increases.

The relationship between the logarithm of unit value and the age ratios is log-linear. This function gives the percentage change in the price paid for a commodity, per unit change in each age ratio. As an example, if the regression coefficient of for TEENF was, say 0.0256, and two households were identical in every respect, except that one had proportionally one more female aged 12-17, then this household is expected to pay, on average, 2.56% more for a particular commodity relative to the omitted group. In the significant male categories, every additional adult male relative to the omitted group will reduce the rice price by approximately 2%.

The addition of a female teenager will reduce the price paid for meat by 20%, while an additional female of pensioner age will increase the price paid by 8%. Meanwhile, the addition of teen aged males will reduce the average meat price by 15%. The average fruit price paid will rise by up to 17% for the addition of every child (especially female), while additional adults will reduce the price paid for fruit by up to 23%. Every child or teenager accounts for a decrease in the vegetable price by 6-22%, and every adult male by up to 17%. Additional adult females, meanwhile, reduce the vegetable price by 5-9%. As expected, the arrival of new babies will increase the average milk products price by 60% for female infants, and by 100% for male infants. However, additional adults will reduce the price by up to 70%.

5.3 MEASUREMENT ERROR AND QUALITY EFFECTS ON PRICE ELASTICITY ESTIMATES.

After the first stage regressions have been estimated, the budget and household characteristics effects are netted out, and 'corrected' budget share and unit value cluster averages are calculated. A regression of these average shares on average unit values, corrected for measurement error, yields an estimate of the ratio of responses to price of the share and unit value. The affect of price on the budget share can be extracted from this ratio by the use of the theory linking quality and quantity elasticities. In this section, the extent to which measurement error and quality effects bias the price elasticity estimates is assessed. The following table is used to measure the influence of these effects.

Commodity: Estimate Corrections for Quality Effects and Measurement Error

Quality Effects / Measurement Errors	Yes	No
Yes	ϕ: (3.4.14) θ_1: (3.4.15) **I** $\varepsilon_p = \theta_1(w^{-1} - \phi^{-1})$	ϕ: (3.4.16) θ_1: (3.4.15) **II** $\varepsilon_p = \theta_1(w^{-1} - \phi^{-1})$
No	$\theta_2 = 1$ $\theta_1 = \phi$: (3.4.14) **III** $\varepsilon_p = w^{-1}\phi - 1$	$\theta_1 = \phi$: (3.4.16) $\varepsilon_p = w^{-1}\phi - 1$ **IV**

The fourth quadrant shows the covariance between shares and unit values. This value is the sample counterpart to equation 3.4.14 without corrections to the numerator and denominator. In effect, this quadrant provides a price elasticity estimate which ignores measurement error and quality effects[10]. The values provided in the first quadrant are Deaton's price elasticity, which accounts for both quality effects and measurement error. If the elasticity calculation is complicated only to the extent of allowing for measurement error so that unit value moved one for one with price and $\theta_2 = 1$, the third quadrant estimate would be the response of the budget share to price. In the second quadrant, the calculation is complicated only to the extent of allowing for quality effects, and ignoring measurement error.

Table 5.2: Rice - Estimate Corrections for Quality Effects and Measurement Error

Quality Effects / Measurement Errors	Yes	No
Yes	ϕ: -0.3862 θ_1: -0.1856 ε_p = -1.7326	ϕ: 0.3326 θ_1: -0.1856 ε_p = -0.6942
No	$\theta_2 = 1$ $\theta_1 = \phi$: -0.3862 ε_p = -3.6060	$\theta_1 = \phi$: 0.3326 ε_p = -3.2445

[10] **By default, all the elasticities in this table provide estimates which ignore cross-price effects.**

Table 5.3: Meat - Estimate Corrections for Quality Effects and Measurement Error

Quality Effects / Measurement Errors	Yes	No
Yes	ϕ: 0.0164 θ_1: 0.0158 ε_p = -0.3833	ϕ: 0.0093 θ_1: 0.0158 ε_p = -2.1076
No	θ_2 =1 $\theta_1 = \phi$: 0.0164 ε_p = -0.3992	$\theta_1 = \phi$: 0.0093 ε_p = -0.6576

Table 5.4: Fruit - Estimate Corrections for Quality Effects and Measurement Error

Quality Effects / Measurement Errors	Yes	No
Yes	ϕ: 0.0171 θ_1: 0.0155 ε_p = -0.3700	ϕ: 0.0073 θ_1: 0.0155 ε_p = 2.6641
No	θ_2 =1 $\theta_1 = \phi$: 0.0171 ε_p = -0.4074	$\theta_1 = \phi$: 0.0073 ε_p = -0.7466

Table 5.5: Vegetables - Corrections for Quality Effects and Measurement Error

Quality Effects / Measurement Errors	Yes	No
Yes	ϕ: 0.0010 θ_1: 0.0009 ε_p = -0.8523	ϕ: 0.0033 θ_1: 0.0009 ε_p = -1.2554
No	θ_2 =1 $\theta_1 = \phi$: 0.0010 ε_p = 0.9786	$\theta_1 = \phi$: 0.0033 ε_p = -0.9319

Table 5.6: Milk Products- Estimate Corrections for Quality Effects and Measurement Error

Quality Effects / Measurement Errors	Yes	No
Yes	ϕ: 0.0124 θ_1: 0.01253 ε_p = 0.0879	ϕ: 0.0038 θ_1: 0.0125 ε_p = -3.1621
No	θ_2 =1 $\theta_1 = \phi$: 0.0124 ε_p = 0.0868	$\theta_1 = \phi$: 0.0038 ε_p = -0.6629

Comparison of quadrants I and IV show that for all commodities, with the possible exception of vegetables, the variation in magnitude between the elasticity estimates is large. The presence of quality effects and measurement error in the ϕ estimate found in quadrant IV produces an elasticity estimate which is larger in absolute terms than the corrected price elasticity estimate in quadrant I. With the exception of vegetables, estimates would have been almost twice the corrected size. For milk products, an uncorrected regression of budget share on price would have produced an estimate which was 7.5 times larger with an opposite sign.

If dlnV = dlnp, so that there were no quality effects and unit value moved one for one with price, with the exception of rice, correcting for measurement error has a significant impact on the estimates found in quadrants I and III. In the case of vegetables and milk products, estimates change sign to become greater than zero. This suggests that the unit values and budget shares for meat, fruit, vegetables and milk products are less well measured than those for rice. This is not surprising given the relatively small share of total expenditure these commodities command.

If there is no measurement error, correcting for just quality effects also produces large changes in magnitude from those of quadrant IV. All the commodity quality corrected elasticities varied from their uncorrected elasticity estimates. With the exception of rice, the quality corrected elasticity estimates are larger, and with the exception of vegetables, at least three times as large. Also, the fruit estimate now has a different coefficient sign.

Comparison of price elasticities in the top row indicate that not accounting for measurement error would produce dangerously misleading results, the principal reason for using Deaton's methodology as opposed to the methodology developed by Cox and Wohlgenant (1986). Correcting for measurement error as well as quality effects produces results which are significantly different from those estimates which correct for quality effects only. For rice, the estimate corrected for both quality and measurement error is two times larger. For the remaining commodities, the corrected elasticity is between 1.5 and 35 times smaller than the quality adjusted elasticity. In this study, Deaton's observation that the errors of measurement in the measurement of expenditures and quantities may be more important than the contamination of unit values by quality effects is correct.

5.4 ELASTICITIES.

The estimated elasticities are examined in this section. Using the error corrected second stage estimates, demand elasticities are evaluated at the sample budget share means.

Deaton's methodology only allows for uncompensated own-price elasticities to be calculated. However, these elasticity types are the most commonly used for policy analysis. For comparative purposes, a naive model of the logarithm of household per capita commodity consumption was regressed (OLS) on the logarithm of unit value, logarithm of per capita total household expenditure on all goods and services, and demographic variables to directly yield estimates of ε_X and ε_V. It should be noted that this model yields elasticity estimates of ε_X and ε_V which are not dependent on commodity budget share (relative to per capita household expenditure on all goods and services). However, in Deaton's model formulation, both ψ_X and ε_p are functions of budget share, hence Deaton's estimates of ε_X and ε_V are also a function of budget share. We should not be too surprised therefore if the naive model elasticity estimates do not match up with Deaton's estimates. Estimation of this model, however, indicates the differences which lie in the treatment of quality, and of measurement error, as well as in the fact that the naive model can only include those households which record market purchases of a commodity and for whom a unit value index is directly available.

Also, given the discussion in chapter three on the use of total expenditure versus food expenditure, the elasticities from the food expenditure model for each commodity are presented. Comparison with the elasticities from the total expenditure model provide us with an apparent measure of $\frac{\mathrm{dlnx}}{\mathrm{dlnX}}$ as well as allowing us to see whether there are differences in the ε_p estimate between the two models. The results are presented using the following schema:

	Total Expenditure (X)	**Food Expenditure (x)**	**Direct Regression (X)**
Quantity	ε_X	ε_x	ε_X
	ε_p	ε_p	
	ε_V	ε_V	ε_V
Quality	η_X	η_x	
	η_p	η_p	
	η_E	η_E	
Expenditure	ψ_X	ψ_x	
	ψ_p	ψ_p	

The various elasticities are defined as follows:

Quantity Elasticity: $\varepsilon_z = \frac{dlnQ}{dlnz}$

Quality Elasticity: $\eta_z = \frac{dlnv}{dlnz}$

Expenditure Elasticity: $\psi_z = \frac{dlnE}{dlnz}$

where x is total expenditure or food expenditure (X, x respectively) per capita/household; p is commodity price; Q is household per capita commodity consumption measured in kilograms; v is the commodity quality index; E is household per capita commodity expenditure; and V is commodity unit value.

Commodities with expenditure elasticities greater than unity are designated luxury goods, expenditure elasticities that are positive but less than unity denote normal or necessary goods, while negative expenditure elasticities signal inferior goods. *A priori*, we would expect the various price elasticities to be negative. It is reasonable to assume that expenditures will be more responsive than quantities to changes in income because expenditure change in response to income change includes a price effect due to quality as well as the quantity effect. Thus, it is expected that η_X will be positive as an increase in income should result in the purchase of higher quality and hence $\psi_X > \varepsilon_X$. As such, for a normal commodity we would expect $\varepsilon_p < 0$, $\eta_X > 0$ and $\varepsilon_X > 0$. Given that the expression ε_V measures the relationship between a change in quantity and a change in unit value, for a normal good, this elasticity will be larger than ε_p because the comparison of quantities and unit values will tend to overstate the price elasticity in absolute magnitude, at least if the price elasticity is negative, and the product of price and quality elasticities is smaller in absolute value than the total expenditure elasticity. While η_X provides us with an estimate for the response of quality to total (or food) expenditure, η_E tells us what fraction of a increased commodity expenditure will be spent on upgrading commodity quality.

Therefore, while some commodities may have large η_X values, as a proportion of ψ_X, the upgrade in quality may be relatively small.

5.4.1 Rice Elasticities.

The rice elasticity estimates from the total expenditure and food expenditure models have the expected signs and values. The results indicate that rice is a necessary commodity, with a positive quality elasticity. While this elasticity is small, an increase in commodity expenditure would result in the quality of purchases increasing by 23% using total expenditure and 22% using food expenditure. All the price elasticities have the expected negative sign, with an increase in price resulting in a decrease in rice expenditure, the quantity purchased, and the quality of rice purchases. Because rice is a normal commodity with a negative price elasticity, the price elasticity measuring quantity relative to unit value is larger in absolute value than ε_p. The direct regression yields less elastic expenditure and unit value elasticities.

Table 5.7: Rice Price and Expenditure Elasticities

		Total Expenditure	Food Expenditure	Direct Regression
Quantity	ε_X	0.1627	0.1970	-0.0045
	ε_p	-1.7326	-1.545	
	ε_V	-3.6061	-2.7182	-0.3833
Quality	η_X	0.0488	0.0558	
	η_p	-0.5195	-0.4379	
	η_E	0.2307	0.2208	
Expenditure	ψ_X	0.2114	0.2528	
	ψ_p	-1.2521	-0.9827	

5.4.2 Meat Elasticities.

In Indonesia (or urban Java at least) meat is a luxury good. This is not surprising given the traditional rice diet and low per capita income. The quality elasticity for both total and food expenditure models is positive, resulting in an expenditure elasticity which is larger than the physical quantity elasticity with respect to total or food expenditure. While ε_V is larger than ε_p, it is only marginally so because of the large ε_X value.

Table 5.8: Meat Price and Expenditure Elasticities

		Total Expenditure	Food Expenditure	Direct Regression
Quantity	ε_X	1.8227	2.1877	0.9894
	ε_p	-0.3831	-0.4546	
	ε_V	-0.3990	-0.4875	-0.6186
Quality	η_X	0.1897	0.2215	
	η_p	-0.0399	-0.0470	
	η_E	0.0943	0.0919	
Expenditure	ψ_X	2.0123	2.4092	
	ψ_p	0.5770	0.4834	

With the exception of ψ_p, all the price elasticities have the expected negative sign. Because the sum of η_p and ε_p is less than one, an increased price causes an increase in meat expenditure. Therefore, meat expenditure increases in response to price increases to maintain current consumption. Because the calculated elasticities are gross estimates, the income effect may outweigh the substitution effect producing this result. Meanwhile, the direct regression estimate for ε_V is larger than its corresponding Deaton model estimate. As with the rice model, the ε_X value has decreased, with meat becoming a normal commodity (even though it is close to being a luxury commodity) using the naive approach.

5.4.3 Fruit Elasticities.

Like meat, both total expenditure and food expenditure model price elasticities, except ψ_p, have the expected negative coefficient. Because fruit is a luxury commodity, the ε_V value, while larger, is once again not significantly so.

Table 5.9: Fruit Price and Expenditure Elasticities

		Total Expenditure	Food Expenditure	Direct Regression
Quantity	ε_X	1.2208	1.5088	0.9431
	ε_p	-0.3700	-0.3292	
	ε_V	-0.4075	-0.3574	-0.5283
Quality	η_X	0.3037	0.3624	
	η_E	-0.0920	-0.0791	
	η_V	0.1992	0.1937	
Expenditure	ψ_X	1.5245	1.8712	
	ψ_p	0.5380	0.5918	

As expected, an increase in total expenditure or food expenditure produced little response in the quality of fruit demanded. This larger allocation of commodity expenditure to quantity as opposed to quality is confirmed by the small η_E estimate. The results of the direct regression are once again different from the other two models. Using the naive approach the 'price' elasticity would still be negative, but larger, while fruit would now be considered a normal good.

5.4.4 Vegetable Elasticities.

The vegetables commodity has elasticity coefficients which are ordered differently from the other staple commodity, rice. Once again, the ψ_p elasticity has a positive coefficient and the remaining price elasticities negative coefficients.

Table 5.10: Vegetable Price and Expenditure Elasticities

		Total Expenditure	Food Expenditure	Direct Regression
Quantity	ε_X	0.4627	0.5742	0.6142
	ε_p	-0.8524	-0.8711	
	ε_V	-0.9786	-0.9796	-0.9737
Quality	η_X	0.0700	0.0730	
	η_p	-0.1290	-0.1108	
	η_E	0.1314	0.1128	
Expenditure	ψ_X	0.5327	0.6472	
	ψ_p	0.0187	0.0181	

All three expenditure elasticities are positive and inelastic. Yet even with the product of the price and Prais-Houthakker elasticities still being smaller than ε_X, the elasticity for quantity with respect to unit value is not significantly larger than the estimated quantity elasticity with respect to price. Any upgrade in quality is relatively small, with an increase in expenditure mostly allocated to increasing the quantity of vegetables purchased. This may indicate that vegetables are available in fewer varieties. Both elasticities from the naive model have the correct sign, with the quantity elasticity with respect to expenditure being larger than the estimates from the other two models. It is interesting to note that the ε_V elasticity is relatively well measured by all three models.

5.4.5 Milk Products Elasticities.

Of all the commodity elasticities estimated in this study, the milk products estimates are the least comparable and least robust between the three sets of estimates. For food and total expenditure models, all three price elasticities are positive, and with the exception of the ψ_p estimate, vary significantly between both models. The positive ε_p and η_p also result in ψ_p being greater than one.

Table 5.11: Milk Products Price and Expenditure Elasticities

		Total Expenditure	Food Expenditure	Direct Regression
Quantity	ε_X	1.8999	2.3839	0.5948
	ε_p	0.08875	0.0084	
	ε_V	0.08773	0.0084	-0.6700
Quality	η_X	0.2490	0.2315	
	η_p	0.0116	0.0002	
	η_E	0.1159	0.0885	
Expenditure	ψ_X	2.1489	2.6153	
	ψ_p	1.1004	1.0092	

Once again, an increase in expenditure results in only a small upgrade in quality. However, the total expenditure model instead of the food expenditure model has the larger elasticity estimate. Combined with this, any increase in commodity price results in only a minor upgrade in commodity quality. As with meat and fruit, the ε_V estimate approximates the ε_p elasticity.

5.4.6 Discussion.

The calculated elasticities with respect to total and food expenditure conform to *a priori* expectations. All the quantity own price elasticities, with the exception of milk products, are negative. Most of these elasticities are less than unity, with both staple commodities exceeding or approaching one. The inelastic estimates for luxury commodities may indicate the presence of few substitutes for these commodities (although there may be a great deal of intra-commodity substitution). However, the rice price elasticity seems excessively large. To gain a proper perspective about the magnitude of the rice price elasticity, a limited comparison with two other studies from the region in a similar time frame is made. Huang and David (1993) analysed the effects of urbanisation on the demand for cereal grains, specifically rice, wheat, and coarse grains, for nine Asian countries including Indonesia. Using aggregated time series data, a Linear Approximate Almost Ideal Demand System was estimated for the period 1960-1988. The rice expenditure elasticities found in Table 5.12 were twice as large as those estimated in this study. But the price elasticities, which include income effects, are not even half the size of the demand elasticity calculated in this study.

Table 5.12: Expenditure and Own-Price Elasticities for Rice in Asia Estimated by Huang and David

	ε_p[a]	ε_X[b]
Bangladesh	0.38	-0.92
China	0.43	-0.35
India	0.53	-0.52
Indonesia	0.47	-0.88
Japan	-0.21	-0.94
S.Korea	0.46	-0.81
Pakistan	0.49	-0.40
Philippines	0.25	-0.96
Thailand	-0.14	-1.07

Source: Huang and David (1993).
[a]Total expenditure elasticity of demand.
[b]Own-price elasticity of demand.

Fan *et al* (1994), using a dynamic AIDS model and rural household survey data attempted to analyse rural consumption changes in China from 1982-1990. These results are important not only because they are estimated from recent survey data, but also because Mitchell and Ingco (1993) identify China as being at a similar stage of development as Indonesia.

The rice expenditure elasticity estimate of 0.313[11] was two times larger than the estimate computed in this study. Meanwhile, the price elasticity calculated by Fan *et al* of -0.547 was only a quarter of the size of that calculated in this study. Subsequently, even with such a limited comparison, it is obvious that the rice price elasticity is bigger than it should be. The excessive size of the rice price elasticity calculated in this study may arise from the fact that the price elasticities are gross elasticities and may contain quite large income effects.

The quantity, quality, and commodity expenditure elasticities with respect to total or food consumption are all positive, as expected, suggesting either normal or luxury commodities. In addition, the commodity expenditure elasticities are larger than the quantity elasticities because the expenditure elasticity accounts for changes in both quantity and quality. Income effects are expected when total food expenditure rather than

[11] This result for expenditure elasticities is expected because the two studies reviewed in this section do not control for quality effects in the measurement of elasticity estimates from cross-sectional data.

total expenditure based on all goods and services is the explanatory variable, implying larger quantity, quality and commodity expenditure elasticities with respect to food expenditure than total expenditure. With the exception of the milk products quality elasticity, this is the case. It is also of interest to note the closeness of the η_E estimates between the food and total expenditure models. If the difference between elasticity estimates with respect to total and food expenditure is $\frac{\text{dln}x}{\text{dln}X}$, then η_E with respect to total expenditure should equal η_E with respect to food expenditure. With the exception of milk products once again, and to a lesser extent vegetables, these elasticities are almost the same between the two models. This provides some evidence that food expenditure elasticities can be estimated using total expenditure elasticities. This is explored further in the next section.

In general, the quantity elasticity with respect to unit value is greater than the quantity elasticity with respect to price, conforming to *a priori* expectations. However, this difference is not large for luxury commodities, and in the case of milk products is smaller than the associated price elasticity. These results for luxury commodities may occur because of the relatively small upgrade in quality resulting from an increase in total or food expenditure. It should be remembered, however, that the milk products own-price elasticity did have a positive coefficient.

Turning to the results from the direct or naive regression, we see that variable estimates differ significantly from the Deaton methodology estimates. All the own-price (unit value) elasticities have the expected negative coefficient. The quantity expenditure elasticities also vary from the corresponding Deaton model estimates. No estimate is greater than one (although meat and fruit come close), while rice is less that zero. One cannot be too surprised by this result given that we have two quite different demand specifications. But what is clear is that use of such a model can produce deceptive results.

5.5 TOTAL EXPENDITURE VERSUS FOOD EXPENDITURE.

It was noted in Section 3.4 that there is a problem in using commodity budget share with respect to food expenditure as the dependent variable in equation 3.2.1, along with ln(food expenditure) as a regressor, in the computation of elasticities. In several of the elasticity derivations found in Appendix A, it is necessary to assume dln(expenditure)/dln(commodity price) = 0. If this assumption is true, the estimates of ε_p (obtained using both total and food expenditure) should be close. The extent to which this is not so casts a degree of doubt on this assumption.

Examination of the elasticities calculated using total expenditure and food expenditure reveals different estimates between both models. Although the estimate signs are consistent between the two models, they do vary in magnitude. For the two staple commodities, rice and vegetables, the differences are relatively minor. For the remaining commodities, especially milk products, the variation is quite substantive. For the luxury commodities, this variation raises doubts about Deaton's untested assumption that food expenditure could be used in place of total expenditure on all goods and services because it provides some evidence that dln(food expenditure)/dln(commodity price) is not equal to zero. However, for the staple commodities, the evidence is less compelling.

As discussed previously, there is a possibility of moving from an elasticity with respect to total expenditure to the corresponding elasticity with respect to food. Since

$$\frac{d\ln Q}{d\ln x} = \frac{d\ln Q}{d\ln X}\left(\frac{d\ln x}{d\ln X}\right)^{-1}$$

then, given an estimate of $\frac{d\ln x}{d\ln X}$, we can move from one estimate to the other. To make this transition requires regressing $\frac{x}{X}$ (food expenditure budget share) as the dependent variable in equation 3.2.1 to estimate β_1 from the inter-cluster data. However, while this observation has theoretical merit, it was not estimated in this study. The recalculation of an elasticity with respect to food expenditure from an elasticity with respect to total expenditure is considered to be a purely artificial exercise for the researcher with information on both food and total expenditure. It is a simpler exercise to compute the elasticities directly using the more theoretically correct total expenditure, rather than indirectly using expenditure and dln(food expenditure)/dln(total expenditure). Therefore, such an assumption provides little practical value for the researcher who only has access to food expenditure. In addition, we still do not know whether total expenditure specification or food expenditure specification is more correct in estimating the commodity budget share equation.

For the sake of completeness, however, an apparent or proxy value for $\frac{\text{dlnx}}{\text{dlnX}}$ can be obtained from the estimated expenditure elasticities by dividing food expenditure on total expenditure elasticities. These results are shown in Table 5.13.

Table 5.13: Apparent dlnx/dlnX Values

Quantity	ε_X	ε_x	**Apparent dlnx/dlnX**
Rice	0.1627	0.1970	0.826
Meat	1.8227	2.1877	0.833
Fruit	1.2208	1.5090	0.809
Vegetables	0.4627	0.5742	0.806
Milk Products	1.9000	2.3839	0.797
Quality	η_X	η_x	**Apparent dlnx/dlnX**
Rice	0.0488	0.0558	0.875
Meat	0.1897	0.2215	0.856
Fruit	0.3037	0.3624	0.838
Vegetables	0.0700	0.0730	0.959
Milk Products	0.2490	0.2315	1.076
Expenditure	ψ_X	ψ_x	**Apparent dlnx/dlnX**
Rice	0.2114	0.2529	0.836
Meat	2.0123	2.4092	0.835
Fruit	1.5245	1.8712	0.815
Vegetables	0.5327	0.6472	0.823
Milk Products	2.1489	2.6153	0.822

With the exception of the quality elasticities for vegetables and milk products, the range estimates hover between 0.8 and 0.85. This indicates that even though equation 3.2.1 cannot hold for both w_X and w_x, it is possible to go from an elasticity with respect to total expenditure to the corresponding elasticity with respect to food expenditure if ln(food expenditure) is used in the w_x equation. Therefore, elasticities could be computed directly using total expenditure, or, if the researcher so wished, indirectly using food expenditure and dlnx/dlnX.

5.6 QUALITY ELASTICITIES AND HICK'S COMPOSITE COMMODITY THEOREM.

Previously it was shown that derivation of a unique demand elasticity for a commodity is possible when controlling for quality effects in price if physical quantities can be weighted by unchanging base prices. The addition of quantity and quality elasticity estimates gives an estimate for the demand elasticity, as opposed to an elasticity for a particular physical characteristic. Table 5.14 reproduces the income elasticities of physical quantity and quality and the price elasticities of physical quantity and quality, and price and income elasticities of demand.

Table 5.14: Hicksian Composite Commodity Elasticities

Income Elasticities	ε_X	η_X	$\xi_X = \psi_X$	η_E
Rice	0.1627	0.0488	0.2114	0.2307
Meat	1.8227	0.1897	2.0123	0.0943
Fruit	1.2208	0.3037	1.5245	0.1992
Vegetables	0.4627	0.0700	0.5327	0.1314
Milk Products	1.8999	0.2490	2.1488	0.1159
Price Elasticities	ε_p	η_p	ξ_p	
Rice	-1.7326	-0.5195	-2.2521	
Meat	-0.3831	-0.0399	-0.4230	
Fruit	-0.3700	-0.0920	-0.4620	
Vegetables	-0.8524	-0.1290	-0.9814	
Milk Products	0.0888	0.0116	-0.1004	

As witnessed earlier, the income and price elasticities of quality tend to be small (though some income elasticities are statistically significant), and hence the differences between the elasticities of demand are also small. It seems to be the case, as with the results of Deaton (1990), that good heterogeneity within a commodity group (i.e. quality variation) is limited enough that analysis of physical quantity by weight does not yield results very different from an analysis of quantity demanded. Therefore the commodity composition might be relatively insensitive to changes in income or prices easing the problem of quantity aggregation. Thus, the neglect of aggregation issues when measuring quantity is less troublesome than neglect of quality issues in the measurement of price.

The implication of this finding is that Indonesian consumers apparently do not substitute away from physical quantity and toward quality with increases in income or price. This observation is confirmed by the small ψ_X values whereby an increase in expenditure leads to a relatively small upgrade in quality. However, the positive estimates do indicate that any increase in income will increase both the quantity demanded, and to a lesser extent, the quality demanded. The conclusion from this static analysis is that Indonesian GNP, while growing, has not yet reached a level where Indonesian consumers are likely to purchase more highly processed goods. However the expenditure elasticities for all items are positive, implying that urban Indonesian households will continue to increase their consumption on all these food items as their incomes continue to grow.

5.7 IMPLICATIONS FOR NEW ZEALAND EXPORTERS

Comparison with the estimates of Deaton (1990) and Chernichovsky and Meesook (1984)[12] found in Table 5.15 does provide evidence of changes in Indonesian food consumption and possible future opportunities for New Zealand Agricultural exporters. A continuing decline in rice and vegetable consumption as income continues to grow, suggests that these staple products may soon reach their maximum levels and begin to decrease.

Table 5.15: Comparison of Income and Expenditure Elasticities from Selected Studies

	Year	ε_x	η_x	ε_Q
Rice	1981[a]	0.490	0.0290	0.5190
	1990[b]	0.163	0.0488	0.2118
Meat	1981	2.296	0.0885	2.3845
	1990	1.823	0.1897	2.0127
Fruit	1981	1.385	0.0725	1.4575
	1990	1.221	0.3037	1.5247
Vegetables	1981	0.670	-0.0402	0.6298
	1990	0.463	0.0700	0.5330
Milk Products	1978[c]			1.021[d]
	1978			1.493[e]
	1990	1.900	0.2490	2.1490

Source: Deaton (1990), Chernichovsky and Meesook (1984) and own calculations.
[a]Deaton (1990)-1981 SUSENAS.
[b]This study-1990 SUSENAS.
[c]Chernichovsky and Meesook (1984)-1978 SUSENAS.
[d]Average expenditure elasticity across all three expenditure groups.
[e]Average expenditure elasticity across highest two expenditure groups.

The decline of the rice expenditure elasticity, combined with the increases in Indonesian rice production, also implies that Indonesia could well export rice in the future. Meanwhile, Indonesian consumers are increasing their consumption of meat, fruit and milk products as their incomes grow. The expenditure elasticities for these items are elastic, and in the case of milk products, increasing over time. Thus, the demand for these luxury food items will accelerate as incomes rise.

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[12] While such a comparison is somewhat heroic given the changes in factors other than income over the intervening period and the use of differing data sets, such an examination does provide an approximate indication of changes in Indonesian food consumption resulting from per capita GNP growth.

The quality of food items demanded is increasing as well. The quality elasticities are increasing not only in absolute terms, but also as a percentage of increases in expenditure. These growing quality elasticities imply that more highly processed, added value products will be demanded in the future. The rise in demand for these processed foods, as well as larger quantities of meat, fruit and milk products indicates two things. Firstly, that Indonesian consumers are moving away, albeit slowly, from their traditional rice and vegetable diet, as their incomes increase. Secondly, it is improbable that Indonesian agricultural producers will be able to meet this demand, and Indonesia is likely to face increasing pressure to import better quality foods from overseas in the future as its economy expands and per capita incomes rise further. New Zealand exports to Indonesia are relatively small, and consist of beef, veal, butter, and evaporated, condensed, and dried milk. The results of this study indicate that there is potential for New Zealand meat exporters and the New Zealand Dairy Board to increase their exports to Indonesia. Indonesia could also be considered a potential export destination for Enza. In addition, exports could include not just raw commodities, but also more highly processed items.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

Price and expenditure elasticities of demand and quality for the five commodities rice, meat, fruit, vegetables, and milk products were estimated. The methodology employed controls for aggregation errors in commodity price and quantity, and errors of measurement in expenditures and quantities, in the estimation of demand functions using household budget survey data. It also provides a more general expression of consumer preferences.

The empirical elasticities by and large conform to the propositions of demand theory. With the exception of milk products, all own price elasticities are negative; both vegetables and rice are necessary goods while meat, fruit and milk products are luxury commodities in the Indonesian diet. Comparison with the results of Deaton (1990) and Chernichovsky and Meesook (1984) demonstrated that over the past decade the consumption of rice, vegetables, fruit and meat has declined with increases in income, while milk products has increased with income. Each commodity was also found to be made up of higher quality goods. Nonetheless, the quality effects were small, and abstracting from empirical problems of measurement error and conditional demands, the treatment of using physical quantities and unit values may be appropriate. Subsequently, there is some evidence to support the view that Indonesian consumers are changing not only the quantities consumed, but also the types of foods they eat. Whether it is possible to say conclusively that Indonesians are moving to a more western style diet is less clear.

The study also showed that Deaton's observation of measurement error being more important than adjusting for quality effects in the contamination of unit values was correct. As such, those studies which use unit values without adjusting for either quality or measurement error are likely to produce biased elasticity estimates. It can be concluded therefore, that methodology developed by Deaton is the most suited to the measurement of consumer demand from survey data.

However, problems were encountered with the methodology used in this study and will require further work to confidently link the model with consumer demand theory. While the price elasticities of the other commodities seem to provide reasonable estimates, the rice price elasticity seemed excessively large. The rice price elasticity calculated using Deaton's methodology is even larger than the price elasticity calculated from a naive direct regression (which Deaton vehemently opposed the use of). This finding is implausible given the model's theoretical framework. The only possible explanation which can be put forward is that because the estimated elasticities are gross elasticities, they may contain large income effects. The increase in per capita incomes means that rice, which once had few obvious substitutes, may now have a large number of substitutes. Certain goods that were once considered luxury items may now be necessary goods, able to compete with rice as a staple commodity. Added to this was the lack of robustness surrounding the milk products elasticities.

In addition, Deaton (1988) assumed that, if separable in preference, food expenditure was a theoretically acceptable alternative for total expenditure. Comparison of elasticities calculated with respect to food expenditure and those calculated with respect to total expenditure cast some doubt on this assumption. As expected, the expenditure elasticities calculated using food expenditure were larger than those calculated using total expenditure. However, the price elasticities between the two models were less comparable. Theoretically, the price elasticities estimates should be the same. This casts some doubt on the use of food expenditure in place of total expenditure to estimate demand elasticities using this methodology, even if food expenditure is separable.

The use of zero expenditures in the measurement of unconditional demands is not fully explored by Deaton. Including zero observations in an OLS regression yields inconsistent and biased parameter estimates. If the proportion of zero expenditures is high, the model parameter estimates would be over estimated (Maddala, 1983 and Greene, 1991). And a regression from the non-zero budget share values does not represent the budget share equation for the population as a whole. Subsequently, these biased estimates could be the cause of the varying elasticity estimates between the total expenditure and the food expenditure model. Therefore, the task for future research is how to estimate unbiased parameter estimates for the population as a whole. One method is the Tobit model. But, when using Deaton's within-cluster approach, a household that has a budget share less than the cluster mean, the within-cluster budget share estimate is negative for this household. When estimating a Tobit, observations are usually censored at zero. Therefore, an alternative methodology must be found that gives equivalent results to those of the within-cluster model. Deaton (1988, p420) suggests an approach whereby cluster dummy variables are used to eliminate the price effects. Such an approach would allow observations to be censored at zero. However, such a model does not account for prices and fixed cluster effects.

Therefore, while the methodology provides reasonable elasticity estimates, and is theoretically still the most appropriate methodology to apply when using cross-section data, it should only be applied cautiously. It is unlikely that constancy of relative prices would hold spatially or intertemporally in many data sets. In addition, while the methodology developed in Deaton (1990) allows for the testing of homogeneity and symmetry, the methodological problems highlighted above, which were presumably not encountered or considered by Deaton, need to be resolved for the procedure to be consistent with the theory of demand.

APPENDIX A: Derivation of Elasticity Formulae

As discussed in Chapter 3.2.1, Deaton (1988) expresses unit value of a commodity (E/Q) as

$$V = pv \qquad \text{A.1}$$

where p is an index of commodity price and v is Deaton's commodity quality index. Hence we obtain

$$E = vpQ \qquad \text{A.2}$$

Since commodity budget share is given by

$$w = \frac{E}{X} \qquad \text{A.3}$$

we have

$$w = \frac{vpQ}{X} \qquad \text{A.4}$$

From equation A.1 we have

$$d\ln V = d\ln p + d\ln v$$

hence, since $\frac{d\ln p}{d\ln X} = 0$

$$\frac{d\ln V}{d\ln X} = \frac{d\ln v}{d\ln X} = \eta_x$$

From equation 3.2.2 we have

$$\eta_x = \beta_2 \qquad \text{A.5.}$$

From equation A.3 we have

$$\text{dlnw} = \text{dlnE} - \text{dlnX}$$

$$\psi_X = \frac{\text{dlnE}}{\text{dlnX}} = \frac{\text{dlnw}}{\text{dlnX}} + 1.$$

Since $\frac{\text{dw}}{\text{dlnw}} = w^{-1}$, and from equation 3.2.1 $\frac{\text{dw}}{\text{dlnX}} = \beta_1$, we have

$$\frac{\text{dlnw}}{\text{dlnX}} = \frac{\text{dlnw}}{\text{dw}} \cdot \frac{\text{dw}}{\text{dlnX}} = w^{-1}\,\beta_1$$

hence

$$\psi_X = w^{-1}\,\beta_1 + 1 \qquad \text{A.6.}$$

From equation A.2 we have

$$\text{dlnE} = \text{dlnv} + \text{dlnp} + \text{dlnQ}$$

and since $\frac{\text{dlnp}}{\text{dlnX}} = 0$, we have

$$\frac{\text{dlnQ}}{\text{dlnX}} = \frac{\text{dlnE}}{\text{dlnX}} - \frac{\text{dlnv}}{\text{dlnX}}$$

$$\varepsilon_X = \psi_X - \eta_X$$

$$\varepsilon_X = w^{-1}\beta_1 + 1 - \beta_2. \tag{A.7}$$

Now,

$$\frac{d\ln v}{d\ln E} = \frac{d\ln v}{d\ln X}\left(\frac{d\ln E}{d\ln X}\right)^{-1}$$

$$\eta_E = \eta_X \psi_X^{-1} = \eta_X(\varepsilon_X + \eta_X)^{-1} \tag{A.8.}$$

From equations A.5 and A.6 we have

$$\eta_E = \beta_2(w^{-1}\beta_1 + 1)^{-1}.$$

Since E = VQ, from equation A.3 we have $w = \frac{VQ}{X}$, hence

$$d\ln w = d\ln V + d\ln Q - d\ln X.$$

Therefore, since $\frac{d\ln X}{d\ln p} = 0$ where X is total household expenditure, we have

$$\frac{d\ln w}{d\ln p} = \frac{d\ln V}{d\ln p} + \frac{d\ln Q}{d\ln p}\ (=\varepsilon_p).$$

From equations 3.2.1 and 3.2.2 we therefore have

$$w^{-1}\theta_1 = \theta_2 + \varepsilon_p$$

$$\varepsilon_p = w^{-1}\theta_1 - \theta_2 \tag{A.9.}$$

Now,

$$\frac{d\ln v}{d\ln p} = \frac{d\ln Q}{d\ln p} \cdot \frac{d\ln v}{d\ln X} \cdot \left(\frac{d\ln Q}{d\ln X}\right)^{-1}$$

$$\eta_p = \frac{\varepsilon_p \eta_X}{\varepsilon_X} \qquad \text{A.10}$$

$$= \frac{(w^{-1}\theta_1 - \theta_2)\beta_2}{w^{-1}\beta_1 + 1 - \beta_2}.$$

From equation A.1 we have

$$d\ln V = d\ln p + d\ln v$$

and

$$\frac{d\ln v}{d\ln p} = \frac{d\ln V}{d\ln p} - 1.$$

Hence, from equation 3.2.2 we also have

$$\eta_p = \theta_2 - 1 \qquad \text{A.11.}$$

Equating the above two expressions for η_p, letting $\phi = \frac{\theta_1}{\theta_2}$, and solving for θ_1, we obtain

$$\theta_1 = \phi[\beta_1 + w(1 - \beta_2)][\beta_1 + w - \phi\beta_2]^{-1}$$

which is equation 3.2.15. Since, following Deaton (1988), we obtain estimates for β_1, β_2 and ϕ, we can estimate θ_1 (and hence θ_2) and hence ε_p and η_p.

From equation A.2 we have

$$d\ln E = d\ln v + d\ln p + d\ln Q$$

$$\frac{d\ln E}{d\ln p} = 1 + \frac{d\ln v}{d\ln p} + \frac{d\ln Q}{d\ln p}$$

$$\psi_p = 1 + \eta_p + \varepsilon_p \qquad \text{A.12.}$$

From equations A.9 and A.11 we have

$$\psi_p = w^{-1}\theta_1.$$

Since we have from the foregoing

$$\frac{d\ln V}{d\ln p} = 1 + \frac{d\ln v}{d\ln p} \qquad \text{A.13}$$

and

$$\frac{d\ln v}{d\ln p} = \eta_p = \frac{\varepsilon_p \eta_X}{\varepsilon_X}$$

we can see that dlnV = dlnp only if there are no quality effects.

Now,

$$\frac{d\ln Q}{d\ln V} = \frac{d\ln Q}{d\ln p}\left(\frac{d\ln V}{d\ln p}\right)^{-1}.$$

Hence, from equation A.13, we have

$$\frac{d\ln Q}{d\ln v} = \frac{\varepsilon_p}{1 + (\eta_X \varepsilon_p / \varepsilon_X)} = \varepsilon_v \qquad \text{A.14.}$$

For a normal commodity we would expect $\varepsilon_p < 0$, $\eta_X > 0$ and $\varepsilon_X > 0$. Since $\eta_p = \frac{\varepsilon_p \eta_X}{\varepsilon_X}$,

and if $|\eta_p| < 1$ as would be expected, then $|\varepsilon_p \eta_X| < \varepsilon_X$, and we have $0 < 1 + \frac{\eta_X \varepsilon_p}{\varepsilon_X} < 1$,

hence $|\varepsilon_V| > |\varepsilon_p|$. Thus, in the presence of quality effects, a comparison of quantities and unit values (via regression of commodity budget share on lnV, and other explanatory variables) will tend to overstate the true price elasticity in absolute magnitude.

Since rearranging A.14 gives

$$\varepsilon_p = \frac{\varepsilon_X \varepsilon_V}{\varepsilon_X - \varepsilon_V \eta_X}$$

we have a means of repairing the bias resulting from comparison of budget shares (quantities) and unit values, and Deaton's model accomplishes exactly this purpose. Again we can see that if there are no quality effects (η_X, $\eta_p = 0$) then $\varepsilon_p = \varepsilon_V$.

In the derivation of ε_p (equation A.9) it was assumed that $\frac{d\ln X}{d\ln p} = 0$. Where X is total household expenditure on all goods and services, this assumption is not unreasonable. Where, instead, total food expenditure (x) is used in the model, this assumption may be more tenuous; it would be most unlikely to hold if p were an index of overall food prices. Where total household expenditure on all goods and services is measured, this variable should be used to estimate equations 3.2.1 and 3.2.2, and to compute commodity budget shares. Food expenditure as a share of total expenditure (x/X) could be used (intercluster regression) to estimate $\frac{d\ln x}{d\ln X}$; this elasticity will be a function of the food budget share. Elasticities such as $\eta_x = \frac{d\ln v}{d\ln x}$, for example, can then be obtained by

$$\eta_x = \left(\frac{d\ln x}{d\ln X}\right)^{-1} \eta_X.$$

From equation A.10

$$\eta_p = \frac{\varepsilon_p \eta_X}{\varepsilon_X}$$

$$= \frac{\varepsilon_p \eta_X}{\psi_X - \eta_X}$$

using equation A.7

$$= \frac{\varepsilon_p \eta_X \psi_X^{-1}}{1 - \eta_X \psi_X^{-1}}$$

$$= \frac{\varepsilon_p \eta_E}{1 - \eta_E}$$

using equation A.8

$$\eta_p = (\eta_p + \varepsilon_p)\eta_E$$

$$\eta_p = (\psi_p - 1)\eta_E$$

using equation A.12.

This is equation 6 in Deaton (1988).

APPENDIX B: Derivation of Equations 3.2.12 and 3.2.13

Dropping the '+' superscript from n^{+}_{i} for convenience, and where $x_i = \ln p_i$, we have

$$y_{2.1} = \alpha_2 + \theta_2 x_1 + u_{2.1} \qquad (n_1 \text{ observations})$$

$$\vdots$$

$$y_{2.C} = \alpha_2 + \theta_2 x_C + u_{2.C} \qquad (n_C \text{ observations})$$

which has an overall mean[13] of

$$\mathbf{y}_2 = \alpha_2 + \theta_2 \mathbf{x} + u_2$$

To compute $\mathrm{var}(y_{2.i})$, where

$$\mathrm{var}(y_{2.i}) = \frac{\sum^{C} (y_{2.i} - \mathbf{y}_2)^2}{C - 1}$$

we must substitute terms in the numerator of the variance equation, so that

$$\Sigma(y_{2.i} - \mathbf{y}_2)^2 = \Sigma(\theta_2 x_i + u_{2.i} - \theta_2 \mathbf{x} - \mathbf{u}_2)^2$$

Expanding this term gives,

$$\Sigma(y_{2.i} - \mathbf{y}_2)^2 = \theta^2_2 \Sigma(x_i - \mathbf{x})^2 + \Sigma(u_{2.i} - \mathbf{u}_2)^2 + 2\theta_2 \Sigma(x_i - \mathbf{x})(u_{2.i} - \mathbf{u}_2) \qquad \text{B.1}$$

[13] Terms in bold represent sample mean values.

Now taking expectations of B.1, the first term equals $\theta^2_2(C-1)$ Var(x), while the covariance term is equal to zero. Before taking expectations of the second term, expanding this expression yields

$$\Sigma(u_{2.i} - \mathbf{u}_2)^2 = \Sigma u^2_{2.i} + C\mathbf{u}^2_2 - 2\mathbf{u}_2\Sigma u_{2.i} \qquad \text{B.2}$$

Now, $E(u^2_{2.i}) = \frac{\sigma_{22}}{n_i}$, so

$$E\Sigma u^2_{2.i} = \sigma_{22}\Sigma\frac{1}{n_i} \qquad \text{B.3}$$

The mean of the $u_{2.i}$ values is equal to the following

$$\mathbf{u}_2 = \frac{\Sigma u_{2.i}}{C}$$

so that

$$\mathbf{u}^2_2 = \frac{(\Sigma u_{2.i})^2}{C^2}$$

and

$$C\mathbf{u}^2_2 = \frac{(\Sigma u_{2.i})^2}{C}$$

Now

$$E(\Sigma u_{2.i})^2 = \Sigma Var(u_{2.i}) + \text{covariance terms}(=0)$$

and since

$$E\,(u_{2.i})^2 = \sigma_{22}\Sigma\frac{1}{n_i}$$

we have

$$E(C\mathbf{u}^2{}_2) = \frac{\sigma_{22}\Sigma\frac{1}{n_i}}{C} \qquad \text{B.4}$$

Now,

$$E(\mathbf{u}_2\,u_{2.i}) = \frac{1}{C}\,[\,E(u^2{}_{2.i})) + \text{covariance terms}(=0)] = \frac{\sigma_{22}\Sigma\frac{1}{n_i}}{C}$$

so that

$$E[-2\mathbf{u}_2\Sigma u_{2.i}] = \frac{-2\sigma_{22}\Sigma\frac{1}{n_i}}{C} \qquad \text{B.5}$$

Subsequently, after substitution of these expressions in B.2, the expected value of B.2 is

$$E\Sigma(u_{2.i} - \mathbf{u}_2)^2 = \sigma_{22}[\Sigma\frac{1}{n_i} + \Sigma\frac{\frac{1}{n_i}}{C} - 2\Sigma\frac{\frac{1}{n_i}}{C}\,] = \frac{\sigma_{22}\Sigma\frac{1}{n_i}(C-1)}{C}$$

We therefore have the result that $\sum^{C} (y_{2.i} - \mathbf{y}_2)^2$ estimates

$$\theta^2{}_2(C-1)\text{Var}(x) + \frac{(C-1)}{C}\,\sigma_{22}\Sigma\frac{1}{n_i}$$

Thus $\text{var}(y_{2.i})$ estimates $\theta^2{}_2\text{Var}(x) + \sigma_{22}/\tau^+$

where $t^+ = C/\Sigma \frac{1}{n_i^+}$.

We can note in passing that if fixed cluster effects f_c were included in equation 3.2.2, then $var(y_{2.i})$ would include a term Var(f).

The model for the ith cluster mean budget share, after eliminating the effect of total expenditure and household characteristics is

$$y_{1.i} = \alpha_1 + \theta_1 x_1 + fi + u_{1.i}$$

Following the same steps as previously, and assuming $Cov(x_i, f_i) = 0$, we find that $Cov(y_{1.i}, y_{2.i})$ estimates $\theta_1\theta_2 Var(x) + \sigma_{12}/\tau^+$.

We can note in passing that if the fixed cluster effects were included in equation 3.2.2, then $cov(y_{1.i}, y_{2.i})$ would include a term Var(f), and we would be unable to proceed to the following result without an independent estimate of Var(f). It is in this sense that Deaton's model would not be identified if the fixed cluster effects were included in both the budget share and unit value equations.

From the above results it is clear that

$$\frac{Cov(y_{1.i}, y_{2.i}) - \sigma_{12}/\tau^+}{Var(y_{2.1}) - \sigma_{22}/\tau^+} = \frac{\theta_1}{\theta_2}$$

hence substitution of unbiased sample estimates for population values in the above expression lead to a consistent estimator for $\frac{\theta_1}{\theta_2} = \phi$.

APPENDIX C: Direct Regression Results

Model Specification.

The dependent variable, ltqp represents the logarithm of total quantity.

The independent variables refer to the following:

lnv = logarithm of unit value;

ltp = logarithm of per capita total household expenditure;

lhs = logarithm of household size;

s(f/m)1 = ratio of female/male household members aged 0-5;

s(f/m)2 = ratio of female/male household members aged 6-11;

s(f/m)3 = ratio of female/male household members aged 12-17;

sm4 = ratio of male household members aged 18-34;

s(f/m)5 = ratio of female/male household members aged 35-54;

s(f/m)6 = ratio of female/male household members aged 55-64; and

s(f/m)7 = ratio of female/male household members aged 65.

APPENDIX C1 - RICE.

Ordinary Least Squares Estimation

Model: LTQP
Dependent variable: LTQP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	990.80707	61.92544	769.308	0.0001
Error	5193	418.01026	0.08049		
C Total	5209	1408.81734			

Root MSE	0.28372	R-Square	0.7033
Dep Mean	10.68673	Adj R-SQ	0.7024
C.V.	2.65485		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	10.013778	0.099499	100.642	0.0001
LNV	1	-0.383306	0.037949	-10.101	0.0001
LTP	1	-0.004475	0.007501	-0.597	0.5508
LHS	1	0.895970	0.010521	85.162	0.0001
SF1	1	-0.080310	0.048276	-1.664	0.0963
SF2	1	0.012332	0.045436	0.271	0.7861
SF3	1	0.084006	0.044825	1.874	0.0610
SF5	1	0.096575	0.034234	2.821	0.0048
SF6	1	0.140396	0.037644	3.730	0.0002
SF7	1	0.038101	0.044186	0.862	0.3886
SM1	1	-0.082905	0.048199	-1.720	0.0855
SM2	1	0.108130	0.045136	2.396	0.0166
SM3	1	0.272343	0.044145	6.169	0.0001
SM4	1	0.230170	0.037384	6.157	0.0001
SM5	1	0.204467	0.043987	4.648	0.0001
SM6	1	0.148736	0.052641	2.825	0.0047
SM7	1	0.175708	0.052726	3.332	0.0009

APPENDIX C2 - MEAT .

Ordinary Least Squares Estimation

Model: LTQP
Dependent variable: LTQP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	1053.00389	65.81274	162.127	0.0001
Error	2888	1172.33310	0.40593		
C Total	2904	2225.33699			

Root MSE	0.63713	R-Square	0.4732
Dep Mean	8.08331	Adj R-SQ	0.4703

C.V. 7.88203

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-4.341300	0.329317	-13.183	0.0001
LNV	1	-0.618590	0.033010	-18.739	0.0001
LTP	1	0.989383	0.023138	42.761	0.0001
LHS	1	0.928736	0.032460	28.612	0.0001
SF1	1	0.200499	0.144429	1.388	0.1652
SF2	1	0.034846	0.137365	0.254	0.7998
SF3	1	-0.235784	0.129236	-1.824	0.0682
SF5	1	0.118292	0.110490	1.071	0.2844
SF6	1	0.246231	0.129568	1.900	0.0575
SF7	1	0.181923	0.162124	1.122	0.2619
SM1	1	0.042474	0.141503	0.300	0.7641
SM2	1	0.046765	0.134219	0.348	0.7275
SM3	1	-0.118381	0.137418	-0.861	0.3891
SM4	1	-0.237803	0.114484	-2.077	0.0379
SM5	1	0.023871	0.139362	0.171	0.8640
SM6	1	0.050493	0.182617	0.276	0.7822
SM7	1	0.144501	0.182865	0.790	0.4295

APPENDIX C3 - FRUIT.

Ordinary Least Squares Estimation

Model: LTQP
Dependent variable: LTQP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	1337.07128	83.56696	193.014	0.0001
Error	4201	1818.85408	0.43296		
C Total	4217	3155.92536			

Root MSE	0.65799	R-Square	0.4237
Dep Mean	9.26607	Adj R-SQ	0.4215
C.V.	7.10113		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-3.456059	0.267828	-12.904	0.0001
LNV	1	-0.528345	0.020710	-25.512	0.0001
LTP	1	0.943105	0.019688	47.902	0.0001
LHS	1	0.769887	0.027268	28.234	0.0001
SF1	1	0.399931	0.123252	3.245	0.0012
SF2	1	0.292585	0.116854	2.504	0.0123
SF3	1	0.144664	0.116854	1.268	0.2047
SF5	1	-0.179467	0.091800	-1.955	0.0507
SF6	1	-0.038583	0.108451	-0.356	0.7220
SF7	1	-0.023227	0.125230	-0.185	0.8529
SM1	1	0.281646	0.122366	2.302	0.0214
SM2	1	0.462022	0.115658	3.995	0.0001
SM3	1	0.174065	0.115015	1.513	0.1303
SM4	1	0.056347	0.095679	0.589	0.5560
SM5	1	0.076432	0.114573	0.667	0.5047
SM6	1	0.219090	0.151247	1.449	0.1475
SM7	1	0.031223	0.150646	0.207	0.8358

APPENDIX C4 - VEGETABLES.

Ordinary Least Squares Estimation

Model: LTQP
Dependent variable: LTQP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	2444.75494	152.79718	622.981	0.0001
Error	5373	1317.82375	0.24527		
C Total	5389	3762.57870			

Root MSE	0.49525	R-Square	0.6498
Dep Mean	9.56826	Adj R-SQ	0.6487
C.V.	5.17592		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	2.015798	0.169551	11.889	0.0001
LNV	1	-0.973667	0.012163	-80.055	0.0001
LTP	1	0.614212	0.012119	50.682	0.0001
LHS	1	0.767831	0.018562	41.366	0.0001
SF1	1	0.159750	0.083756	1.907	0.0565
SF2	1	-0.023285	0.078855	-0.295	0.7678
SF3	1	-0.073554	0.077460	-0.950	0.3424
SF5	1	-0.005666	0.059544	-0.095	0.9242
SF6	1	-0.016638	0.066144	-0.252	0.8014
SF7	1	-0.105192	0.076410	-1.377	0.1687
SM1	1	0.028538	0.083286	0.343	0.7319
SM2	1	0.053897	0.077872	0.692	0.4889
SM3	1	0.092924	0.076299	1.218	0.2233
SM4	1	0.074420	0.067135	1.109	0.2677
SM5	1	-0.064785	0.079477	-0.815	0.4150
SM6	1	-0.007357	0.093116	-0.079	0.9370
SM7	1	-0.190029	0.092021	-2.065	0.0390

APPENDIX C5 - MILK PRODUCTS.

Ordinary Least Squares Estimation

Model: LTQP
Dependent variable: LTQP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	340.99511	21.31219	59.712	0.0001
Error	1018	363.34060	0.35692		
C Total	1034	704.33571			

Root MSE	0.59742	R-Square	0.4841
Dep Mean	7.96330	Adj R-SQ	0.4760
C.V.	7.50222		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1.385142	0.536790	2.580	0.0100
LNV	1	-0.670041	0.024073	-27.833	0.0001
LTP	1	0.594849	0.037900	15.695	0.0001
LHS	1	0.568011	0.051992	10.925	0.0001
SF1	1	0.969497	0.212653	4.559	0.0001
SF2	1	-0.273517	0.208664	-1.311	0.1902
SF3	1	-0.106308	0.211544	-0.503	0.6154
SF5	1	0.128729	0.179438	0.717	0.4733
SF6	1	0.419716	0.245713	1.708	0.0879
SF7	1	-0.137621	0.237611	-0.579	0.5626
SM1	1	0.840340	0.226487	3.710	0.0002
SM2	1	-0.024570	0.216370	-0.114	0.9096
SM3	1	0.323922	0.230760	1.404	0.1607
SM4	1	-0.194960	0.189074	-1.031	0.3027
SM5	1	-0.162813	0.227053	-0.717	0.4735
SM6	1	-0.457450	0.346547	-1.320	0.1871
SM7	1	-0.332502	0.281291	-1.182	0.2375

APPENDIX D: Deaton Model Regression Results using Total Expenditure

Model Specification.

The variables specified in the following Appendices are different to those specified in chapter five. The dependent variables represent the following:

vw = within-cluster budget share;

vlnv = within-cluster logarithm of unit value;

The independent variables refer to the following, where w**** refers to a variable from the within-cluster budget share equation, and v**** refers to variables from the within-cluster unit value equation.

ltpcx = within-cluster logarithm of per capita total/food household expenditure;

lhs = within-cluster logarithm of household size;

s(f/m)1 = within-cluster ratio of female/male household members aged 0-5;

s(f/m)2 = within-cluster ratio of female/male household members aged 6-11;

s(f/m)3 = within-cluster ratio of female/male household members aged 12-17;

sm4 = within-cluster ratio of male household members aged 18-34;

s(f/m)5 = within-cluster ratio of female/male household members aged 35-54;

s(f/m)6 = within-cluster ratio of female/male household members aged 55-64; and

s(f/m)7 = within-cluster ratio of female/male household members aged 65.

APPENDIX D1 - RICE.

Budget Share Equation.

Ordinary Least Squares Estimation
Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	11.51876	0.76792	370.286	0.0001
Error	5648	11.71309	0.00207		
U Total	5663	23.23185			

Root MSE	0.04554	R-Square	0.4958
Dep Mean	-0.00000	Adj R-SQ	0.4945
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	-0.116863	0.001678	-69.632	0.0001
WLHS	1	-0.001601	0.001754	-0.913	0.3614
WSF1	1	-0.026066	0.007919	-3.292	0.0010
WSF2	1	-0.006822	0.007367	-0.926	0.3544
WSF3	1	0.001295	0.007174	0.180	0.8568
WSF5	1	0.019941	0.005532	3.605	0.0003
WSF6	1	0.013498	0.006093	2.215	0.0268
WSF7	1	-0.005409	0.006893	-0.785	0.4327
WSM1	1	-0.033254	0.007859	-4.231	0.0001
WSM2	1	-0.001320	0.007319	-0.180	0.8568
WSM3	1	0.012819	0.007129	1.798	0.0722
WSM4	1	0.007909	0.005964	1.326	0.1848
WSM5	1	0.007599	0.007089	1.072	0.2838
WSM6	1	0.017339	0.008293	2.091	0.0366
WSM7	1	-0.003575	0.008023	-0.446	0.6559

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	1.71794	0.11453	21.800	0.0001
Error	5199	27.31369	0.00525		
U Total	5214	29.03162			

Root MSE	0.07248	R-Square	0.0592
Dep Mean	0.00000	Adj R-SQ	0.0565
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.048776	0.002822	17.285	0.0001
VLHS	1	0.011050	0.002957	3.738	0.0002
VSF1	1	0.003559	0.013071	0.272	0.7854
VSF2	1	0.011300	0.012210	0.925	0.3548
VSF3	1	-0.009160	0.011983	-0.764	0.4446
VSF5	1	-0.008884	0.009199	-0.966	0.3342
VSF6	1	-0.000853	0.010166	-0.084	0.9331
VSF7	1	-0.006313	0.011828	-0.534	0.5935
VSM1	1	-0.000080699	0.012995	-0.006	0.9950
VSM2	1	-0.003548	0.012170	-0.292	0.7706
VSM3	1	-0.021652	0.011975	-1.808	0.0706
VSM4	1	-0.025697	0.010012	-2.567	0.0103
VSM5	1	-0.008572	0.011775	-0.728	0.4667
VSM6	1	0.006581	0.014069	0.468	0.6400
VSM7	1	-0.021709	0.014111	-1.538	0.1240

APPENDIX D2 - MEAT.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	0.62063	0.04138	57.676	0.0001
Error	5640	4.04596	0.00072		
U Total	5655	4.66659			

Root MSE	0.02678	R-Square	0.1330
Dep Mean	-0.00000	Adj R-SQ	0.1307
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	0.027628	0.000987	27.985	0.0001
WLHS	1	0.009586	0.001034	9.269	0.0001
WSF1	1	0.005783	0.004671	1.238	0.2158
WSF2	1	0.002868	0.004338	0.661	0.5085
WSF3	1	-0.004504	0.004227	-1.066	0.2866
WSF5	1	-0.005645	0.003262	-1.730	0.0836
WSF6	1	-0.005413	0.003593	-1.507	0.1320
WSF7	1	-0.005350	0.004067	-1.316	0.1883
WSM1	1	0.010966	0.004639	2.364	0.0181
WSM2	1	0.007545	0.004313	1.750	0.0803
WSM3	1	-0.006492	0.004199	-1.546	0.1221
WSM4	1	-0.014039	0.003515	-3.994	0.0001
WSM5	1	-0.007346	0.004179	-1.758	0.0789
WSM6	1	-0.005543	0.004891	-1.133	0.2572
WSM7	1	0.002012	0.004732	0.425	0.6706

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	15.10666	1.00711	10.666	0.0001
Error	2902	274.02402	0.09443		
U Total	2917	289.13068			

Root MSE	0.30729	R-Square	0.0522
Dep Mean	0.00000	Adj R-SQ	0.0473
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.189676	0.017056	11.121	0.0001
VLHS	1	0.045052	0.017500	2.574	0.0101
VSF1	1	-0.036704	0.074574	-0.492	0.6226
VSF2	1	0.063786	0.070486	0.905	0.3656
VSF3	1	-0.202036	0.065680	-3.076	0.0021
VSF5	1	-0.005084	0.057086	-0.089	0.9290
VSF6	1	0.024055	0.066374	0.362	0.7171
VSF7	1	0.080482	0.083182	0.968	0.3334
VSM1	1	-0.023773	0.072552	-0.328	0.7432
VSM2	1	-0.043816	0.069260	-0.633	0.5270
VSM3	1	-0.146931	0.070432	-2.086	0.0371
VSM4	1	-0.107868	0.058569	-1.842	0.0656
VSM5	1	-0.003577	0.071432	-0.050	0.9601
VSM6	1	-0.042287	0.092837	-0.456	0.6488
VSM7	1	-0.036649	0.093897	-0.390	0.6963

APPENDIX D3 - FRUIT.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	0.21703	0.01447	29.621	0.0001
Error	5650	2.75984	0.00049		
U Total	5665	2.97688			

Root MSE	0.02210	R-Square	0.0729
Dep Mean	-0.00000	Adj R-SQ	0.0704
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	0.015109	0.000815	18.529	0.0001
WLHS	1	0.002931	0.000851	3.444	0.0006
WSF1	1	0.007643	0.003846	1.987	0.0469
WSF2	1	0.006802	0.003574	1.903	0.0571
WSF3	1	0.001800	0.003484	0.517	0.6053
WSF5	1	-0.009862	0.002684	-3.674	0.0002
WSF6	1	-0.006309	0.002959	-2.132	0.0331
WSF7	1	-0.005993	0.003342	-1.793	0.0730
WSM1	1	0.012834	0.003817	3.363	0.0008
WSM2	1	0.009589	0.003553	2.699	0.0070
WSM3	1	0.000028	0.003460	0.008	0.9936
WSM4	1	-0.003494	0.002889	-1.210	0.2265
WSM5	1	-0.003191	0.003442	-0.927	0.3538
WSM6	1	-0.006096	0.004025	-1.515	0.1299
WSM7	1	-0.011222	0.003891	-2.884	0.0039

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	51.99107	3.46607	23.210 0.0001	
Error	4215	629.45155	0.14934		
U Total	2917	681.44262			

Root MSE	0.38644	R-Square	0.0763
Dep Mean	0.00000	Adj R-SQ	0.0730
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.303740	0.017298	17.559	0.0001
VLHS	1	0.058640	0.017805	3.293	0.0010
VSF1	1	0.081999	0.077229	1.062	0.2884
VSF2	1	0.172102	0.072578	2.371	0.0178
VSF3	1	0.027916	0.070394	0.397	0.6917
VSF5	1	-0.059699	0.057064	-1.046	0.2955
VSF6	1	-0.98373	0.067118	-1.466	0.1428
VSF7	1	-0.117762	0.077853	-1.513	0.1305
VSM1	1	0.020043	0.076173	0.263	0.7925
VSM2	1	0.128001	0.071884	1.781	0.0750
VSM3	1	0.005294	0.072053	0.073	0.9414
VSM4	1	-0.026252	0.059124	-0.444	0.6571
VSM5	1	-0.042182	0.070826	-0.596	0.5515
VSM6	1	-0.236350	0.092916	-2.544	0.0110
VSM7	1	-0.230306	0.093218	-2.471	0.0135

APPENDIX D4 - VEGETABLES.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	0.41850	0.02790	95.653	0.0001
Error	5483	1.59926	0.00029		
U Total	5498	2.01775			

Root MSE	0.01708	R-Square	0.2074
Dep Mean	0.00000	Adj R-SQ	0.2052
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	-0.022556	0.000642	-35.109	0.0001
WLHS	1	-0.010533	0.000671	-15.690	0.0001
WSF1	1	0.000052427	0.003014	0.017	0.9861
WSF2	1	-0.004008	0.002814	-1.424	0.1545
WSF3	1	-0.007004	0.002737	-2.559	0.0105
WSF5	1	0.004652	0.002121	2.193	0.0284
WSF6	1	0.000357	0.002336	0.153	0.8787
WSF7	1	-0.007442	0.002662	-2.796	0.0052
WSM1	1	-0.003166	0.002994	-1.057	0.2903
WSM2	1	-0.007939	0.002794	-2.841	0.0045
WSM3	1	-0.002625	0.002741	-0.958	0.3382
WSM4	1	-0.005575	0.002296	-2.428	0.0152
WSM5	1	-0.011815	0.002731	-4.326	0.0001
WSM6	1	-0.009164	0.003176	-2.885	0.0039
WSM7	1	-0.012836	0.003167	-4.052	0.0001

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	8.89289	0.59286	3.339	0.0001
Error	5392	957.41594	0.17756		
U Total	5407	966.30883			

Root MSE	0.42138	R-Square	0.0092
Dep Mean	0.00000	Adj R-SQ	0.0064
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.070005	0.016017	4.371	0.0001
VLHS	1	-0.016125	0.017231	-0.936	0.3494
VSF1	1	-0.137284	0.075477	-1.819	0.0690
VSF2	1	-0.095497	0.070504	-1.354	0.1756
VSF3	1	-0.216516	0.068800	-3.147	0.0017
VSF5	1	-0.055940	0.053139	-1.053	0.2925
VSF6	1	-0.077836	0.059260	-1.313	0.1891
VSF7	1	-0.086076	0.067924	-1.267	0.2051
VSM1	1	-0.085537	0.074761	-1.144	0.2526
VSM2	1	-0.094174	0.069950	-1.346	0.1783
VSM3	1	-0.111773	0.068946	-1.621	0.1050
VSM4	1	-0.100300	0.059859	-1.676	0.0939
VSM5	1	-0.078081	0.070794	-1.103	0.2701
VSM6	1	-0.131832	0.082524	-1.597	0.1102
VSM7	1	-0.172432	0.081915	-2.105	0.0353

APPENDIX D5 - MILK PRODUCTS.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	0.33668	0.02245	50.643	0.0001
Error	5634	2.49703	0.00044		
U Total	5649	2.83371			

Root MSE	0.02105	R-Square	0.1188
Dep Mean	0.00000	Adj R-SQ	0.1165
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	0.013086	0.000778	16.827	0.0001
WLHS	1	0.002193	0.000813	2.699	0.0070
WSF1	1	0.045715	0.003680	12.421	0.0001
WSF2	1	0.005273	0.003409	1.547	0.1220
WSF3	1	-0.003348	0.003318	-1.009	0.3131
WSF5	1	-0.003228	0.002558	-1.262	0.2069
WSF6	1	-0.003310	0.002818	-1.174	0.2403
WSF7	1	-0.001735	0.003186	-0.545	0.5861
WSM1	1	0.042365	0.003641	11.637	0.0001
WSM2	1	0.005039	0.003386	1.489	0.1367
WSM3	1	-0.001604	0.003298	-0.486	0.6268
WSM4	1	-0.006477	0.002752	-2.354	0.0186
WSM5	1	-0.008329	0.003280	-2.540	0.0111
WSM6	1	-0.006530	0.003836	-1.703	0.0887
WSM7	1	-0.001362	0.003706	-0.367	0.7133

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	41.80324	2.78688	6.926	0.0001
Error	1039	418.07233	0.40238		
U Total	1054	459.87556			

Root MSE	0.63433	R-Square	0.0909
Dep Mean	-0.00000	Adj R-SQ	0.0778
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.249007	0.060384	4.124	0.0001
VLHS	1	0.234773	0.063337	3.707	0.0002
VSF1	1	0.593622	0.246154	2.412	0.0161
VSF2	1	-0.248573	0.242112	-1.027	0.3048
VSF3	1	-0.185848	0.237527	-0.782	0.4341
VSF5	1	-0.311777	0.207616	-1.502	0.1335
VSF6	1	-0.421526	0.284766	-1.480	0.1391
VSF7	1	-0.454489	0.274650	-1.655	0.0983
VSM1	1	1.016713	0.260780	3.899	0.0001
VSM2	1	-0.297799	0.246834	-1.206	0.2279
VSM3	1	-0.341260	0.271803	-1.256	0.2096
VSM4	1	-0.559530	0.218274	-2.563	0.0105
VSM5	1	-0.640786	0.260005	-2.465	0.0139
VSM6	1	-0.706217	0.397870	-1.775	0.0762
VSM7	1	-0.408068	0.319471	-1.277	0.2018

APPENDIX E: Deaton Model Regression Results using Food Expenditure

APPENDIX E1 - RICE .

Budget Share Equation.

Ordinary Least Squares Estimation
Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	23.43847	1.56256	297.393	0.0001
Error	5648	29.67576	0.00525		
U Total	5663	53.11423			

Root MSE	0.07249	R-Square	0.4413
Dep Mean	-0.00000	Adj R-SQ	0.4398
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	-0.191818	0.003149	-60.923	0.0001
WLHS	1	-0.005588	0.002842	-1.966	0.0494
WSF1	1	-0.046144	0.012544	-3.678	0.0002
WSF2	1	-0.004369	0.011671	-0.374	0.7082
WSF3	1	0.011266	0.011427	0.986	0.3242
WSF5	1	0.032096	0.008820	3.639	0.0003
WSF6	1	0.028321	0.009698	2.920	0.0035
WSF7	1	-0.003157	0.010991	-0.287	0.7739
WSM1	1	-0.052689	0.012453	-4.231	0.0001
WSM2	1	0.003294	0.011601	0.284	0.7765
WSM3	1	0.036928	0.011334	3.258	0.0011
WSM4	1	0.023676	0.009477	2.498	0.0125
WSM5	1	0.018884	0.011295	1.672	0.0946
WSM6	1	0.033895	0.013181	2.571	0.0102
WSM7	1	0.008835	0.012769	0.692	0.4890

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	1.63914	0.10928	20.740	0.0001
Error	5199	27.39248	0.00527		
U Total	5214	29.03162			

Root MSE	0.07259	R-Square	0.0565
Dep Mean	0.00000	Adj R-SQ	0.0537
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.055846	0.003320	16.822	0.0001
VLHS	1	0.014013	0.003013	4.651	0.0001
VSF1	1	-0.007106	0.013025	-0.546	0.5854
VSF2	1	0.001919	0.012171	0.158	0.8747
VSF3	1	-0.007367	0.012007	-0.614	0.5396
VSF5	1	-0.005414	0.009227	-0.587	0.5574
VSF6	1	-0.000967	0.010181	-0.095	0.9243
VSF7	1	-0.003548	0.011865	-0.299	0.7649
VSM1	1	-0.010734	0.012952	-0.829	0.4073
VSM2	1	-0.012878	0.012135	-1.061	0.2886
VSM3	1	-0.024861	0.011978	-2.076	0.0380
VSM4	1	-0.036077	0.010009	-3.604	0.0003
VSM5	1	-0.016244	0.011806	-1.376	0.1689
VSM6	1	0.000689	0.014070	0.049	0.9609
VSM7	1	-0.021874	0.014132	-1.548	0.1217

APPENDIX E2 - MEAT.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	3.27166	0.21811	98.097	0.0001
Error	5640	12.54013	0.00222		
U Total	5655	15.81178			

Root MSE	0.04715	R-Square	0.2069
Dep Mean	-0.00000	Adj R-SQ	0.2048
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	0.075241	0.002049	36.720	0.0001
WLHS	1	0.029308	0.001853	15.820	0.0001
WSF1	1	-0.009197	0.008185	-1.124	0.2612
WSF2	1	-0.013033	0.007602	-1.715	0.0865
WSF3	1	-0.003627	0.007446	-0.487	0.6262
WSF5	1	0.001326	0.005752	0.231	0.8177
WSF6	1	-0.005975	0.006326	-0.945	0.3449
WSF7	1	0.001711	0.007170	0.239	0.8115
WSM1	1	-0.002954	0.008131	-0.363	0.7164
WSM2	1	-0.007925	0.007560	-1.048	0.2946
WSM3	1	-0.020578	0.007384	-2.787	0.0053
WSM4	1	-0.048624	0.006178	-7.870	0.0001
WSM5	1	-0.029335	0.007366	-3.982	0.0001
WSM6	1	-0.021131	0.008599	-2.457	0.0140
WSM7	1	0.001860	0.008329	0.223	0.8233

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	14.55040	0.97003	10.252	0.0001
Error	2902	274.58027	0.09462		
U Total	2917	289.13068			

Root MSE	0.30760	R-Square	0.0503
Dep Mean	0.00000	Adj R-SQ	0.0454
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.221519	0.020432	10.842	0.0001
VLHS	1	0.060278	0.018006	3.348	0.0008
VSF1	1	-0.078631	0.074316	-1.058	0.2901
VSF2	1	0.023784	0.070182	0.339	0.7347
VSF3	1	-0.185504	0.065834	-2.818	0.0049
VSF5	1	0.016650	0.057171	0.291	0.7709
VSF6	1	0.022815	0.066440	0.343	0.7313
VSF7	1	0.099293	0.083361	1.191	0.2337
VSM1	1	-0.069330	0.072247	-0.960	0.3373
VSM2	1	-0.085700	0.068938	-1.243	0.2139
VSM3	1	-0.161370	0.070417	-2.292	0.0220
VSM4	1	-0.144699	0.058470	-2.475	0.0134
VSM5	1	-0.033007	0.071586	-0.461	0.6448
VSM6	1	-0.055408	0.092910	-0.596	0.5510
VSM7	1	-0.021960	0.094046	-0.234	0.8154

APPENDIX E3 - FRUIT.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	0.98531	0.06569	50.442	0.0001
Error	5649	7.35628	0.00130		
U Total	5664	8.34158			

Root MSE	0.03609	R-Square	0.1181
Dep Mean	-0.00000	Adj R-SQ	0.1158
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	0.041254	0.001568	26.304	0.0001
WLHS	1	0.012229	0.001415	8.643	0.0001
WSF1	1	-0.001573	0.006246	-0.252	0.8011
WSF2	1	0.003599	0.005804	0.620	0.5352
WSF3	1	0.009519	0.005688	1.673	0.0943
WSF5	1	-0.006741	0.004391	-1.535	0.1248
WSF6	1	-0.006461	0.004829	-1.338	0.1809
WSF7	1	-0.002646	0.005465	-0.484	0.6282
WSM1	1	0.004874	0.006199	-0.786	0.4318
WSM2	1	0.003734	0.005774	-0.647	0.5179
WSM3	1	-0.001675	0.005640	-0.297	0.7665
WSM4	1	-0.018685	0.004705	-3.971	0.0001
WSM5	1	-0.016605	0.005644	-2.942	0.0033
WSM6	1	-0.018594	0.006562	-2.834	0.0046
WSM7	1	-0.012212	0.006351	-1.923	0.0545

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	52.07225	0.98531	50.442	0.0001
Error	4078	7.35628	0.00130		
U Total	4093	8.34158			

Root MSE	0.38906	R-Square	0.0778
Dep Mean	0.00000	Adj R-SQ	0.0744
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.362364	0.020902	17.336	0.0001
VLHS	1	0.075044	0.018619	4.031	0.0001
VSF1	1	0.000009	0.078484	0.001	0.9990
VSF2	1	0.110142	0.074157	1.485	0.1376
VSF3	1	0.080178	0.072207	1.110	0.2669
VSF5	1	-0.025276	0.058845	-0.430	0.6676
VSF6	1	-0.102729	0.068664	-1.496	0.1347
VSF7	1	-0.121464	0.079293	-1.532	0.1256
VSM1	1	-0.055415	0.077446	-0.716	0.4743
VSM2	1	0.059208	0.073142	0.809	0.4183
VSM3	1	0.161191	0.073402	0.221	0.8254
VSM4	1	-0.109621	0.060467	-1.813	0.0699
VSM5	1	-0.149933	0.072826	-2.059	0.0396
VSM6	1	-0.331192	0.094324	-3.511	0.0005
VSM7	1	-0.226683	0.094813	-2.391	0.0169

APPENDIX E4 - VEGETABLES.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	0.70443	0.04696	58.078	0.0001
Error	5483	4.43360	0.00081		
U Total	5498	5.13803			

Root MSE	0.02844	R-Square	0.1371
Dep Mean	0.00000	Adj R-SQ	0.1347
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	-0.030692	0.001265	-24.269	0.0001
WLHS	1	-0.015643	0.001138	-13.746	0.0001
WSF1	1	-0.009728	0.004995	-1.947	0.0515
WSF2	1	-0.012853	0.004664	-2.756	0.0059
WSF3	1	-0.009881	0.004561	-2.167	0.0303
WSF5	1	0.010914	0.003537	3.086	0.0020
WSF6	1	0.004171	0.003889	1.073	0.2835
WSF7	1	-0.009374	0.004439	-2.112	0.0348
WSM1	1	-0.013589	0.004964	-2.738	0.0062
WSM2	1	-0.019667	0.004632	-4.246	0.0001
WSM3	1	-0.008518	0.004558	-1.869	0.0617
WSM4	1	-0.018773	0.003816	-4.919	0.0001
WSM5	1	-0.026876	0.004552	-5.904	0.0001
WSM6	1	-0.023168	0.005281	-4.387	0.0001
WSM7	1	-0.019294	0.005274	-3.658	0.0003

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	8.12435	0.54162	3.048	0.0001
Error	5392	958.18448	0.17770		
U Total	5407	966.30883			

Root MSE	0.42155	R-Square	0.0084
Dep Mean	0.00000	Adj R-SQ	0.0056
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.073039	0.019009	3.842	0.0001
VLHS	1	-0.013365	0.017560	-0.761	0.4466
VSF1	1	-0.155964	0.075130	-2.076	0.0379
VSF2	1	-0.113183	0.070168	-1.613	0.1068
VSF3	1	-0.215789	0.068866	-3.133	0.0017
VSF5	1	-0.054040	0.053224	-1.015	0.3100
VSF6	1	-0.080538	0.059280	-1.359	0.1743
VSF7	1	-0.086151	0.068062	-1.266	0.2056
VSM1	1	-0.103957	0.074442	-1.396	0.1626
VSM2	1	-0.111054	0.069652	-1.594	0.1109
VSM3	1	-0.120234	0.068863	-1.746	0.0809
VSM4	1	-0.116117	0.059768	-1.943	0.0521
VSM5	1	-0.087863	0.070896	-1.239	0.2153
VSM6	1	-0.142316	0.082457	-1.726	0.0844
VSM7	1	-0.173733	0.081962	-2.120	0.0341

APPENDIX E5 - MILK PRODUCTS.

Budget Share Equation.

Ordinary Least Squares Estimation

Model: VW
Dependent variable: VW

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	1.41916	0.09461	63.113	0.0001
Error	5634	8.44579	0.00150		
U Total	5649	9.86494			

Root MSE	0.03872	R-Square	0.1439
Dep Mean	0.00000	Adj R-SQ	0.1416
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
WLTPCX	1	0.036624	0.001686	21.720	0.0001
WLHS	1	0.009336	0.001521	6.138	0.0001
WSF1	1	0.077695	0.006734	11.537	0.0001
WSF2	1	0.003365	0.006241	0.539	0.5898
WSF3	1	-0.004049	0.006106	-0.663	0.5073
WSF5	1	-0.000861	0.004711	-0.183	0.8550
WSF6	1	-0.004370	0.005183	-0.843	0.3992
WSF7	1	0.002181	0.005869	0.372	0.7102
WSM1	1	0.074792	0.006665	11.222	0.0001
WSM2	1	0.000586	0.006200	0.095	0.9247
WSM3	1	-0.007323	0.006058	-1.209	0.2268
WSM4	1	-0.022507	0.005053	-4.455	0.0001
WSM5	1	-0.020795	0.006038	-3.444	0.0006
WSM6	1	-0.016116	0.007044	-2.288	0.0222
WSM7	1	-0.003250	0.006815	-0.477	0.6335

Unit Value Equation.

Ordinary Least Squares Estimation

Model: VLNV
Dependent variable: VLNV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	39.03923	2.60262	6.426	0.0001
Error	1039	420.83633	0.40504		
U Total	1054	459.87556			

Root MSE	0.63643	R-Square	0.0849
Dep Mean	-0.00000	Adj R-SQ	0.0717
C.V.	.		

NOTE: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
VLTPCX	1	0.231475	0.072947	3.173	0.0016
VLHS	1	0.241501	0.065457	3.689	0.0002
VSF1	1	0.512276	0.245128	2.090	0.0369
VSF2	1	-0.314889	0.241590	-1.303	0.1927
VSF3	1	-0.176907	0.238433	-0.742	0.4583
VSF5	1	-0.257995	0.207905	-1.241	0.2149
VSF6	1	-0.418814	0.286002	-1.464	0.1434
VSF7	1	-0.448108	0.275939	-1.624	0.1047
VSM1	1	0.931144	0.259597	3.587	0.0004
VSM2	1	-0.380995	0.246112	-1.548	0.1219
VSM3	1	-0.401841	0.271712	-1.479	0.1395
VSM4	1	-0.622136	0.218346	-2.849	0.0045
VSM5		-0.675960	0.261382	-2.586	0.0098
VSM6	1	-0.718097	0.399169	-1.799	0.0723
VSM7	1	-0.372143	0.320830	-1.160	0.2463

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