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A REGIONAL ANALYSIS OF THE EFFECTS OF FOOD SUBSIDY POLICIES ON HOUSEHOLD CONSUMPTION PATTERNS IN MOROCCO

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A REGIONAL ANALYSIS OF THE EFFECTS OF FOOD SUBSIDY POLICIES ON HOUSEHOLD CONSUMPTION PATTERNS IN MOROCCO

by

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ABSTRACT

A REGIONAL ANALYSIS OF THE EFFECTS OF FOOD SUBSIDY POLICIES ON HOUSEHOLD CONSUMPTION PATTERNS IN MOROCCO

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Since the early 1970s the Government of Morocco (GOM) has used consumer price subsidies to transfer income to the poor and to keep urban wages poor. The fiscal crisis the subsidies has engendered has led to pressure for their removal. This thesis uses a demand model with a functional form similar to the AIDS to estimate regional elasticities of demand. The elasticities are used to discuss the regional consumption effects of removing the subsidies. Heckman's two-stage procedure is used to correct for the sampling bias introduced when households report zero consumption. The elasticities were found to vary by region. Barley is found to an inferior good in the two urban areas and a necessity in the rural areas. The inverse Mill's ratio was found to be significant in only 2 of 10 demand equations.

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CHAPTER 1: INTRODUCTION

Since the early 1970s the Government of Morocco (GOM) has used consumer price subsidies to transfer income, ostensibly to the poor, and to keep urban wages low[1]. The windfall revenue from the phosphate boom[2] between 1973 and 1975 easily covered the costs of the consumer subsidies on imported foods such as soft wheat, vegetable oil, sugar powder, meat, and dairy products. By 1981, however, the subsidies were a serious drain on public resources and were contributing to a general fiscal crisis. The crisis started in 1976 when the price of phosphates on the international market crashed. Further contributing to the fiscal crisis were a prolonged war in the Sahara Desert, increased costs of imported oil, a series of severe droughts, and general stagnation in the agricultural sector.

In 1981 the GOM was forced to turn to the International Monetary Fund (IMF) for assistance in improving the balance of payments and restructuring the foreign debt. One of the conditions of the IMF assistance was the gradual removal of

[1] Tuluy and Salinger (p 65) argue that if one accounts for the overvaluation of the Dirham, the subsidization of soft wheat actually began as early as 1960. In the case of sugar, the indirect effect of the overvalued currency was that beginning in 1960, consumers were taxed less than if one only considers the direct effects. Subsidization here will refer to only direct intervention by the GOM.

[2] Morocco is the world's leader in exports of phosphate.

consumer subsidies. Although the consumer subsidies on meat and dairy products were eliminated by 1979, the consumer prices of soft wheat, vegetable oil, and sugar are still subsidized. Attempts by the GOM in 1981 and 1984 to remove the subsidies on these consumer goods were thwarted by fierce riots during which many civilians were killed. The severity of the unrest attests to the importance of the subsidies to the population; the speed with which the changes were rescinded shows the potential threat such unrest can pose to the legitimacy of the GOM.

Historically, the subsidy program operated through a series of rebates to participants in the marketing chain.[3] In the case of soft wheat, for example, licensed traders bought wheat from farmers at support prices, sold to the mills at a fixed price and were reimbursed the difference, plus transportation costs and a fixed margin. Traders could also import grain from the world market at world market prices. When world prices were lower (higher) than the support price, the traders (government) reimbursed the (traders) government the difference between the support price and the world price, minus (plus) transportation costs and a fixed profit margin. Millers were also rebated when they sold flour to wholesalers and bakeries. This was the major part of the subsidy. Wholesalers and millers sold

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[3] The following discussion of the subsidy program is borrowed in part from Laraki (1988). For more details on the system of subsidies operated see Laraki (1988).

their products to retailers and bakeries at fixed prices but were not reimbursed for their processing and transportation costs. Similarly, retailers sold to consumers at a fixed price but are not reimbursed for their costs.[4]

In 1988 the GOM reformed the subsidy system. It declared that it would subsidize only 1 million tons of soft wheat per year. In the same year, it discontinued the subsidy on soft wheat luxury flour (farine de luxe). Since then it has subsidized only soft wheat national flour (farine nationale). The GOM estimates regional supply and demand based on consumption surveys from the Statistics Division, seed needs, loses, stocks, production, and milling needs. It then determines monthly import needs and merchants are authorized to imported this amount. Rebates are still issued to the various actors in the marketing chain, and a the consumption price is subsidized. The subsidies are financed by a variable levy on imports and general taxes.

Since there is excess demand for goods at the subsidized price, the subsidies are a rent to whoever can get the subsidized goods. It is therefore unclear whether the beneficiaries of the subsidy program are actually the poor, or others who have access to subsidized flour, quota holders in surplus areas, and traders who are able to

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[4] The subsidy programs for vegetable oil and sugar operated in a similar manner and are therefore not described in detail here.

purchase soft wheat from farmers at below support price market prices and claim they purchased it at the support price. This is a question for further research.

While removing the subsidies may ease the financial crisis, there are some poor who will be hurt by their removal. In his PhD dissertation entitled Food Consumption and Food Subsidies in Morocco: Justifications for Policy Reform, Laraki investigates how the financial costs of food subsidies can be decreased without affecting the standard of living and nutritional status of the poor. He estimates the welfare, nutritional and budgetary effects of various price policies in the urban and rural areas. His findings indicate that because the current subsidy program is untargeted, many of the benefits accrue to high-income households. Yet because the poor spend a high proportion of their income on food, price increases associated with the removal of the current consumer subsidy program may have severe negative welfare and nutritional effects on poor households. He concludes that eliminating the current subsidies on soft wheat, vegetable oil and sugar powder and replacing them with subsidies on barley and hard wheat would not have detrimental welfare effects but would result in important savings for the government.

While Laraki's analysis distinguished between urban and rural households, it did not distinguish between households in different regions of the country. Morocco is geographically diverse, with a fertile agricultural plain in the northeast and arid regions to the south and east, with the respective areas consuming different commodities. Estimating responses to price and income changes by grouping all low-income households together may blur these distinctions. A regional analysis of the effects of removing the consumer price subsidies will be the goal of this research.

Importance of Study

Disaggregated consumption parameters are needed to trace the effects of price and income policies on the food intake of the poor. For designing policies that target the poor, knowledge of these parameters is essential (Timmer, et al., 1983, p. 61). Because the consumption patterns are different in urban and rural areas, eliminating or reforming the consumer subsidies will affect the urban population differently than it will affect the rural population. Price policies may also affect the poor in rural Marrakech differently than they affect the poor in rural Sidi-Kacem. Unintended distributional consequences could result if there are unknown differences between regions. A regional analysis of the effects of various price and income policies will help delineate some of the potential distributional consequences.

Furthermore, where significant regional variations in consumption patterns exist, it may be necessary to implement more than one food-subsidy program. These could include non-price policies such as food stamps, ration cards, supplemental feeding programs, or direct transfers.

Hypotheses

This thesis examines four geographical regions (rural Marrakech, rural Sidi-Kacem, urban Sidi-Kacem, and urban Casablanca) of Morocco to test the following hypotheses:

1. The estimated consumption parameters vary not only by income quartile and by urban and rural area, but also by geographical location. These differences stem from varying production patterns, access to ports, and availability of complements and substitutes which contribute to the establishment of habit, tradition, and taste in consumption. Different preferences will result in different responses to income and price changes.

2. Barley is the only inferior good in Morocco. Barley is thus the only commodity suitable for self-targeting. Subsidies of other staples will leak to higher-income households. There may therefore be better, more cost-effective ways of

reaching the poor than price subsidies on soft-wheat flour, vegetable oil, and sugar.

3. If increasing the welfare of the poor is the goal of a consumer price subsidy, subsidizing the consumption of soft wheat may be effective, despite its high cost, if a large percentage of the poor consume soft wheat and have access to the subsidized soft wheat flour. Given the speculative activities in the marketing chain of soft wheat, reallocating quotas by regional needs may be effective in assuring access by the poor to subsidized soft wheat.

The following methodological hypotheses will also be tested:

1. Since market prices are not available, unit values are used as proxies for prices. Deaton has described several problems associated with using unit values as proxies for prices (these are described in chapter 3), the main problem being that unit values reflect quality choices. The hypothesis tested will be that the unit values do reflect quality choices and may not be used as

proxies for prices without correction for the quality choice.

2. For many of the goods studied, several households reported that they did not consume any of a particular good during a reference period. As is explained in chapter 3, whether or not the households that reported zero consumption are included in the sample, the resulting coefficients are biased and inconsistent because of the nonzero mean. Including the inverse Mill's ratio as an independent variable in the regression corrects for the nonzero mean of the disturbance term. The hypothesis tested here is that the coefficient on the Mill's ratio is significant.

Methods

The Statistics Division of the Ministry of Planning of Morocco undertook a national household budget survey of expenditure patterns of 14,520 households in 1984/85. This study will use a sub-sample of 1027 households from this survey to estimate price and income elasticities in four regions (rural Marrakech, rural Sidi-Kacem, urban Sidi-Kacem, and urban Casablanca). The elasticities will then be used to assess the distributional consequences of various price policies by geographical area.

I will use a functional form similar to the AIDS to estimate the parameters of the model. This functional form specifies the budget share as the dependent variable. This allows for the calculation of elasticities across income classes and regions without having to include interaction terms as independent variables in the model.

In estimating the model, I will use Heckman's two-stage procedure for correcting for the bias introduced when a large percentage of the sampled population reports zero-consumption of a staple commodity.

Organization of the Thesis

Chapter 2 presents a theoretical and conceptual framework for analyzing the effect of food subsidies on the poor. The chapter discusses how price and non-price consumer subsidies affect consumption. Chapter 3 discusses general modeling issues: how one selects a functional form for modeling consumption behavior, problems associated with using unit values in cross-sectional data when prices are not available, biases resulting from using truncated samples when a large proportion of the sample reported zero consumption of a particular commodity, and biases in standard errors when one uses a complex sampling design. The chapter also describes the AIDS. Chapter 4 describes the areas studied and presents descriptive statistics on these areas to try to understand who the poor are, where they live, and what they consume. From this information, some preliminary hypotheses of how consumers will respond to price and income changes are formulated. Chapter 5 presents the empirical results from the model and an analytic discussion of the parameters. The final chapter presents the conclusions and policy implications of the analysis. It also suggests areas for further research.

CHAPTER 2: THEORETICAL AND CONCEPTUAL FRAMEWORK

Introduction

A consumption subsidy is defined as any policy that keeps the consumption price of a commodity below the price that would prevail in the absence of intervention. It may take the form of a law that legislates the retail price of a commodity, or it may be an overvalued exchange rate that makes imports inexpensive, in which case the consumption of imported goods is subsidized. Food stamps that serve as cash in the purchase of food products may be considered a form of subsidy, as may direct distribution of food to the poor, ration shops, or supplementary feeding programs. The effectiveness, cost, and effect on consumption patterns of a subsidy program depend on the goal of the subsidy, the type of subsidy, the particular conditions of a country, and the elasticity of demand for the subsidized good and its substitutes. This chapter describes several subsidy programs and discusses the advantages and disadvantages of each. It also discusses the effect of a subsidy on consumption and presents a conceptual framework for analysis.

Goals of Subsidy Programs

The goals of a subsidy program may be varied. Five objectives of food subsidies listed by Valdés (1988) are 1) reducing malnutrition among low-income groups; 2) achieving food security (i.e., reducing instability in food consumption, particularly for some targeted segment of the population); 3) redistributing income in urban areas; 4) lowering food prices, thus enabling wages to be low relative to the price of industrial goods; and 5) reducing domestic price inflation. Different forms of subsidy may be successful at reaching different objectives and unsuccessful at meeting others. For this reason, it is often difficult to say, a priori, that one form of subsidy is "better" than another. The questions of "at what cost?" and "for what purpose?" must always be considered when evaluating the effectiveness of a subsidy program. For example, programs that focus exclusively on mothers and preschoolers (groups most often identified as "at risk") may be effective at reducing malnutrition, but only at a high cost (Kennedy, 1988).

Although it is difficult to prejudge the effectiveness of a particular type of subsidy, the evidence from several country studies shows that the untargeted or poorly targeted food subsidy programs are not the most effective means of transferring income from better-off to poor households, improving food consumption among the poor, or improving their nutritional status (Pinstrup-Andersen, 1988). However, this evidence must be seen in light of other objectives of food subsidies such as fulfilling social contracts to provide low-cost food to the general population.

Targeted versus Untargeted Subsidies

Subsidies may be targeted or untargeted. Targeted subsidies are subsidies directed at groups of the population that are identified as "at risk," or particularly vulnerable to malnutrition. Untargeted subsidies, on the other hand, provide low-cost staple grains or basic commodities to households at below-market prices, regardless of income, nutritional status, or any other criterion.

Targeting is accomplished by basing program participation on income level, nutritional status, geographic location, age (school-aged children, for example), vulnerability to malnutrition (pregnant and lactating women, for example, are particularly vulnerable to malnutrition), or some other criterion. Examples of targeted programs include "fair-price shops" located in specifically chosen locations, food stamps issued to families that meet specified criteria, and supplementary feeding programs that reach school-aged children or pregnant and lactating women. A subsidy may "self-target" if the subsidized food is one which only the target group consumes. Self-targeting toward the poor can be accomplished by subsidizing the consumption of goods for which the income elasticity of demand is negative. That is, as income increases, the consumption of the good decreases. One of the difficulties of this type of subsidy is identifying a good with a negative income elasticity. Few consumption studies have found purely "inferior" goods. The consumption of staples tends to either stabilize or increase with rising incomes (Kumar and Alderman, 1988). Also, low income elasticity foods are often nontradables, so that implementation of the subsidy is difficult.

One of the advantages of targeted subsidies, to the extent that the targeting is effective, is that they are more likely than untargeted subsidies to reach the intended group. The disadvantage is that targeting can be difficult and costly to achieve. It is often difficult to identify "at risk" groups, geographic targeting will undoubtedly miss some people and include some unintended, and programs such as supplementary feeding programs may lead to reallocation of food within the household so that the net consumption of the intended beneficiary may not change at all. In areas in which a large segment of the population is needy, targeting may be less necessary than when only a small segment of the population is "at risk," since the "at risk" group will more likely be reached by a general subsidy. Finally, the high administrative costs of targeting may outweigh any savings achieved by only subsidizing a select group of households or individuals.

An example of an untargeted food subsidy is an unrestricted food price subsidy: unlimited amounts of the subsidized goods are, in principle, available at below-market prices to anyone who chooses and is able to buy them. Untargeted subsidy programs reach a wider population, but they do not guarantee that the "at risk" group is reached. In fact, because the price is fixed below market price, the quantity demanded will exceed the quantity supplied. If imports are not used to make up the difference, the artificially low price will mean that non-price mechanisms may be used to allocate goods. Long lines to purchase the subsidized goods may be necessary, and the resale of goods common. While lower-income people may be more able than wealthier to afford to stand in line to obtain a subsidized good, wealthier people may be able to hire people to stand in line to obtain the goods. If one is able to purchase large quantities, wealthier people, who may have access to more disposable income, may also be able to buy large quantities and resell the goods at a higher price to less fortunate consumers, or divert subsidized grain to animal feed. Limiting the quantity one is able to purchase reduces this possibility. Resale is also limited if the subsidized good is bulky to transport or highly perishable.

Explicit vs Implicit Subsidies

Given the above definition of a subsidy, a subsidy can be either explicit or implicit. Explicit subsidies entail a fiscal outlay by the government. They are generally financed out of the general government treasury. As such, it is difficult to pinpoint the exact source of financing. It is also difficult to speculate about how the money would have been spent if not on subsidies. If explicit subsidies are financed by general taxes, those who pay taxes may not be the ones who benefit from them. If taxes are progressive, the redistribution of income from the wealthier to the poorer members of the population pay for the subsidies.

Contrary to explicit subsidies, implicit subsidies require no fiscal outlay by the government. This does not mean, however, that they have zero economic cost. Implicit subsidies include an overvalued exchange rate, low fixed producer prices that make the price of food products inexpensive to the final consumer, export taxes, and forced food procurement.

Costs of Subsidies

Although explicit subsidies are easier to account for than implicit subsidies, both have costs that are often not taken into account when considering the cost of subsidies to the economy. For example, food subsidies place downward pressure on wages since subsidies provide what may be considered "in-kind" payments (Pinstrup-Andersen, 1988). When considering the income embodied in a particular subsidy, one must account for the income foregone with the lower wages.

If the costs of food subsidies increase the budget deficit, and the budget deficit is financed by printing more money, food subsidies may lead to inflation, which erodes the purchasing power of the poor to purchase goods and services other than those subsidized. The net effect may actually be detrimental to the poor.

High costs do not imply an ineffective program. One needs to assess the size of the needy population, the scope of the program, and the effectiveness of the program at reaching established objectives. Furthermore, there are no inherently superior programs. What works in one country may not work in another because different programs have different requirements in terms of administration and infrastructure. For example, as will be discussed below, food stamp programs may be effective if the appropriate infrastructure exists to distribute food, but may be disastrous if retailers have no confidence in the government that coupons will be redeemed.

Forms of Subsidies[5]

Unrestricted food price subsidies

In theory, an unrestricted food price subsidy offers an unlimited quantity of a good at a subsidized, below market-level price to anyone who chooses to and is able to purchase it. Coverage is maximized with this system, but generally at a high cost. In reality, however, unrestricted subsidies may be restricted subsidies if the subsidized good is not freely available. Those for whom the subsidy is intended may not benefit if they cannot get access to the goods because of non-price rationing. The larger the percentage of the population needing assistance, the less "leakage" will result from this type of program. Also, the more the good chosen is one that is "self-targeted", that is, a good that the poor eat more of and the wealthy eat less of (income elasticity negative), the less leakage this type of program will have.

Food stamps

In a food stamp program, coupons are issued to households, on the basis of some criterion such as income. The coupons may then be used as cash to purchase food from participating retailers. In order for this type of program to be successful, however, eligible households must be

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[5] This section borrows heavily from Rogers (1988). Only some of the forms of subsidy programs are covered here. For more extensive coverage, see Rogers (1988).

identifiable. That is, if income is to be the determining criterion, good records of income levels must be available. It is also important that institutions and infrastructure be in place to support a food stamp program. For example, it is important to have several retail outlets, as well as banks where coupons can be redeemed. It is critical that the population have confidence in the government because participating stores and banks need to know that the stamps will be redeemable. For these reasons, food stamp programs have been successful mostly in developed countries that have the required infrastructure.

Advantages of the food stamp system are that it makes use of the existing distribution system, which cuts down on administrative costs, decisions about supply are decentralized rather than centralized, and price distortions are minimized. Some disadvantages are that a food stamp system may fail to reach people in areas not currently served by the existing distribution system, and a certain amount of administration is needed to identify eligible households.

Rationing

A rationed subsidy is one in which the quantity available of the subsidized good is restricted to some per capita limit. The advantages of such program are that it limits resale of the subsidized good since each individual can only buy a limited quantity. Even if the poor do resell, however, it adds to their real income and the subsidy may then be considered as an implicit income transfer. Rationing may also reduce leakage to wealthier households since it may not be worth their while or money to stand in line for a limited amount of the good. Another advantage is that the costs of the program are predictable, which makes financial planning easier. The disadvantages of rationing are that a complex administration is required to administer coupon books and keep track of rations. A high degree of literacy among sellers is also necessary.

How Subsidies Affect Consumption

How subsidies affect consumption depends on the type of subsidy and on which goods are subsidized. If the subsidy serves as an income transfer, as in the case of food stamps, the result is an outward shift of the consumer's budget constraint. This is illustrated in figure 2-1, which shows the tradeoffs in consumption between food and non-food.

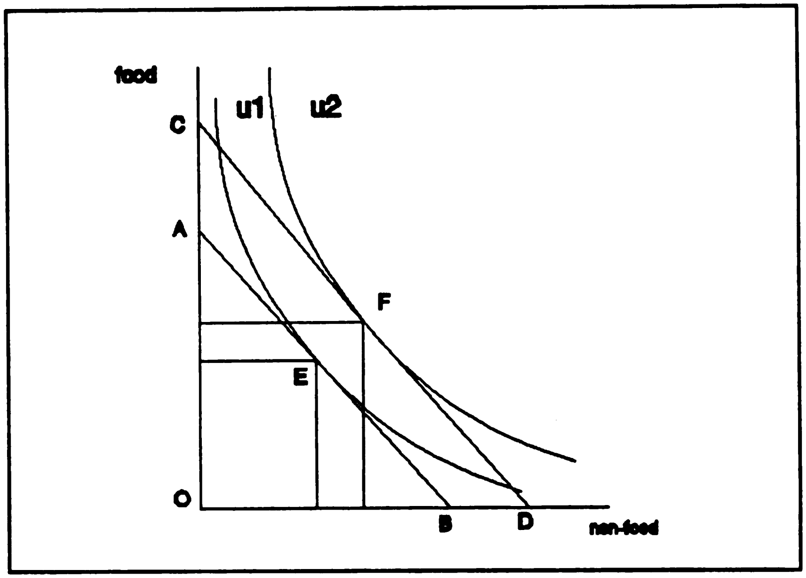

Figure 2-1: Tradeoffs in consumption between food and non-food

An increase in the income available to spend on food shifts the original budget line, AB, to the new budget line, CD. The consumer can be on a higher indifference curve by consuming bundle F, where the indifference curve is tangent to the new budget line, rather than E, the old consumption bundle. Although this particular illustration indicates that the consumer will consume more of both food and non-food, this is not necessarily the case. If food is "inferior," the consumption of food will decrease as income increases. By connecting all the points of consumer choice for all levels of income changes, one can construct an income-expansion path. Engel's law says that the income-expansion path is steeper for low income consumers and relatively flatter for higher income consumers. This reflects the larger proportion of income spent on food by lower income consumers. The income elasticity captures the relationship between changes in income and consequent changes in consumption, at a particular income level. As indicated by the income-expansion curve, the income elasticity is likely to vary by income level. It is also likely to vary by consumer. The income-expansion path is also predicated on a particular set of relative prices. If the relative prices change as well, the income-expansion path may be invalidated. The point is that one income elasticity for an entire country is unlikely to accurately capture the diversity among consumers or the variation in price scenarios in different regions.

If the subsidy establishes a below-market price for a commodity, the effect is a rotation of the budget line. This is shown in figure 2-2.

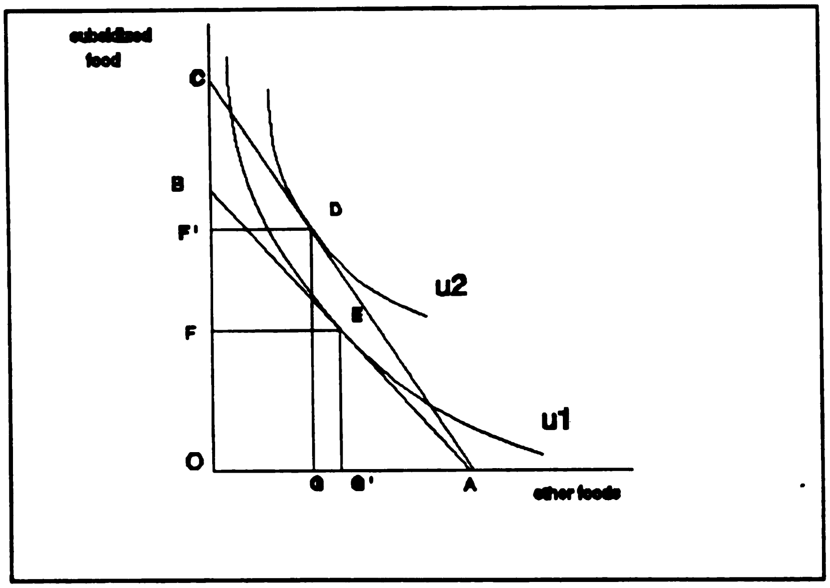

Figure 2-2: Tradeoffs in consumption between subsidized food and other food

Without intervention the budget line is represented by AB and the consumption bundle is represented by E, where the indifference curve is tangent to the budget line. When the price of the good to be subsidized falls, the budget line rotates to AC. The consumption of the subsidized good increases to OF', and the consumption of other food goods drops to OG. This change reflects both an income and a substitution effect. Lower prices cause real purchasing power to increase if there is no decrease in money income. This increase in purchasing power will cause the consumption of all goods to increase (except inferior goods). The change in **relative** prices also causes a shift toward the less expensive good (the pure substitution effect). The total response to the change in the price of the good (the price elasticity) is a combination of the income effect and the pure substitution effect. Unless the good subsidized is an inferior good that is consumed in large quantities, the own-price elasticity will be negative.

Income elasticities can give some guidance as to how consumption will change with a change in a subsidy policy. If the income elasticity of the subsidized good is negative, the subsidy to the poor will be higher in both absolute and relative terms than the subsidy to the wealthy. If it is positive but less than one, the benefit to the poor will be relatively higher but absolutely smaller than the benefit to the wealthy. If the income elasticity is greater than one, both the absolute and relative benefit will be higher for the wealthy (Pinstrup-Andersen and Alderman, 1988).

The choice of good to subsidize can also affect consumption patterns. If the good is one already consumed by the poor, such as wheat, rice, or other staples, the subsidy will serve as an income transfer and will increase the consumption of all goods. If the subsidy is on a good rarely consumed by the poor, such as milk, beef, oil, or some other luxury good, marginal rather than inframarginal consumption is altered and the subsidy may cause shifts away from the consumption of less expensive nutrients sources (Kumar and Alderman, 1988).

Conceptual Framework

The discussion above of how subsidies affect consumption is based on neoclassical demand theory, which suggests that a consumer derives utility from the goods he/she consumes. The way in which consumption yields utility to the consumer gives rise to the utility function. The rational consumer will choose a consumption bundle in order to maximize his/her level of utility. Since consumers are restricted by their budgets, maximization will be subject to a budget constraint.

One way of obtaining a consumer's demand equations is by maximizing a utility function subject to a budget constraint. This will result in a complete system of demand equations, each of which is a function of prices and income. The estimation of these demand equations is one of the main objectives of modeling consumer behavior.

If the demands are the result of the maximization of a utility function subject to a budget constraint, consumer theory tells us that the demand equations will have certain properties. These are "adding-up," "homogeneity," "symmetry," and "negativity."

Adding Up

The "adding-up" criterion expresses the notion that consumers spend all of their disposable income. This will be true for the expenditure on the entire consumption bundle as well as on sub-groups of consumption. It implies, for example, that the value of the quantity of food purchased sums to the total expenditure on food. Adding up is expressed as:

$$\sum p_k q_k = x \tag{2-1}$$

where:

p_k = the price of the kth good

q_k = the quantity of the kth good

x = total expenditure

By rewriting $\sum p_k q_k$ in terms of derivatives, one can look at how changes in income may affect changes in quantity. Differentiating (2-1), the budget constraint, with respect to income and rewriting in terms of elasticities and budget shares this may by written as:

$$\sum_k w_k e_k = 1 \tag{2-2}$$

where:

w_k = the share of the budget spent on good k

e_k = the expenditure elasticity of demand for good k

This is the Engel aggregation condition. To see how this is obtained, see Appendix 2-1. We also know that:

$$\sum_i w_i = 1 \qquad (2\text{-}3)$$

The Cournot aggregation condition is obtained by differentiating (2-1) with respect to price. Written in terms of budget shares and elasticities this yields:

$$\sum_k w_k e_{ki} + w_i = 0 \qquad (2\text{-}4)$$

where:

e_{ki} = the cross-price elasticity between goods k and i

w_i = the budget share spent on good i

Homogeneity

If one multiplies both income and all prices by a constant, θ, the linear budget constraint that the consumer faces remains unchanged. If the budget constraint remains unchanged then the corresponding demand for each good also remains unchanged. Demand is therefore also homogeneous of degree 0 in prices and income. This may be expressed by:

$$q_i(\theta x, \theta p) = q_i(x, p) \qquad (2\text{-}5)$$

where:

q_i = the demand for good i

This property implies that only relative prices matter in consumption decisions. This is expressed in terms of elasticities as:

$$\sum_i e_{ki} + e_k = 0 \qquad (2-6)$$

where:

e_{ki} = the cross-price elasticity between goods k and i

e_k = the income elasticity of demand for good k

This restriction says that the sum of the own- and cross-price elasticities plus the income elasticity for any commodity is zero.

Symmetry

Symmetry implies that the cross-price derivatives of the Hicksian demands are symmetric:

$$\frac{\delta h_j(u,p)}{\delta p_i} = \frac{\delta h_i(u,p)}{\delta p_j} \qquad (2-7)$$

where:

$h_i(u,p)$ = the Hicksian demand for good i as a function of utility and prices, i.e., the demand that results from the minimizing the expenditure needed to reach a given level of utility
u = consumer utility

This result comes from the relationship between the cost function and demands. The Hicksian demands result from differentiating the cost function twice. Young's theorem tells us it will also be symmetric.

Weak Separability

The estimation of an entire system of demand equations can easily become intractable. For n commodities, the estimation procedure would require calculating n income elasticities and n^2 own- and cross-price elasticities, a total of n(n+1) parameters. The classical restrictions described above reduce this number of parameters to $(n^2 + n - 2)/2$. Even so, if n is large, degrees of freedom problems may result. The assumption of weak separability of preferences is one way of dealing with this situation. Weak separability of preferences suggests that one can divide the set of n commodities into mutually exclusive subsets without losing any generality. This assumption implies that the marginal rate of substitution between two commodities within a subset be independent of the quantity consumed of a good in another subset. This allows us to model the consumption of a set of commodities independently of the commodities consumed in other groups. In the discussion above about how subsidies affect consumption, for example, weak separability allows one to talk about how a change in the price of a food commodity will change the consumption of all foods, without reference to how the consumption of non-food goods will change. If one assumes weak separability between food and non-food, the change in the price of the food good should not affect the consumption of the non-food goods. Assuming weak separability reduces the number of parameters to be estimated. As Deaton and Muellbauer (1980b, p. 125) point out, by assuming weak separability "detailed commodity expenditure can be related to group outlay and prices alone. This has obvious econometric advantages since it is possible to find an explanation for behavior through a much smaller number of variables."

Conclusion

Income and price elasticities can aid in analyzing the anticipated effects of different subsidy programs on the consumption patterns of different groups. Goods with high positive income elasticities, for example, are not as suitable as goods with low income elasticities for reaching the poor since upper-income consumers consume more of the good and therefore receive more of the subsidy than low-income consumers.

The estimation of income and price elasticities is based on neoclassical demand theory, which assumes that consumers derive utility from the goods they consume and that consumers maximize their utility subject to a given budget constraint. Their estimation will be the goal of the rest of this thesis.

CHAPTER 3: METHODS

Introduction

Designing effective food policy requires a comprehensive understanding of how consumers will be affected by a prospective policy. Knowledge of how consumers respond to income and price changes is therefore imperative. Yet estimating income and price elasticities via econometric analysis of household budget data is a highly subjective endeavor. The choice of functional form for modeling consumer behavior can dramatically alter the estimates.

Demand Systems vs. Single Demand Equations

There are basically two ways of modeling the demand for commodities: the complete systems approach and the single equation approach. The complete systems approach entails estimating the set of demand equations that result from allocating total expenditure among a group of commodities. Under the assumption of separability, this implies that the consumption of all goods consumed need not be modeled, but rather that the consumption of a complete subset of goods be modeled together. Whether modeling a subset or the entire consumption basket of a consumer, the sum of expenditures on the goods in that category must sum to total expenditure on that category. The complete systems approach allows for the interdependence of demand for various commodities in the group.

In contrast, in the case of the single-equation estimation where the equations are not part of a system of equations, one models the consumption of one commodity at a time without reference to the interrelationships between the goods. The single-equation approach is not based on the maximization of utility constrained by the budget constraint. Rather, an ad hoc specification of the demand functions is used to render the estimation problem manageable. The double logarithmic functional form is a commonly used model of this type. In modeling the consumption of a single commodity, this approach may suffice. Yet it still must be recognized that the link between theory and empirical work is quite weak. If one is looking only at the demand for a single commodity, neither adding-up nor symmetry may be validated since both require cross-equation restrictions. Homogeneity is the only testable restriction.[6] In examining a whole group of commodities using the double logarithmic specification, it is impossible for adding up to be satisfied.[7] Most researchers have been acutely aware of this problem but have

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[6] Adding-up, homogeneity, and symmetry are described in detail in Chapter 2.

[7] To see how adding-up is not satisfied in the double-logarithmic specification, see Deaton and Muellbauer (1980b, p 17-18).

traditionally chosen to ignore it because, as Deaton and Muellbauer (1980b) point out, when modeling a limited number of commodities, the specification of the functional form of the remaining commodities remains unstated.

The choice between estimating an entire system of demand equations and estimating single demand equations involves several tradeoffs. Because of the cross-equation restrictions embodied in the symmetry condition, the estimation of a complete system will require non-linear estimation. This may render this approach more costly than the single equation estimation technique. Furthermore, the statistical problems of multicollinearity and nonspherical error structure for complete systems are more burdensome than under the single equation approach (Raunikar and Huang, 1987, p.24). The advantages of the systems approach are that the postulates of consumer theory are directly testable and the generation of empirical results is consistent with the economic theory of consumer behavior. Yet the theoretical superiority of the systems approach may be outweighed by the high estimation costs.

When employing a complete demand system one must assume that the functional form is the same for all goods, while single equations allow different functional form for different commodities.

There are two ways of formulating demand systems: 1) specify a functional form for the direct or indirect utility function or for the cost function from which the demand equations can be derived and 2) specify the functional form of the demand equations directly and impose restrictions on them to ensure that they conform to the theory. As mentioned above, all equations in the system are of the same functional form since cross-equation restrictions must be imposed. The problems with the first approach are that the number of known and well-behaved utility functions is very limited, and the derivation of demand equations is not always possible. There may be doubts about the suitability of adopting a particular specification, and in many cases, the derived demand relations turn out to be nonlinear in their parameters. For these reasons, economists have sometimes preferred to work with an arbitrary but manageable functional form for demand, imposing constraints which insure their theoretical plausibility (Capps and Havlicek, 1987).

Complete demand systems include the translog system, the Rotterdam system, the addilog system, the constant elasticity of demand system (CEDS), the linear expenditure system (LES), and the AIDS. The AIDS is discussed below; the others are discussed in Appendix 3-1.

Flexible Functional Forms

One of the problems associated with the single-equation approach such as the double logarithmic equation is that the choice of the function is ad hoc. Flexible functional forms circumvent this problem by approximating the "direct utility function, the indirect utility function or the cost function by some specific functional form that has enough parameters to be regarded as a reasonable approximation to whatever the true, unknown function may be" (Deaton and Muellbauer, 1980b, p 74). Thus the functional form specified is an approximation to any true function. This approach to consumption modeling offers a more general framework of analysis, hence the name "flexible" functional form. This is the basis for the translog model, the generalized Leontief model, and the AIDS.

A second-order Taylor approximation to a true utility function should give rise to demand functions satisfying all the theoretical requirements. If the empirically estimated demand functions do not satisfy the theoretical requirements, one must question whether the demand theory accurately represents behavior. But the empirical estimation is based on a particular shape of the utility function that may or may not be the correct utility function. Therefore, one does not know if the theory is wrong or if the approximation is inaccurate (Deaton and Muellbauer, 1980b).

One of the advantages of the flexible functional form offered by the AIDS is that its generality allows one to easily impose and test the homogeneity and symmetry conditions. The adding up is satisfied automatically.

The AIDS

Duality theory tells us that the consumer who maximizes utility subject to a budget constraint is simultaneously minimizing the cost of attaining that utility level. It is therefore true that if we obtain a set of demand equations from a particular cost function or indirect utility function, these demands correspond to a certain utility function. This will be true as long as the cost function exhibits the following properties: it must be homogeneous of degree one in prices, increasing in utility, nondecreasing in prices, and concave in prices.

The AIDS starts from this premise and specifies a particular functional form for a cost function. It then employs the duality theory to arrive at a complete set of demand equations. The AIDS is based upon the Working and Leser model for Engel curves, which proposes that the value shares are a function of the logarithm of total expenditures. This may be expressed as:

$$w_i=\alpha_i+\beta_i \log x \tag{3-1}$$

where:

w_i is a budget share for good i
x is total expenditure
α_i and β_i are parameters

A cost function that gives rise to this set of Engel curves is:

$$\log c(u,p) = (1-u)\log a(p) + u\log b(p) \tag{3-2}$$

where:

c (u,p) is the cost function;
p is the vector of prices;
u is a utility level;
a (p) and b(p) are linear homogeneous concave functions.

The specific functional forms of log a(p) and log b(p) were chosen by Deaton and Muellbauer such that the resulting cost function has enough parameters to be a an approximation to any arbitrary cost function. The functions they have chosen are:

$$\log a(p) = \alpha_o + \sum \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj} \log p_k \log p_j \tag{3-3}$$

and

$$\log b(p) = \log a(p) + \beta \prod p_k^{\beta k} \tag{3-4}$$

where:

α, β, and γ are parameters

The AIDS cost function may then be written as:

$$\log c(u,p) = \alpha_o + \sum_k \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj} \log p_k \log p_j + u\beta_o \prod p_k^{\beta k} \tag{3-5}$$

Equation 3-5 "has sufficient parameters that at a selected point the first- and second-order derivatives with respect to p and u can be set equal to those of an arbitrary cost function" (Johnson, et al., 1986, p.6). Equation 3-5 is a second-order Taylor expansion to any cost function. Hence the flexible-form attribute of the AIDS. From this cost function, the Hicksian demand functions can be obtained by applying Shephard's Lemma (see Appendix 3-2). The Hicksian demands, expressed in terms of the budget share (w_i) will be of the form:

$$\frac{\partial \log c(u,p)}{\partial \log p_i} = w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i u \beta_o \prod p_k^{\beta k} \tag{3-6}$$

where:

$$w_i = \frac{p_i q_i}{x} \tag{3-7}$$

and

$$\gamma_{ij}=\frac{1}{2}(\gamma^{*}_{ij}+\gamma^{*}_{ji}) \tag{3-8}$$

At equilibrium, c(u,p) is equal to total expenditure, x. Thus, equation 3-5 can be solved for u in terms of p and x. This expression for u is then substituted into equation 3-6 to yield the Marshallian demand functions:

$$w_i=\alpha_i+\sum\gamma_{ij}\log p_j+\beta_i\log\{\frac{x}{P}\} \tag{3-9}$$

where P is the price index defined by:

$$\log P=\alpha_o+\sum_k\alpha_k\log p_k+\frac{1}{2}\sum_j\sum_k\gamma_{kj}\log p_k\log p_j \tag{3-10}$$

Restrictions

Adding-up

As is true for all complete demand systems, the "adding-up" criterion is satisfied by construction in the AIDS. The adding up restriction requires:

$$\sum_{i=1}^{n}\alpha_i=1 \quad \sum_{i=1}^{n}\gamma_{ij}=0 \quad \sum_{i=1}^{n}\beta_i=0 \tag{3-11}$$

This implies that only n-1 income coefficients need to be estimated since the the estimates of the nth may be derived from the above condition.

We know from the section on adding-up in Chapter 2 that adding-up will be satisfied as long as

$$\sum_i w_i = 1 \qquad (3\text{-}12)$$

Even if the system is estimated as a set of single equations using OLS, this will be true since the observed expenditure on individual goods, summed over all goods in the category, will equal total observed expenditure on that category.

Homogeneity

Homogeneity, on the other hand, is not satisfied automatically but may be "tested" by imposing the restriction

$$\sum_j \gamma_{ij} = 0 \qquad (3\text{-}13)$$

and then using F ratios for each equation to test whether or not the results are significantly different from the unrestricted case. Once the assumption of homogeneity has been made, it is only necessary to estimate n-1 price parameters. The nth may than be calculated using 3-13.

Symmetry

Symmetry in the AIDS requires that

$$\gamma_{ij}=\gamma_{ji} \tag{3-14}$$

Since this requires cross equation restrictions, it may only be tested using non-linear methods.

Limitations

Income Elasticities

The formulae for calculating the income and price elasticities from the AIDS are given in Appendix 3-3. The income elasticities are given by $(\frac{\beta_i}{w_i}+1)$. If β is positive, the income elasticity will be greater than unity (luxury good) for all income classes; if the β is negative, the income elasticity will be less than unity (necessity or inferior good) for all income classes. A good cannot be a luxury for one income class and a necessity or inferior good for another.

Whether or not this is a serious limitation depends on whether you would expect the goods in question to be necessities for one group and luxuries for another. In developing countries where a some basic foods are luxuries for some income groups but necessities for others, this may be a serious limitation.

Similarly, whether the good is a luxury, necessity, or inferior good, demand always becomes more income inelastic as income rises. To see that this is true, assume the good is a luxury item, which implies that the β coefficient is positive and that the budget share is increasing with incomes. The income elasticity will always be greater than unity but will diminish as the share increases. For a necessity or inferior good, the β coefficient will be negative but the budget share will decline as income rises. Thus the income elasticity will become more inelastic with higher income levels.

The only means of rectifying this problem is by using a squared income term. The transcendental logarithmic demand function (TL) as described by Swamy and Binswanger (1983) uses the same functional form as the AIDS except that the squared income term is included. This is justified by the authors by dropping the assumption of perfect aggregation over consumers.[8] If aggregation is an issue, it is here that judgement is necessary in making the tradeoff between maintaining perfect aggregation or increasing the flexibility of the functional form. In this study, aggregation is not necessary since the data are at the household level. Adding a squared income term in this case

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[8] Perfect aggregation refers to "the conditions under which it is possible to treat aggregate consumer behavior as if it were the outcome of the decisions of a single maximizing consumer" (Deaton and Muellbauer, 1980b, p. 148). This is an issue when using aggregate market data.

does not detract from the theoretical soundness of the model.

Deaton and Muellbauer (1980a, p.315) point out that "the flexible functional form property of the AIDS cost function implies that the demand functions derived from it are first-order approximations to any set of demand functions derived from utility-maximizing behavior." While the cost function does represent an approximation to any cost function, it is itself a particular cost function, thus its generality is not as global as was originally argued.

Practical Aspects

Data Requirements

When using the AIDS to model consumer behavior, the first decision to be made is the group of commodities for which the estimates will be made. The separability assumptions allow one to estimate parameters for a separate group (such as food) based on system estimations. The key here is to define an expenditure category narrowly enough so that the number of products is manageable but broad enough so that weak separability holds.[9]

Stone's Index

The price index (3-10) of the AIDS is one of the points which makes the model fairly intractable since it makes the

[9] Weak separability is defined in Chapter 2.

estimation non-linear. In order to avoid the non-linearity, most researchers use the "Stone's index" (P^*) as suggested by Deaton and Muellbauer:

$$\log P^* = \sum w_k \log p_k \tag{3-15}$$

The Stone's index is easy to calculate and may be an adequate approximation to the true index as long as prices are closely collinear. Since using the Stone's index makes the estimation procedure linear, it is highly tempting to adopt this strategy. It must be noted, however, that estimation problems arise because the use of the Stone's index means that w_i is on both sides of the equation. When the dependent variable (w_i) is correlated with the error term, the classic assumptions of linear regression are violated. Most researchers chose not to address this issue, yet it is important to recognize that the parameters estimated using the Stone's index will be biased. If one is doing non-linear estimation anyway, it is advisable to use the original index (3-10).

Software Requirements

If one does not want to test the symmetry condition and if the Stone's index is used as a proxy for the true price index, the estimation of the AIDS becomes linear. The system may be estimated equation by equation using OLS. Thus one can use any software package which offers OLS, subject to the data handling abilities of the software.

If, on the other hand, one does want to test the symmetry condition, or if the true price index is used, then non-linear estimation is necessary and a programming language such as GAUSS, FORTRAN, C, or any software which can handle non-linear estimation must be used.

A functional form that is similar to the linear AIDS will be used to estimate the system of demand equations for the Morocco data. The modifications that will be made to the AIDS are discussed in Chapter 5.

Other Modeling Issues

In addition to questions of which functional form to use to model consumer behavior, there are some anomalies in modeling that must be addressed. They include, but are not limited to, using unit values as proxies for price when using cross-sectional data, reported non-consumption of goods by households, the effect of sampling design on the reliability of standard error estimates, and weighting regressions when a complex survey design has been used. These issues are discussed in this section.

Unit Values

In demand analysis using cross-sectional household budget surveys, it is traditionally assumed that all households face the same prices. (Cox and Wohlgenant cite Allen and Bowley, Prais and Houthakker, George and King). This assumption is based on the notion that prices remain unchanged during a short period of time. For this reason, most cross-sectional surveys do not even collect data on prices. It is likely, however, that there is price variation in cross-sectional data due to spatial and seasonal fluctuations in price. The former results if the sample is distributed over a large geographical region that exhibits variable transportation and other distributional costs; the latter results if cross-sectional surveys are conducted over a period of a year or more such that capturing seasonal effects is possible.

The result of the assumed lack of price variability has been an adherence to estimating Engel curves. However, Polinsky (as cited in Cox and Wohlgenant) suggests that if there is true price variation, then the failure to capture price effects could lead to misleading and biased results.

Since most cross-sectional data sets do not contain information on prices, but do contain data on expenditures and quantities, many researchers use a unit value (expenditure divided by quantity) as a proxy for price (Timmer and Alderman, 1979). As Deaton points out "armed with expenditures and with quantities, the temptation to divide one by the other is irresistible." (Deaton, 1988b, p.419).

Deaton has outlined several problems associated with using unit values as proxies for price:

1) **Consumers choose the quality of their purchases, and unit values reflect this choice.**

The awkward transition from theory to application gives rise to this problem. Neo-classical consumer demand theory describes the demand for a homogeneous good with a single price. In application, non-homogeneous goods are aggregated to make the estimation problem tractable. For example, meat is not a homogeneous product with a single price; there are several different kinds of meat, and different qualities and cuts within the sub-categories of meat. Unit values will reflect the quality chosen. Since consumers chose the quality of the goods they consume, "the regression of quantity on unit value is a regression of one choice variable on another, and runs all the usual risks of possible lack of identification, simultaneity bias, and interpretational ambiguity (Deaton, 1988b, p 420)."

2) **Quality choice may itself reflect the influence of prices, as consumers respond to price changes by altering both quantity and quality.**

If market prices rise, the unit values will presumably rise by less because consumers will move away from the more expensive qualities and types toward the less expensive. Consumers could thus adjust consumption toward lower-priced, lower-quality goods, keep total expenditure the same, and keep the total quantity consumed the same. In this case, unit values would not change although market prices had risen. The consequence is that if unit values are used instead of prices when regressing quantity on price, a quantity difference will be associated with a smaller change in unit value than the change in price had prices been used. The elasticity will therefore be larger for the unit value than for the price; using unit values will exaggerate the price elasticity.

3) **Measured unit values are contaminated by errors of measurement in expenditures and in quantities and are likely to be spuriously negatively correlated with measured quantities.**

Unit values are calculated by dividing expenditure by quantities. If the quantities are measured with positive (negative) error, that is, the measured quantity is higher (lower) than the true quantity, the unit value will be too low (high). There will be a spurious correlation between quantity and unit value.

From the viewpoint of demand analysis, spatial and temporal unit value variation is desirable because it can help to capture price effects (Cox and Wohlgenant, p.908). However, variation in unit values due to the quality effects just described is more problematic. "A preliminary step in the analysis of a cross-sectional data set from which prices are derived by dividing observed expenditures by quantities is to determine whether prices are correlated with income. If they are, one needs to determine an indicator price, by region and season, that reflects a constant quality" (Alderman, 1986, p.59). In other words, one needs to determine if the quality elasticity (the elasticity of unit value with respect to total household expenditure) is zero. If it is, one can assume that the unit value index moves proportionately with the market price. If the quality elasticity is positive, unit values will move less than proportionally with prices, the shortfall depending on the size of the quality elasticity as well as on the overall price elasticity. If the quality elasticity is positive, an "indicator" price needs to be calculated which "purges" the unit value series of the quality effects.[10]

In order to test for the quality elasticity, Deaton assumes that all households in a cluster, or a unit of observation, face the same "true" prices because they are surveyed at the same time and are in a small geographical area (usually a village). Thus, any differences in unit values observed within a cluster must be due to the quality differences described above. Regressing unit value on total expenditure and household size indicates the extent of the quality effect. One would expect higher-income households

[10] The method for "purging" the unit value series of the quality effects is described in Deaton (1988a) as well as in Laraki (1988). Since the quality elasticity was found to be zero for this case, the method is not described here.

to buy higher quality goods, keeping household size constant.

The Groupe de Travail pour l'Estimation des Elasticities de Demande des Produits Agro-Alimentaire (1990) tests for the quality elasticity by estimating:

$$\log V = c_o + c_{D/N}\log(D/N) + c_{U/N}\log(U/N) + c_L L \qquad (3\text{-}16)$$

where:

V is unit value
D/N is per capita income
U/N is adult equivalents divided by number of household memebers[11]
L is a vector of dummy variables representing region
c_o, $c_{D/N}$, $c_{U/N}$, and c_L are parameters

The results are presented in Appendix 3-4. They suggest that the quality elasticity, $c_{D/N}$, is significantly different from zero in only 6 out of 13 cases.

Adding a dummy variable for the different clusters would indicate the importance of income on unit values within each cluster. Regressing deviations from cluster means for the above equation yields the same result as including a dummy variable for every cluster (Deaton, 1988a, p.6). The results of the regression presented in table 3-1 indicate no significant within-cluster effects of income on

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[11] "Adult equivalent" is defined on page 97.

unit values. It should be noted that this analysis is limited to the extent that income is homogeneous within a cluster, making it difficult to assess the quality effect by looking at deviations from cluster means.

Table 3-1: Regression Coefficients from Regressing Unit Value on Total Expenditure and Household Size

Dependent Variable	Independent Variables	
Unit Value	Log of Per Capita Expenditure	Log of Per Capita Adult Equivalent
Hard Wheat	0.022 0.022	-0.009 0.097
Soft Wheat	0.024 0.022	0.147 0.091
Barley	0.018 0.021	0.076 0.081
Mutton	0.006 0.006	0.004 0.024
Beef	0.005 0.004	0.013 0.014
Chicken	0.001 0.012	-0.033 0.045
Table Oil	-0.006 0.003	0.016 0.014
Olive Oil	0.018 0.007	-0.029 0.027
Butter	0.019 0.010	-0.067 0.041
Tea	0.001 0.010	0.055 0.040
Coffee	0.013 0.014	-0.150 0.055
Sugar	0.007 0.005	0.058 0.022
Fresh Milk	0.002 0.002	0.009 0.008

Standard errors are below coefficients

Based on these results and those of the Groupe de Travail, one can conclude that the substantial variation exhibited in the unit value data reflect actual price variation; the unit values do not seem to be contaminated by the quality effects described here. The analysis will therefore use unit values as proxies for price. This thesis does not, however, test for the measurement error described above.

Non-Consumption

One problem that arises in cross-sectional surveys is that of the "limited dependent variable." Limited dependent variables occur when the data on a dependent variable are limited to a certain range. There are two types of samples with limited dependent variables: truncated samples and censored samples. A sample is truncated when the independent variables are not available for dependent variables outside the given range. Common examples of truncated samples include negative income tax experiments in which information on only a sample of households with income below some threshold is provided, or experiments to determine the earnings of low achievers for which information on only individuals with intelligence scores below a specified level are sampled. Censored samples, on the other hand, are samples for which the dependent variable is in a certain range but the sample also include observations on the independent variables when the dependent variable is outside the range.

The classic treatment of the censored regression model is the tobit model, developed by Tobin (1958) using the example of the consumption of durable goods. Most households will not purchase a car, or other durable goods, during a reference period although this does not necessarily mean they would never purchase a car. For non-durable goods, if the goods are highly disaggregated, it is likely that some of the households will not have consumed the good during the reference period. The problem with the resulting censored sample is explained concisely by Kmenta using the example of durable goods: "since expenditure on durable goods is not continuous, purchases are not made until the 'desire' to buy the good exceeds a certain level. However, we cannot observe desires, only expenditures, and those will be nonzero only if the good is actually purchased. 'Negative' expenditures, corresponding to various levels of desire below the threshold level, cannot be observed, and all households with no purchases are recorded as showing zero expenditure" (Kmenta, 1986, p.560).

The durable goods example can be extended to include food items which may not have been purchased during the reference period.

The problem of using a censored sample in regression analysis is explained as follows:

Let

$$Y_i^{*}=\alpha+\beta X_i+\epsilon_i^{*} \qquad (i=1,2,\ldots,n) \qquad (3\text{-}17)$$

be a regression for which all basic assumptions are satisfied. Let the dependent variable, Y^{*}, represent the consumption of some commodity, and X represent income. For the households that consumed positive quantities of the commodity, Y^{*} is the actual quantity. For households that did not consume any of the commodity, Y^{*} represents an index of the "desire" to purchase the commodity.

For households that did not consume the good, Y^{*} is not observed and is recorded as zero. Thus, instead of observing Y_i^{*}, we actually observe Y_i, which is defined as

$$Y_i = Y_i^{*} \text{ if } Y_i^{*} > 0,$$
$$= 0 \quad \text{if } Y_i^{*} \le 0.$$

Equation 3-17 then becomes

$$Y_i=\alpha+\beta X_i+\epsilon_i \qquad (3\text{-}18)$$

where Y_i is truncated at zero and ϵ is truncated at $-(\alpha + \beta X)$. This means that the lower tails of Y_i and ϵ_i are both cut off and the probabilities are piled up at the cut-off point. The implication of this is that the mean of Y_i is different from that of Y_i^{*} and that of ϵ_i is different from ϵ_i^{*}, which is zero. This is true whether the points for which $Y_i=0$ are or are not included in the sample (i.e., this is true whether the sample is truncated or censored). Limiting the range of the values of the dependent variable thus leads to a nonzero mean of the disturbance and to biased and inconsistent least squares estimators.

How to Correct for a Censored Sample

Tobin originally proposed maximum likelihood technique to deal with the limited dependent variable problem. This technique is called "Tobin's probit" or "tobit".

Heckman proposed another way of dealing with the problem of censored data. Suppose that of all n observations there are m (m<n) observations for which $Y_i^* > 0$. The regression equation for these observations is

$$Y_i=\alpha+\beta X_i+\epsilon_i \qquad (i=1,2,\ldots m) \tag{3-19}$$

where Y_i and ϵ_i are truncated normal variables. Since the regression is only for those observations for which $Y_i^* > 0$, the conditional expectation of Y_i given $Y_i^* > 0$ is

$$E(Y_i|Y_i^*>0)=\alpha+\beta X_i+E(\epsilon_i|Y_i^*>0)=\alpha+\beta X_i+E(\epsilon_i|\epsilon_i^*>-\alpha-\beta X_i) \tag{3-20}$$

$$(i = 1,2\ldots,m)$$

Given that $\epsilon_i^* \sim N(0,\sigma^2)$, the mean of the corresponding truncated variable, ϵ_i, is

$$E(\epsilon_i|\epsilon_i^*>-\alpha-\beta X_i)=\sigma\lambda_i \tag{3-21}$$

where

$$\lambda_i=\frac{f(\frac{\alpha+\beta X_i}{\sigma})}{F(\frac{\alpha+\beta X_i}{\sigma})} \tag{3-22}$$

and f(*) represents the density and F(*) the cumulative distribution function of a standard normal variable. λ_i is called the inverse of the Mill's ratio. To allow for the non-zero mean of ϵ_i, the equation

$$Y_i=\alpha+\beta X_i+\sigma\lambda_i+\epsilon_i \qquad (i=1,2,\ldots,m) \tag{3-23}$$

is run on the m observations for which $Y_i^* > 0$. The error term in equation 3-23 then has a mean of zero.

If λ_i were observable, this equation would have a disturbance with zero mean and the least squares coefficients would be unbiased. Since λ_i is not observed, it must be estimated. The estimation procedure is as follows: probit analysis is run using a dichotomous variable for consumption and non-consumption as the dependent variable, and the explanatory variables of the model as the independent variables. The results are used to construct $(\alpha + \beta X_i)/\sigma$. λ_i can then be calculated using equation 3-22.

Once λ_i is estimated, equation 3-23 can be estimated using the least squares method using the m observations for which $Y_i>0$. The estimators of α and β are consistent and asymptotically normal.

Heckman's Two-Stage Procedure

Although the problem of "non-consumption" is less of a problem the higher the percentage of surveyed units having positive consumption, the case of fairly disaggregated food groups, such as those used here, warrant the correction for censored sample bias. Table 3-2 presents the percentage of the sampled population that reported positive consumption of the various commodities.

Table 3-2: Percentage of Sampled Population Reporting Positive Consumption of Products

Product	Percentage
Mutton	40
Beef	54
Chicken	46
Table Oil	89
Olive Oil	43
Butter	46
Coffee	73
Tea	94
Sugar	98
Fresh Milk	30
Soft Wheat	86
Hard Wheat	30
Barley	39

The approach taken here to correct for the censored sample bias will follow Heckman (1976, 1979), and to correct for the resulting heteroskedasticity. The following steps will be taken:

1. Probit analysis will be run using as a dependent variable the dummy variable for consumption/non-consumption. The independent variables will be those used in the model of demand.

2. The predicted values of the dependent variable will be calculated and used in equation 3-22 to estimate the inverse of the Mill's ratio.

3. The inverse of the Mill's ratio will be used in the demand equations as an independent variable to correct for the missing variable bias.

Sampling Design

Standard errors calculated using standard statistical packages assume simple random sampling (SRS) in which every element of the population has an equal chance of being selected for inclusion in the sample. When simple random sampling is not used to sample a population, the formula used for the standard errors from SRS is no longer valid. For the consumption survey used here, the sampling methods were a combination of clustering and stratification.[12] Stratification, and in particular proportionate stratification as employed in the data set used here, leads to more precision in the survey estimates than would SRS. Clustering, however, decreases the precision relative to SRS. Although the standard errors reported here may over- or under-state the true standard errors because of the sampling technique, they are probably close to accurate since the decrease in precision resulting from clustering is offset by the over precision that results from stratification. Therefore, no correction for sampling is made to the standard errors.

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[12] Clustering and stratification and their implications for the estimation of standard errors are discussed in Appendix 3-5. Appendix 3-6 gives a detailed discussion of the sampling procedures used to sample the Moroccan population for the consumption survey.

Weighting

Because of the complex survey design involved in sampling the Moroccan population, households are not given equal weighting. Instead, each household is assigned an extrapolation coefficient, or weight, which may be used to extrapolate the sample to the population level. In calculating means, it is imperative that each household be weighted by its coefficient to provide a consistent estimate of the population mean. There is disagreement, however, on whether or not to use the weights when doing regression analysis. Standard texts either ignore the issue or suggest that no weighting be used.

Buse and Chavas (1990) argue that the decision of whether or not to use weights in the regression depends on the explicit assumptions that undergird the economic model. They compare the assumptions of three models: a simple linear model, weighted least squares, and a weighted average coefficient where individual coefficients are calculated for each stratum and a weighted average is computed for the overall coefficient. Weighted least squares weights the regression by a diagonal matrix whose diagonal elements are the sampling weights. This would be an appropriate model if the heteroskedasticity of the error term is characterized by the specific function obtained from the sampling weights, that is, if the standard deviation of the error term is proportional to the inverse of the weighting matrix. If not, then the coefficients obtained are not minimum variance estimators. In general, there is no reason to believe that the standard deviation of the error term will be proportional to the inverse of the weighting matrix, thus using weights in the regression is inappropriate. This argument justifies the unweighted regression analysis used here.

Conclusion

The application of consumer theory to applied demand analysis still poses several obstacles for researchers. The unobservability of a consumer's utility function, and the restrictions on demand equations that theory requires are just a few of the problems. Thus the bridge between consumer theory and application is still quite weak. As Deaton and Muellbauer (1980b, p 80) believe "It is our view that a careful transition from theory to application is a fundamental prerequisite of sound econometric work, and we find much current empirical work profoundly unsatisfying because of the lack of such a basis."

The AIDS is a model of consumer behavior which addresses some of these issues. It "gives an arbitrary first-order approximation to any demand system; it satisfies the axioms of choice exactly; it aggregates perfectly over consumers without invoking parallel linear Engel curves; it has a functional form which is consistent with known household-budget data; it is simple to estimate, largely avoiding the need for non-linear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters" (Deaton and Muellbauer, 1980a, p 312). Yet several limitations of the model should be highlighted. Although the model gives a first-order approximation to any demand system, the functional form for the cost function used to derive the demands is a particular cost function, the choice of which remains ad hoc; a good cannot be a luxury for one income class and a necessity or inferior good for another; and demand always becomes more inelastic as income rises.

The approach in this analysis will be to estimate demand using a functional form similar to the AIDS. Each equation will be estimated using OLS. This approach has the advantage over the double log specification that regional analysis is possible without introducing interaction terms. The number of coefficients to be estimtated is thus smaller with this approach than with the double log. The income variable will be proxied by total expenditure, rather than total expenditure on the foods in the system, to make the estimation of elasticities more straightforward. Since unit values for non-food goods are not available, it is impossible to calculate the Stone's index. As such, the income term will not be deflated by a price index.[13]

Several other issues arise when modeling consumption using cross-sectional data. These include reported zero-consumption, using unit values as proxies for prices, using survey weights in regression analysis, and sampling design. The following procedures will be used to deal with these issues:

1) Heckman's two-staged procedure will be used to correct for the censoring bias of reported zero-consumption;

2) because the quality elasticity was found in most cases to be negligible, unit values will be used as proxies for prices;

3) survey weights will not be used in the regression because of the lack of evidence that the heteroskedasticity of the error term is related to the sampling weights; and

4) the design effects is assumed to be negligible since the sampling procedure used both stratification and clustering.

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[13] It should be noted that when the expenditure term is not deflated by a price index, the resulting expenditure elasticity will be contaminated by price effects that have not been eliminated through deflating.

CHAPTER 4: DESCRIPTIVE STATISTICS

Description of Study Areas

The 1984/85 consumption survey divided Morocco into seven regions, with both rural and urban areas in each region. Each region has many provinces. This study uses a subsample of three provinces - Sidi Kacem (rural and urban), Casablanca (urban), and Marrakech (rural). These provinces were chosen because although they are all within the agricultural area of Morocco, they represent diverse parts of the country. A description of each area is given here.

General Description of Morocco

Morocco is located in the northwestern corner of Africa. Four mountain ranges (the Rif, the Middle-, High- and Anti-Atlas) divide the country into two distinct areas - to the east of the Atlas mountains is mostly desert area with little agricultural production; the area bounded by the Atlantic Ocean and the four mountain ranges defines an area where most of the agricultural production of the country takes place (see map on next page). Within the agricultural area, a further distinction can be made: modern irrigation and agricultural development have been largely confined to the broad plains and plateaus defined by the Gharb, Chaouia, Sais, Abda, Doukkala, Haouz, Souss, and Basse Moulouya. On the other hand, traditional agriculture, which receives

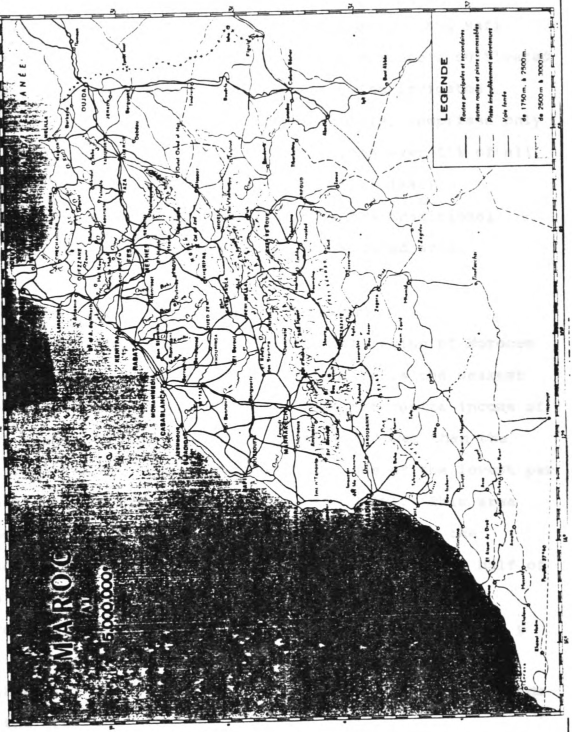

Figure 4-1: Map of Morocco

little or no government assistance, is largely situated in the area delimited by Kenitra, Fes, Marrakech, and Safi. Traditional agriculture occupies 70% of Morocco's cultivated land and involves over 90% of farmers. The irrigated sector, which is situated on the best soils, comprises only 10-15% of the arable lands but contributes over 85% of all commercial agricultural production (Payne, 1986).

The four areas studied are within the traditional agricultural area but none is in an irrigated area.

Study Area of Marrakech

Marrakech is located in the Tensift region of Morocco in the center of the country. The Tensift is the weakest part of the country economically, with per capita income of 3011 Dirham (DH) in 1984/85,[14] 17 percent lower than the national average. Rural Marrakech has one of the lowest per capita expenditures in the country (2451 DH). This area produces most of the nation's barley. Barley is the traditional domestically grown food crop. It covers half of the cultivated cereals acreage and accounts for 40-50 percent of total grains production (Tuluy and Salinger, p 13). Marrakech also produces olive oil, the traditional edible oil; Marrakech and Fes together cultivate two-thirds of the area planted to olive trees.

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[14] In 1984 the official exchange rate was 8.81 DH/$; the equilibrium exchange rate was 9.50 DH/$ (Tuluy and Salinger, 1988).

Sidi-Kacem

Sidi-Kacem is located in the Northwestern part of Morocco, a part of the country which is in the fertile agricultural plain. This area produces both soft and hard wheat. The Northwest is one of the most economically favorable areas but also has one of the highest disparities in income between the poorest and the wealthiest households.

Casablanca

Casablanca is the largest city in Morocco and is located along the central part of the Atlantic coast. For this reason, Casablanca probably has access to more imported goods than do the other study areas. Urban Casablanca has a higher per capita expenditure per year than any other part of the country; per capita income is 1.2 times higher than the national average (Laraki, p49). Consequently, cereal products become less important in the food budget than meat (Laraki).

Descriptive Statistics about Food Consumption in Morocco

Analyzing the effect of various food policies on the consumption patterns of the poor requires an understanding of who the poor are, where they live, and what they consume. This section uses basic statistics on Morocco and some statistics from the subsample of the 1984/85 consumption survey to give a preliminary overview of the situation of the poor.

World Bank unpublished data suggest that in 1984, nearly 35 percent of the population (of which 23 percent resides in the rural areas) lived below the absolute poverty level (World Bank, 1986). Absolute poverty in that year was defined to be per capita income of less than 2376 DH (current 1984) in urban areas, and less than 1533 DH (current 1984) in rural areas.

Using total expenditure[15] as a proxy for income, table 4-1 indicates the percentage of the sampled population living below the absolute poverty level, based on the above definition of absolute poverty.

Table 4-1: Percentage of Sampled Population Living Below the Poverty Level by Study Area

Study Area	Percent
Urban Sidi-Kacem N=105	19
Rural Sidi-Kacem N=220	15
Marrakech N=385	18
Casablanca N=317	14

Note: N is the number of households surveyed in each area.

[15] Total expenditure includes home-production valued at the local market price and the opportunity cost of renting for those who own their home.

Although the percentage of the population that lives below the poverty level is smaller for the sampled population than for the total population, it is still clear that the poor are not concentrated in one geographical area. In order to evaluate the effects of various policies on the poor, it is helpful to know if there are any common consumption patterns among them. Some of the basic consumption data will help identify common traits.

Food Shares

As seen in table 4-2, even though rural Sidi Kacem has the lowest per capita total expenditure, households in Marrakech spend the least on food.

Table 4-2: Statistics on Total Expenditures and Expenditures on Food

Study Area	Tot Annual Expend. Per Cap (Dirham)	Per Cap Annual Expend. on Food in Lowest Income Quartile (Dirham)	% of Total Expend. Devoted to Food	% of Total Expend. Spent on Food by Lowest Income Quartile
Urban Sidi-Kacem N=105	5778 (4045)	1848 (474)	49 (13)	55 (12)
Rural Sidi-Kacem N=220	2885 (2631)	1394 (279)	60 (13)	61 (13)
Marrakech N=385	2983 (2197)	1310 (260)	58 (12)	60 (12)
Casablanca N=317	6454 (7239)	2137 (584)	49 (14)	57 (14)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

It is a little misleading to compare total expenditure across zones without correcting for regional differences in the cost of living.[16] However, inflation during the study period was less than 4 percent, and cost-of-living indeces are not available for the rural areas. Table 4-2 shows that although absolute expenditures on food are higher in urban Sidi Kacem and Casablanca than in rural Sidi Kacem and Marrakech, the percentage of total expenditures devoted to food is higher in the rural areas than in the urban areas. This corroborates Engel's law which states that as incomes rise, the percentage of income spent on food declines.

The study subsample has an average per capita total expenditure of 4087 DH, slightly higher than the national average for that year of 3623 DH. Similarly, both rural study areas and both urban study areas have per capita total expenditures above the national average for rural and urban areas (4915 DH urban, 2637 DH rural).

From these data, it appears that one can distinguish urban from rural groups since per capita expenditure, per capita expenditure on food, and share of total expenditure devoted to food are similar by rural/urban breakdown. However, a look at the percentage of the food budget

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[16] Although prices are important in determining consumption patterns, they are not included in this chapter. Unit values are included in Appendix 5-1 and will be incorporated into the regression analyses.

allocated to different foods and quantities consumed shows some differences by study area, especially for cereals.

Cereals

Cereals constitute a major part of the diets of Moroccans in terms of both calories and expenditures. Nationally, cereals accounted for nearly 30% of the total food budget (Direction de la Statistique); in the study sample the average was 21%.

Few households reported consuming grain of hard wheat, soft wheat, or barley. Although households may purchase grain or use home-grown grain, they probably reported their consumption in the form in which it was used or consumed (flour, most likely) (Direction de la Statistique). There is also likely multicollinearity between the products of one grain. For these reasons, no analysis of individual grain products will be undertaken for this study. All cereal figures reported here have been converted into grain equivalent.[17]

Table 4-3a shows that among consuming households the consumption of soft wheat is higher than the consumption of

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[17] Conversion factors are in Appendix 4-3. The products listed there indicate which products are made from the different grains. The most commmon forms of consumption reported in the survey are the following:

soft wheat: flour and bread
hard wheat: flour and grain
barley: flour, semoule, and grain

hard wheat in all study areas except Casablanca. However, table 4-3b shows that when figures are based on overall consumption, per capita consumption of soft wheat is higher than that of hard wheat, even in Casablanca. Soft wheat is also the cereal consumed by the highest percentage of households in all four study areas. Almost all urban households consume some soft wheat (98%); about 80% of the households in the rural areas consume soft wheat. Barley is heavily consumed in Marrakech, although the consumption of hard wheat and soft wheat in Marrakech is also high.

The percentage of the food budget spent on hard and soft wheat products in table 4-4 is clearly delineated by rural/urban lines: the households in the rural areas spend a higher percentage of the food budget on cereals than do those in the rural areas. Only a negligible portion of the food budget is devoted to barley in all areas except Marrakech, where it is almost as important as the other cereals. When the figures are converted to an overall average (by multiplying the figures in table 4-4 by the percentage consuming), soft wheat becomes the most important budgetary item for all four study areas.

Table 4-3a: Average Per Capita Consumption of Cereals by Study Area for Households Consuming that Cereal (kg)

Study Area	Hard Wheat	Soft Wheat	Barley
urban Sidi-Kacem N=105	136 (126) [40%]	163 (109) [98%]	8 (4.3) [13%]
Rural Sidi-Kacem N=220	169 (121) [62%]	183 (147) [76%]	32 (28) [3%]
Marrakech N=385	124 (88) [13%]	155 (147) [80%]	141 (137) [72%]
Casablanca N=317	116 (105) [25%]	85 (77) [98%]	16 (21) [33%]

Notes:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.
- Figure in brackets is the percentage of the population that reported positive consumption of the good.

Table 4-3b: Average Per Capita Consumption of Cereals by Study area for all Households Surveyed (kg)

Study Area	Hard Wheat	Soft Wheat	Barley
Urban Sidi-Kacem N=105	54 (50)	160 (107)	1 (.56)
Rural Sidi-Kacem N=220	105 (75)	139 (112)	.96 (0.8)
Marrakech N=385	16 (11)	124 (118)	102 (99)
Casablanca N=317	29 (26)	83 (76)	5 (7)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-4: Percentage of Food Budget Spent on Cereal Products by Consuming Households

Study Area	Soft Wheat	Hard Wheat	Barley
Urban Sidi-Kacem N=105	11 (8)	8 (5)	1 (0.5)
Rural Sidi-Kacem N=220	15 (11)	18 (12)	6 (7)
Marrakech N=385	15 (11)	15 (11)	13 (10)
Casablanca N=317	9 (7)	10 (8)	1 (2)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-5a and 4-5b indicate that cereals are probably necessities for most households in all four areas, as the consumption of all three cereals increases less than proportionally as income increases. These tables also illustrate the importance of soft wheat even for the lowest income quartiles. Even though the per capita quantity consumed increases as income increases, the percentage of low-income households consuming soft wheat is high.

For hard wheat, on the other hand, the percentage of low-income households that consume any hard wheat is low relative to the percentage of high-income households that consume hard wheat. This is reflected in the low overall per capita consumption of hard wheat among the low-income groups. Both the quantity consumed and the percentage of households consuming increase as incomes increase.

Table 4-5a: Average Per Capita Consumption of Cereals by Region and Income Quartile for All Households Surveyed (kg)

Study Area	Income Quartile	Hard Wheat	Soft Wheat	Barley
Urban Sidi-Kacem N=105	1	18 (13)	146 (107)	0.7 (0.3)
	2	44 (31)	169 (136)	1.2 (0.9)
	3	57 (67)	171 (98)	1.8 (0.7)
	4	96 (70)	153 (85)	0.7 (0.2)
Rural Sidi-Kacem N=220	1	46 (39)	113 (70)	1.1 (0.6)
	2	70 (59)	132 (82)	2.7 (2.1)
	3	143 (91)	129 (92)	0.5 (0.2)
	4	165 (92)	186 (169)	- -
Marrakech N=385	1	11 (8)	62 (47)	59 (53)
	2	16 (12)	99 (71)	86 (57)
	3	23 (15)	131 (99)	115 (96)
	4	14 (10)	203 (187)	148 (156)
Casablanca N=317	1	7 (6)	54 (50)	5 (7)
	2	14 (10)	79 (68)	6 (7)
	3	54 (49)	83 (71)	6 (8)
	4	42 (29)	110 (90)	4 (5)

Notes:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.

Table 4-5b: **Average Per Capita Consumption of Cereals by Region and Income Quartile for Households Consuming that Cereal (kg)**

Study Area	Income Quartile	Hard Wheat	Soft Wheat	Barley
Urban Sidi-Kacem N=105	1	79 (56) [23%]	152 (111) [96%]	9 (4) [8%]
	2	112 (80) [39%]	169 (136) [100%]	8 (6) [15%]
	3	155 (180) [37%]	171 (98) [100%]	8 (3) [22%]
	4	155 (113) [62%]	159 (89) [96%]	9 (2) [8%]
Rural Sidi-Kacem N=220	1	114 (97) [40%]	149 (92) [76%]	27 (14) [4%]
	2	121 (101) [58%]	165 (103) [80%]	45 (35) [6%]
	3	196 (124) [73%]	189 (135) [68%]	13 (6) [4%]
	4	211 (118) [78%]	238 (217) [78%]	- - [0%]
Marrakech N=385	1	113 (84) [10%]	92 (70) [67%]	93 (84) [63%]
	2	113 (82) [14%]	119 (85) [83%]	127 (84) [68%]
	3	127 (84) [18%]	160 (121) [82%]	153 (128) [75%]
	4	140 (100) [10%]	226 (208) [90%]	178 (188) [83%]
Casablanca N=317	1	57 (50) [12%]	55 (51) [98%]	14 (20) [37%]
	2	68 (49) [21%]	81 (69) [98%]	19 (22) [33%]
	3	142 (128) [38%]	85 (72) [98%]	18 (24) [33%]
	4	139 (97) [30%]	115 (94) [96%]	14 (19) [27%]

Notes:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.
- Figure in brackets is the percentage of the sampled population that reported positive consumption of the good.

Thus, if hard wheat is subsidized, the subsidy will benefit wealthier households more since they consume more hard wheat than do the poor, and the percentage of wealthy households that consume hard wheat is higher than the percentage of poor households that consume hard wheat. A subsidy on hard wheat will also leak more than does the subsidy on soft wheat because there is a larger increase in the consumption of hard wheat as incomes increase than the increase in soft wheat. The data indicate that the soft wheat subsidy may actually be reaching the poor, given the high percentage of households that consume soft wheat.

In urban Sidi Kacem the consumption of soft wheat does not increase very much with income, and even declines for the last quartile; the quantity consumed of hard wheat increases across income quartiles both overall and for consuming households only (except in the upper income quartiles for overall consumption). The subsidy on soft wheat probably reaches the poor better than would a subsidy on hard wheat.

In Casablanca, consumption of all wheats is significantly lower than in the other areas. This probably reflects a switch into meats, the consumption of which is generally higher, even for the poor, in Casablanca than in other areas. Consumption of cereals still increases with income in Casablanca, but the amount consumed is much lower.

The unit values of soft and hard wheat are higher in Casablanca than they are in the other study areas, probably because the other areas are more predominantly cereal growing areas. The relative price of meat is thus lower in Casablanca (the nominal unit values of meats are about the same in all four study areas). This may explain the higher meat consumption in Casablanca.

In this sample, barley is important only in Marrakech both in terms of quantity and percentage of households consuming any. The consumption of hard and soft wheat in Marrakech is lower than the consumption of barley, but still important.

Meat

Meat is an important part of the Moroccan diet, even among the poor. Meats occupy the largest portion of the food budget (23%) in urban areas and are second only to cereals in rural areas (19%). Mutton, beef, and poultry are the most important meats; together they account for 83% of expenditures on meat. Tables 4-6a and 4-6b show the per capita consumption of mutton, beef, and chicken for all households surveyed and for only those reporting positive consumption of meats. Table 4-7 shows the percentage of the food budget devoted to these meats.

Table 4-6a: Average Per Capita Consumption of Meats by Study area for All Households Surveyed (kg)

Study Area	Mutton	Beef	Chicken
Urban Sidi-Kacem N=105	4.1 (4.4)	5.6 (6.3)	4.8 (4.2)
Rural Sidi-Kacem N=220	2.2 (3.0)	1.2 (0.8)	3.8 (2.1)
Marrakech N=385	2.9 (5.0)	1.3 (1.0)	1.5 (2.1)
Casablanca N=317	4.5 (4.6)	7.9 (9.2)	5.0 (4.2)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-6b: Average Per Capita Consumption of Meats by Study area for Households Reporting Consumption of that Meat (kg)

Study Area	Mutton	Beef	Chicken
Urban Sidi-Kacem N=105	11.4 (12.2) [36%]	8.1 (9.2) [69%]	7.2 (6.4) [66%]
Rural Sidi-Kacem N=220	7.6 (10.5) [29%]	3.0 (1.9) [41%]	6.7 (7.1) [56%]
Marrakech N=385	7.3 (12.4) [40%]	3.4 (2.8) [37%]	6.3 (8.6) [24%]
Casablanca N=317	11.9 (12.0) [38%]	10.0 (11.6) [79%]	8.2 (6.9) [61%]

Note:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.
- Figure in brackets is the percentage of the sampled population that reported positive consumption of the good.

Table 4-7: Percentage of Food Budget Spent on Meat Products by Consuming Households

Study Area	Mutton	Beef	Chicken
Urban Sidi-Kacem N=105	9 (7)	11 (11)	6 (3)
Rural Sidi-Kacem N=220	10 (5)	8 (4)	11 (7)
Marrakech N=385	10 (9)	8 (5)	7 (5)
Casablanca N=317	10 (9)	13 (4)	6 (4)

Note: N is the number of households surveyed.
Figure in parentheses is the standard deviation.

Among those households that consume beef, mutton, and chicken (table 4-6b), mutton is the most important meat in terms of quantity in all four study areas. But because fewer households eat mutton than beef (except in Marrakech), the overall per capita consumption of beef is higher than other meats in the urban areas (table 4-6a). Chicken becomes the most important meat in rural Sidi Kacem, and mutton is still the most important meat in Marrakech (table 4-6a).

Among households consuming meats, beef is the most important expenditure item in the urban areas; mutton is more important in the rural areas. The consumption of meats seems to be clearly delineated by urban/rural lines. The only clear provinceal difference is that chicken appears to be slightly more important in the food budget in rural Sidi

Kacem compared to other areas, and compared to the consumption of other meats in that area.

Table 4-8a: Per Capita Consumption of Meats by Region and Income Quartile for All Households Surveyed (kg)

Study Area	Income Quartile	Mutton	Beef	Chicken
Urban Sidi-Kacem N=105	1	0.3 (0.1)	1.2 (0.8)	1.1 (0.5)
	2	1.2 (0.7)	2.7 (0.8)	3.5 (0.6)
	3	4.3 (3.3)	4.8 (3.4)	5.3 (5.2)
	4	9.3 (7.7)	12.7 (10.4)	8.3 (5.1)
Rural Sidi-Kacem N=220	1	0.3 (0.1)	0.4 (0.2)	1.2 (0.5)
	2	0.9 (0.3)	1.3 (0.7)	2.2 (1.2)
	3	1.4 (0.8)	1.5 (0.8)	4.3 (2.4)
	4	6.2 (7.0)	1.7 (1.1)	7.8 (8.1)
Marrakech N=385	1	0.3 (0.1)	0.6 (0.3)	0.5 (0.3)
	2	1.2 (0.8)	0.7 (0.4)	1.1 (0.8)
	3	3.1 (2.9)	1.2 (0.6)	1.4 (1.6)
	4	6.9 (10.5)	2.4 (1.6)	2.8 (3.6)
Casablanca N=317	1	0.2 (0.1)	2.4 (2.0)	2.9 (2.7)
	2	2.6 (3.6)	6.4 (5.1)	4.9 (4.2)
	3	3.7 (3.6)	7.3 (5.3)	5.6 (4.2)
	4	11.6 (8.7)	14.5 (14.3)	6.7 (4.6)

Note:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.

Table 4-8b: Average Per Capita Consumption of Meats by Region and Income Quartile for Consuming Households (kg)

Study Area	Income Quartile	Mutton	Beef	Chicken
Urban Sidi-Kacem N=105	1	2.8 (1.2) [12%]	2.6 (1.8) [46%]	2.5 (1.3) [42%]
	2	5.0 (3.2) [23%]	3.9 (2.0) [69%]	5.3 (3.3) [65%]
	3	7.3 (5.6) [59%]	5.9 (4.6) [74%]	6.5 (6.3) [82%]
	4	18.5 (15.3) [50%]	14.9 (12.2) [85%]	11.3 (7.0) [73%]
Rural Sidi-Kacem N=220	1	1.8 (0.6) [16%]	1.7 (0.9) [22%]	3.4 (1.4) [36%]
	2	3.6 (1.2) [25%]	3.1 (1.6) [42%]	4.4 (2.3) [51%]
	3	5.5 (3.0) [25%]	2.8 (1.5) [54%]	6.3 (3.6) [66%]
	4	13.0 (14.5) [48%]	3.9 (2.6) [44%]	10.8 (11.2) [72%]
Marrakech N=385	1	2.0 (0.7) [15%]	1.7 (0.9) [34%]	2.7 (1.3) [20%]
	2	3.1 (2.1) [40%]	2.1 (1.1) [35%]	4.2 (3.1) [25%]
	3	6.0 (5.7) [51%]	3.4 (1.9) [34%]	7.0 (7.1) [22%]
	4	12.5 (19.0) [55%]	5.4 (3.6) [44%]	10.0 (12.8) [28%]
Casablanca N=317	1	1.9 (1.2) [10%]	3.4 (2.9) [70%]	5.0 (4.7) [57%]
	2	6.3 (8.7) [41%]	7.9 (6.3) [81%]	7.5 (6.5) [65%]
	3	9.6 (8.9) [38%]	8.8 (6.4) [83%]	8.8 (6.5) [64%]
	4	17.3 (13.0) [67%]	17.5 (17.2) [83%]	11.5 (8.0) [58%]

Note:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.
- Figure in brackets is the percentage of the sampled population that reported positive consumption of the good.

The information in tables 4-6a and 4-6b is broken down by income quartile in tables 4-8a and 4-8b. In all of the study areas, for all households surveyed as well as only for those reporting positive consumption, the consumption of the three meats increases substantially with incomes. Among consuming households, the highest income quartile consumes as much as nine times the quantity of meat as the lowest income quartile. In most cases, the percentage of households consuming a given meat also increases as income increases. The increase in the number of consuming households is not substantial, however, for beef and chicken in Casablanca, where the number of households consuming these meats is high even among the lowest-income quartiles.

Geography may not play a role in determining the consumption of meats. Both rural Sidi Kacem and Marrakech households have similar, low per-capita consumption of all meats, urban Sidi Kacem households consume slightly more meat, and Casablanca, which has the highest per capita total expenditure, consumes the most.

The consumption of mutton, beef, and chicken increases with increasing incomes despite the virtually constant unit values across income quartiles. (This is also true for oils; the case is mixed for cereals.) This hints that the quality issue described in chapter 3 may not be very important. In other words, as income rises, households still want to consume more in quantity (and more households are coming into the market) and are not making dramatic shifts into higher quality meats. Unit values could be constant, however, if food prices were higher in poor areas, so that the constant unit values reflect higher-quality consumption by the wealthy.

These data, as well as the data on other commodities, should be interpreted with care. Appendix 4-2 shows that the number of household members declines as income rises. Yet one would expect that the wealthier households would serve relatives and friends in addition to immediate family members. The survey may not have captured all consuming individuals of a household. The per capita quantities may be thus be more overstated as incomes rise.

Oils

The two main oils consumed in Morocco are olive oil, the traditional oil, and vegetable oil, most of which is imported. Butter is also consumed. For some households, butter is a substitute for oils, for others, it is a complement. There are not large differences in the consumption of butter or olive oil, in terms of either percentage or quantity consumed, with the exception of olive oil being more important in Marrakech and butter being slightly less important in Casablanca.

Table 4-9: Percentage of Food Budget Spent on Oil Products by Consuming Households

Study Area	Vegetable Oil	Olive Oil	Butter
Urban Sidi-Kacem N=105	5 (3)	4 (3)	3 (2)
Rural Sidi-Kacem N=220	6 (3)	6 (6)	5 (4)
Marrakech N=385	4 (2)	8 (5)	4 (4)
Casablanca N=317	4 (2)	4 (4)	2 (2)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-10a: Average Per Capita Consumption of Oils by Province for all Households Surveyed (kg)

Study Area	Vegetable Oil	Olive Oil	Butter
Urban Sidi-Kacem N=105	17.8 (11.6)	1.5 (1.1)	2.2 (2.0)
Rural Sidi-Kacem N=220	12.7 (8.2)	1.5 (1.4)	0.9 (0.8)
Marrakech N=385	7.9 (7.1)	6.3 (5.5)	0.8 (0.9)
Casablanca N=317	18.0 (17.2)	1.6 (1.4)	1.8 (2.7)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-10b: Average Per Capita Consumption of Oils by Province for Consuming Households (kg)

Study Area	Vegetable Oil	Olive Oil	Butter
Urban Sidi-Kacem N=105	19.6 (12.8) [91%]	6.9 (5.1) [22%]	3.4 (3.2) [64%]
Rural Sidi-Kacem N=220	13.7 (8.8) [93%]	6.3 (6.2) [23%]	3.2 (2.7) [29%]
Marrakech N=385	9.8 (8.8) [81%]	8.8 (7.7) [72%]	3.0 (3.7) [25%]
Casablanca N=317	18.9 (18.1) [95%]	7.0 (6.1) [23%]	2.4 (3.6) [76%]

Note:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.
- Figure in brackets is the percentage of the population that reported positive consumption of the good.

Vegetable oil is the most heavily consumed oil in all of the areas, which is to be expected given the relative prices of vegetable oil and olive oil. Despite the disparity in prices, in Marrakech, olive oil is still important in consumption. Both olive oil and vegetable oil are consumed by a large percentage of households in Marrakech; in the other study areas, vegetable oil is the most important both in terms of the number of households consuming and in terms of quantity. Butter is consumed by 76% of the households in Casablanca, although the per capita quantity consumed among consuming households is the lowest of all four areas.

Beverages

Sugar is included in the beverages category because of the complementarity between sugar and both coffee and tea. Per capita consumption of sugar in Morocco is 30 kg per annum, a major source of calories in the Moroccan diet (compared to a world average of 21 kg per capita and a developing-country average of 12 kg per capita) (Tuluy and Salinger, p.20). For consuming households and overall, both Casablanca and Marrakech have higher per capita consumption of sugar (about the same level) than do urban Sidi Kacem and rural Sidi Kacem. They also have higher per capita consumption of tea. Casablanca also has the highest consumption of coffee. One thing to note about the beverages is the high percentage of the population that consumes coffee, tea, and sugar.

Table 4-11: Percentage of Food Budget Spent on Beverages by Consuming Households (kg)

Study Area	Coffee	Tea	Fresh Milk	Sugar
Urban Sidi-Kacem N=105	3 (2)	3 (2)	2 (1)	4 (3)
Rural Sidi-Kacem N=220	3 (2)	3 (2)	5 (4)	7 (4)
Marrakech N=385	3 (2)	5 (3)	4 (3)	10 (5)
Casablanca N=317	2 (2)	4 (3)	2 (2)	6 (4)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-12a: Average Per Capita Consumption of Beverages and Sugar for All Households Surveyed (kg)

Study Area	Coffee	Tea	Fresh Milk	Sugar
Urban Sidi-Kacem N=105	1.4 (1.1)	0.8 (0.8)	1.7 (1.0)	24 (15)
Rural Sidi-Kacem N=220	1.1 (1.2)	1.1 (1.0)	18.2 (18.2)	27 (16)
Marrakech N=385	1.0 (1.1)	1.7 (1.3)	10.8 (9.0)	35 (23)
Casablanca N=317	1.7 (2.3)	1.9 (1.6)	0.8 (0.7)	35 (30)

Note: N is the number of households surveyed in each area.
Figure in parentheses is the standard deviation.

Table 4-12b: Average Per Capita Consumption of Beverages and Sugar for Consuming Households (kg)

Study Area	Coffee	Tea	Fresh Milk	Sugar
Urban Sidi-Kacem N=105	1.7 (1.3) [81%]	1.0 (1.0) [78%]	21 (13) [8%]	25 (16) [96%]
Rural Sidi-Kacem N=220	1.5 (1.6) [72%]	1.1 (1.0) [97%]	33 (33) [55%]	27 (16) [99%]
Marrakech N=385	1.3 (1.4) [76%]	1.7 (1.3) [98%]	25 (21) [43%]	35 (23) [99%]
Casablanca N=317	2.5 (3.4) [68%]	2.0 (1.7) [93%]	21 (17) [4%]	36 (31) [98%]

Note:
- N is the number of households surveyed in each area.
- Figure in parentheses is the standard deviation.
- Figure in brackets is the percentage of the population that reported positive consumption of the good.

Conclusions of this Section

Barley seems to be important only in Marrakech, with other areas spending only about 1% of the food budget on barley. The quantity of barley consumed in other areas is also small, while the quantity consumed in Marrakech is high (141 kg per capita for households that consume it). This is not surprising considering that Marrakech is the largest barley producing province in Morocco. Seventy percent of those surveyed in Marrakech reported positive consumption of barley, compared with less than 28% in the three other provinces. Furthermore, more than half of those reported that on average 95% of their consumption of barley came from home production.

Cereals appear to be important for all income groups, although less so for upper-income quartiles. As incomes increase, the quantity of all cereals increases while the percentage of the food budget spent on cereals declines. Both soft wheat and hard wheat are important for the lowest-income quartile in rural Sidi Kacem and Marrakech. The quantity consumed of all cereals (both overall and among consuming households) is low relative to consumption levels in other areas.

Subsidizing any of the cereals is likely to benefit wealthier households because the wealthy consume more cereals than do the poor. In terms of increasing the calories consumed by the poor, soft wheat seems more logical to subsidize than hard wheat because the poor eat more of it than they do hard wheat (except in Marrakech and Casablanca, where its about the same), and the rate of increase in consumption with rising incomes is not as fast as hard wheat.

The subsidy on sugar seems likely to affect the consumers in Marrakech and Casablanca more than in the other areas, given their high per-capita consumption of sugar. Although sugar is a major source of calories in the Moroccan diet, the validity of subsidizing sugar on nutritional grounds must be questioned.

Finally, the subsidy on vegetable oil is probably not effective in reaching the poor in Marrakech, given the high per-capita consumption of olive oil and the relatively low per capita consumption of vegetable oil. It may be increasing the consumption of vegetable oil among the poor in other areas, given the high percentage of low-income households that consume vegetable oil.

Although the descriptive data give some indication of consumption patterns by study area and income quartile, how households respond to price and income changes will be more useful in terms of predicting behavior. Elasticity estimates will follow the discussion of methods in the next chapter. The estimates will be compared to the estimates from the Groupe de Travail to see if there are regional differences in the elasticity estimates as well as to see if a slightly different methodological approach alters the estimates.

CHAPTER 5: ANALYTIC DISCUSSION OF RESULTS

This chapter presents the general model corresponding to the methods described in chapter 3, and an analysis of the elasticities of demand that are derived from it. The policy implications drawn from this discussion follow in chapter 6.

Description of Variables in the Model

Dependent Variables

Since the models used to estimate income and price elasticities are based on the AIDS, the dependent variable for each commodity is the budget share allocated to that commodity. The budget share is calculated by dividing annual household expenditure on a commodity by the total annual household expenditure. Expenditure on a commodity is the unit value multiplied by the quantity consumed.

The commodities modeled are: soft wheat, hard wheat, barley, olive oil, vegetable oil, butter, beef, mutton, chicken, and sugar. These commodities were chosen because they are the most basic staples for Moroccan households. These broad commodity groups were constructed by aggregating more detailed consumption data. Soft wheat, for example, comprises soft wheat flour, bread made of soft wheat, soft wheat grain, and other product made from soft wheat, all converted to their grain equivalents.[18]

Independent Variables

The specification of the AIDS inspired the choice of the independent variables. The AIDS specifies the budget share as a function of own price, cross prices of all goods in the system, and total real expenditure, all in logarithmic form. Although the models presented here do not constitute a true AIDS, own price, cross prices, and total expenditure were included as independent variables. Other than own price, only the prices of goods assumed to be either substitutes or complements to the good being modeled were included. This is justified on the assumption that the coefficients on the prices of other goods are zero. Household size was also hypothesized to be an important determinant of consumption.

Unit Values

Because prices were not available, unit values served as proxies for prices. A unit value is defined as total expenditure on a good divided by the quantity purchased of that good. If the unit value was missing because either the quantity or expenditure was missing, the average unit value

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[18] The coefficients used to convert goods to their grain equivalents are contained in Annex 4-3

for the cluster (5 households) was used. This is based on the assumption that all households in a cluster face the same prices. Chapter 3 describes the tests used to justify the use of unit values as proxies for prices without correcting for the quality effects or measurement error.

Total Expenditure

Total expenditure was defined as the sum of household expenditures on all goods in one year. Although the AIDS specifies the total expenditure variable as total expenditure on all goods in the system, total expenditure on all goods consumed, not just on those being modeled, is used here. The use of total expenditure on all goods makes it possible to calculate expenditure elasticities directly from the estimated coefficients. This eliminates the need to call upon separabilty assumption since it implies that the coefficients on all other goods that make up the total expenditure are assumed to be zero.

Total expenditure was not deflated by a price index because the data are cross-sectional and regional price indices are not available, and it was impossible to calculate the Stone's index.[19]

[19] See p.63 for discussion of why it is not possible to calculate the Stone's index in this case.

Squared Expenditure Term

A squared expenditure term was also included to allow goods to be a necessity or inferior good for one income quartile and a luxury item for another (see Chapter 3). When the squared income term was not significantly different from zero, the term was dropped.

Inverse Mill's Ratio

In addition to prices and total expenditure, the inverse Mill's ratio was included as an independent variable to account for the censoring problem described in Chapter 3. The inverse Mill's ratio is defined as

$$\lambda_i = \frac{f\left(\frac{\alpha+\beta X_i}{\sigma}\right)}{F\left(\frac{\alpha+\beta X_i}{\sigma}\right)} \tag{5-4}$$

where f(*) represents the density and F(*) the cumulative distribution function of a standard normal variable.

Household Size

"Adult equivalents," which convert the number of all household members into an "equivalent" adult number, is used to account for the effect of family structure on consumption. The number of adult equivalents was calculated using the following coefficients: head of household =1, other adults=0.7, children less than 15 years old=0.5.[20] Including this variable allows one to discuss the effect of household expenditure on consumption, holding household size constant.

Dummy Variables

Dummy variables for the study areas of Casablanca, and rural and urban Sidi Kacem were also included to account for regional differences in consumption. Theoretically, if the dummy variables are entered linearly and not as part of an interaction term, the dummy variables should only shift the intercept term; the slope coefficients should not change. Multicollinearity between the dummy variables and other parameters in the model, however, may affect other parameter estimates when the dummy variables are included.

A dummy variable for home production was also included. The dummy variable had a value of one if the household had any home production of the good, a zero otherwise.

Interaction Terms

The elasticities will vary by study areas since the budget shares vary by study area, and the budget shares are part of the formula for the elasticities. The elasticities may also vary if the slope coefficient on the price or

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[20] Although it may be more appropriate to count all adults equally, the data used here prohibit using different coefficients since the raw data from which the adult equivalents were calculated was not available.

income term varies by study area. Interaction terms were included to allow the slope coefficients to vary by study area. When the interaction terms were not significant, they were dropped from the equation.

The General Model

The most general form of the model, when all of the above independent variables are included is:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_{i1} \log(x) + \beta_{i2}[\log(x)]^2 + \sigma \frac{\phi(x'\beta)}{\Phi(x'\beta)} + \pi_i \log CU + \sum_{z=1}^{3} \delta_{iz} D_z + \sum_j \sum_{z=1}^{3} \zeta_{iz} D_z \log p_j + \sum_{z=1}^{3} \tau_{iz} D_z \log x + \psi D_i \quad (5\text{-}5)$$

where:

w_i = the share of total expenditure allocated to the ith good
p_j = the unit value of the jth good
x = total household expenditure

$\frac{\phi(x'\beta)}{\Phi(x'\beta)}$ = Inverse Mill's ratio

CU = number of consuming units in the household
D_1 = dummy variable for Casablanca
D_2 = dummy variable for rural Sidi Kacem
D_3 = dummy variable for urban Sidi Kacem
D_i = dummy variable for home production of good i

α_i, γ_{ij}, β_{i1}, β_{i2}, σ, π_i, δ_{i1}, δ_{i2}, δ_{i3}, ζ_1, ζ_2, ζ_3, τ_1, τ_2, τ_3, ψ are parameters

Judging Which is the Best Model

For each commodity, several variations of the above model were tested. Each included own price, income, household structure, and dummy variables for study areas. Prices of substitutes and complements, a squared income term, and interaction terms were also included in subsequent regressions, but were dropped when their coefficients were not significant.

Although there is no one criterion with which to judge which model most accurately reflects reality, several criteria can be used to make an overall assessment. The most important is the theoretical soundness of the model. The analyst should have strong *a priori* reasons to suspect that one variable is a determinant of another.

The standard errors of a parameter's estimate can be used to formulate t-tests of the significance of a variable. Economists commonly test the significance of variables at the 1 or 5 percent level; the 5 percent level will be used here. A five percent significance level means that if the sample were repeated an infinite number of times, there would be 5 percent chance that the coefficient would not be within 2 standard deviations of the original estimate.

When the model includes the inverse Mill's ratio as an independent variable, the standard errors must be adjusted to account for the fact that the variable is an estimate and is not directly observed. The formula for the standard error when the inverse Mill's ratio is used is included in Appendix 5-1.

The R^2 is commonly used to assess how much of the variation in the independent variable is attributable to the variation in the independent variables. When the inverse Mill's ratio is used, however, this statistic is invalid. The "information accuracy" will be used instead to assess the model's fit (Theil, Chung,and Seale, 1989). This statistic is defined as:

$$I_{ih} = \hat{w}_{ih} - w_{ih} + w_{ih}\log\frac{w_{ih}}{\hat{w}_{ih}} \qquad (5\text{-}6)$$

where:

w_{ih} is the observed budget share for the ith good for household h

$\hat{w}_{ih}$ is the predicted budget share for the ith good for household h.

If $\hat{w}_{ih}$ perfectly predicts w_{ih}, I_{ih} will be zero; the better the fit of the model, the closer will be I_{ih} to zero.

The estimated elasticities are presented in tables 5-1 through 5-10. The first-stage probit results used to calculate the elasticities are presented in Appendix 5-2.

Table 5-1: Cereal Elasticities

Product	Study Area	Total Expend	Price Soft Wheat	Price Barley	Price Hard Wheat	Mill's Ratio Signif?[a]	Info Accuracy
Soft Wheat	1	0.54* (0.02)	-1.52* (0.02)	0.14* (0.03)	0.33* (0.02)	no	0.0037
	2	0.68* (0.02)	-1.30* (0.01)	0.08* (0.02)	0.19* (0.01)		
	3	0.67* (0.02)	-1.32* (0.01)	0.09* (0.02)	0.20* (0.01)		
	4	0.42* (0.03)	-1.67* (0.02)	0.19* (0.04)	0.42* (0.03)		
Barley	1	-5.28* (0.33)		1.98* (0.50)		no	0.017
	2	0.13* (0.05)		-0.59* (0.07)			
	3	0.64* (0.02)		-0.83* (0.03)			
	4	-2.59* (0.19)		0.70* (0.29)			
Hard Wheat	1	0.18* (0.07)			-0.69* (0.03)	yes	0.0296
	2	0.48* (0.03)			-0.74* (0.02)		
	3	0.22* (0.03)			-1.39* (0.07)		
	4	0.53 (0.05)			-0.65* (0.03)		

Notes:

Study Areas

1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.
a "yes" if significant at least at the 10% level, "no" if not.
figures in parentheses are standard errors

Table 5-2: Soft Wheat Elasticities by Study Area and Income Quartile

Province	Income Quartile	Total Expend	Price Soft Wheat	Price Barley	Price Hard Wheat
1	1	0.58* (0.03)	-1.37* (0.01)	0.10* (0.02)	0.23* (0.01)
	2	0.59* (0.02)	-1.42* (0.02)	0.12* (0.02)	0.27* (0.02)
	3	0.50* (0.03)	-1.60* (0.02)	0.17* (0.03)	0.38* (0.02)
	4	0.41* (0.04)	-1.90* (0.03)	0.25* (0.05)	0.57* (0.04)
2	1	0.73* (0.02)	-1.22* (0.01)	0.06* (0.01)	0.14* (0.01)
	2	0.70* (0.02)	-1.27* (0.01)	0.08* (0.02)	0.17* (0.01)
	3	0.66* (0.02)	-1.33* (0.01)	0.09* (0.02)	0.21* (0.01)
	4	0.56* (0.02)	-1.50* (0.02)	0.14* (0.03)	0.32* (0.02)
3	1	0.70* (0.02)	-1.25* (0.01)	0.07* (0.01)	0.16* (0.01)
	2	0.66* (0.02)	-1.31* (0.01)	0.09* (0.02)	0.20* (0.01)
	3	0.66* (0.02)	-1.34* (0.01)	0.09* (0.02)	0.22* (0.01)
	4	0.67* (0.02)	-1.39* (0.01)	0.11* (0.02)	0.24* (0.02)
4	1	0.49* (0.04)	-1.46* (0.02)	0.13* (0.03)	0.30* (0.02)
	2	0.41* (0.03)	-1.63* (0.02)	0.17* (0.04)	0.40* (0.03)
	3	0.39* (0.03)	-1.73* (0.03)	0.20* (0.04)	0.46* (0.03)
	4	0.33* (0.05)	-2.07* (0.04)	0.30* (0.06)	0.68* (0.04)

Notes:

Study Areas

1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.

Table 5-3: Hard Wheat Elasticities by Study Area and Income Quartile

Study Area	Income Quartile	Total Expend	Price Hard Wheat
1	1	0.51* (0.04)	-0.81* (0.02)
	2	0.19* (0.07)	-0.69* (0.03)
	3	0.27* (0.04)	-0.72* (0.03)
	4	-0.20* (0.08)	-0.54* (0.04)
2	1	0.55* (0.03)	-0.77* (0.02)
	2	0.51* (0.03)	-0.75* (0.02)
	3	0.51* (0.02)	-0.75* (0.02)
	4	0.37* (0.03)	-0.68* (0.03)
3	1	0.52* (0.02)	-1.24* (0.04)
	2	0.26* (0.04)	-1.37* (0.06)
	3	0.15* (0.23)	-1.42* (0.07)
	4	-0.36* (0.06)	-1.68* (0.12)
4	1	0.53* (0.06)	-0.65* (0.03)
	2	0.51* (0.07)	-0.64* (0.03)
	3	0.62* (0.03)	-0.72* (0.02)
	4	0.33* (0.06)	-0.50* (0.04)

Notes:

Study Areas

1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.

Table 5-4: Barley Elasticities by Study Area and Income Quartile

Study Area	Income Quartile	Total Expend	Price Barley
1	1	-2.25* (0.17)	0.54* (0.26)
	2	-4.22* (0.28)	1.47* (0.42)
	3	-8.24* (0.49)	3.38* (0.74)
	4	-10.31* (0.60)	4.36* (0.91)
2	1	-0.02 (0.05)	-0.52* (0.08)
	2	0.41* (0.03)	-0.72* (0.05)
	3	-2.75* (0.20)	0.78* (0.30)
	4	.	.
3	1	0.71* (0.02)	-0.86* (0.02)
	2	0.68* (0.12)	-0.85* (0.02)
	3	0.66* (0.02)	-0.84* (0.03)
	4	0.46* (0.03)	-0.74* (0.04)
4	1	-1.36* (0.12)	0.12 (0.19)
	2	-1.86* (0.15)	0.35 (0.23)
	3	-3.96* (0.26)	1.34* (0.40)
	4	-8.30* (0.49)	3.41* (0.75)

Notes:

Study Area

1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.

Table 5-5: Oil Elasticities

Product	Study Area	Total Expend	Price Veg Oil	Price Olive Oil	Price Butter	Mill's Ratio Signif?	Info Accuracy
Vegetable Oil	1	0.58* (0.03)	-0.79* (0.24)			no	-0.0005
	2	0.66* (0.03)	-0.83* (0.20)				
	3	0.52* (0.04)	-0.76* (0.28)				
	4	0.44* (0.04)	-0.72* (0.32)				
Olive Oil	1	0.02 (0.62)		-1.02* (0.24)		no	0.0274
	2	0.45 (0.35)		-1.01* (0.14)			
	3	0.54 (0.29)		-1.01* (0.11)			
	4	0.04 (0.61)		-1.02* (0.23)			
Butter	1	1.40* (0.49)			-0.89* (0.17)	yes	0.0014
	2	1.20* (0.25)			-0.95* (0.09		
	3	1.23* (0.29)			-0.94* (0.10)		
	4	1.48* (0.59)			-0.87* (0.20)		

Notes:

Study Area
- 1 = urban Sidi Kacem
- 2 = rural Sidi Kacem
- 3 = Marrakech
- 4 = Casablanca

* indicates significant at least at the 5% level.
a "yes" if significant at least at the 10% level, "no" if not.
figures in parentheses are standard errors

Table 5-6: Meat Elasticities

Product	Study Area	Total Expend	Price Chicken	Price Beef	Price Mutton	Mill's Ratio Signif?	Info Accuracy
Chicken	1	0.63* (0.01)	-0.37* (0.01)	-1.44* (0.02)		no	0.0048
	2	0.85* (0.01)	-0.75* (0.01)	0.27* (0.03)			
	3	0.77* (0.01)	-0.60* (0.01)	0.42* (0.05)			
	4	0.68* (0.01)	-0.44* (0.01)	-0.59* (0.01)			
Beef	1	0.86* (0.09)		-1.36* (0.14)	0.26 (0.14)	no	0.0092
	2	0.86* (0.09)		-1.38* (0.15)	0.28 (0.15)		
	3	0.85* (0.09)		-1.38* (0.15)	0.28 (0.15)		
	4	0.89* (0.07)		-0.80* (0.11)	0.20 (0.11)		
Mutton	1	1.08* (0.04)	0.39* (0.02)		-1.05* (0.01)	no	0.007
	2	1.18* (0.04)	0.31* (0.01)		-1.04* (0.01)		
	3	1.17* (0.04)	0.31* (0.01)		-1.04* (0.01)		
	4	1.07* (0.04)	0.39* (0.02)		-1.05* (0.01)		

Notes:

Study Area

1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.
a "yes" if significant at least at the 10% level, "no" if not.
figures in parentheses are standard errors

Table 5-7: Chicken Elasticities by Study Area and Income Quartile

Study Area	Income Quartile	Total Expend	Price Chicken	Price Beef
1	1	0.64* (0.01)	-0.37* (0.01)	-1.42* (0.03)
	2	0.67* (0.01)	-0.44* (0.01)	-1.28* (0.02)
	3	0.65* (0.01)	-0.40* (0.01)	-1.38* (0.02)
	4	0.57* (0.01)	-0.26* (0.01)	-1.67* (0.03)
2	1	0.87* (0.01)	-0.78* (0.01)	0.24* (0.03)
	2	0.86* (0.01)	-0.75* (0.01)	0.26* (0.03)
	3	0.85* (0.01)	-0.75* (0.01)	0.27* (0.03)
	4	0.83* (0.01)	-0.71* (0.01)	0.31* (0.04)
3	1	0.76* (0.01)	-0.58* (0.01)	0.45* (0.05)
	2	0.78* (0.01)	-0.62* (0.01)	0.40* (0.05)
	3	0.74* (0.01)	-0.65* (0.01)	0.38* (0.04)
	4	0.74* (0.01)	-0.56* (0.01)	0.47* (0.06)
4	1	0.74* (0.01)	-0.56* (0.01)	-0.47* (0.01)
	2	0.68* (0.01)	-0.45* (0.01)	-0.59* (0.01)
	3	0.70* (0.01)	-0.49* (0.01)	-0.55* (0.01)
	4	0.52* (0.01)	-0.17* (0.01)	-0.89* (0.01)

Notes:

Study Area
1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.

Table 5-8: Beef Elasticities by Study Area and Income Quartile

Study Area	Income Quartile	Total Expend	Price Beef	Price Mutton
1	1	0.87* (0.08)	-1.35* (0.14)	0.25* (0.13)
	2	0.85* (0.10)	-1.40* (0.16)	0.29* (0.15)
	3	0.84* (0.10)	-1.42* (0.17)	0.30 (0.16)
	4	0.88* (0.07)	-1.31* (0.12)	0.23* (0.12)
2	1	0.87* (0.07)	-1.35* (0.14)	0.25 (0.13)
	2	0.89* (0.07)	-1.29* (0.12)	0.21 (0.11)
	3	0.84* (0.10)	-1.42* (0.17)	0.31 (0.16)
	4	0.86* (0.09)	-1.49* (0.20)	0.35 (0.19)
3	1	0.87* (0.08)	-1.35* (0.14)	0.26 (0.14)
	2	0.84* (0.10)	-1.42* (0.17)	0.30 (0.16)
	3	0.86* (0.09)	-1.37* (0.15)	0.27 (0.14)
	4	0.85* (0.09)	-1.39* (0.16)	0.28 (0.15)
4	1	0.89* (0.07)	-1.29* (0.12)	0.21 (0.11)
	2	0.91* (0.06)	-1.25* (0.10)	0.18 (0.10)
	3	0.89* (0.07)	-1.29* (0.12)	0.21 (0.11)
	4	0.87* (0.07)	-1.30* (0.12)	0.22* (0.11)

Notes:

Study Area

1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.

Table 5-9: Mutton Elasticities by Study Area and Income Quartile

Study Area	Income Quartile	Total Expend	Price Mutton	Price Chicken
1	1	1.14* (0.07)	-1.07* (0.01)	0.49* (0.02)
	2	1.15* (0.04)	-1.05* (0.01)	0.38* (0.02)
	3	1.04* (0.04)	-1.06* (0.01)	0.43* (0.02)
	4	0.89* (0.02)	-1.05* (0.01)	0.36* (0.02)
2	1	1.45* (0.07)	-1.07* (0.01)	0.48* (0.02)
	2	1.22* (0.04)	-1.04* (0.01)	0.31* (0.02)
	3	1.15* (0.03)	-1.04* (0.01)	0.28* (0.01)
	4	1.05* (0.03)	-1.04* (0.01)	0.28* (0.01)
3	1	1.38* (0.06)	-1.05* (0.01)	0.39* (0.02)
	2	1.27* (0.05)	-1.05* (0.01)	0.40* (0.02)
	3	1.14* (0.03)	-1.04* (0.01)	0.29* (0.01)
	4	1.04* (0.02)	-1.04* (0.01)	0.27* (0.01)
4	1	1.47* (0.09)	-1.09* (0.02)	0.66* (0.03)
	2	1.11* (0.03)	-1.04* (0.01)	0.32* (0.02)
	3	1.05* (0.04)	-1.06* (0.01)	0.42* (0.02)
	4	0.85* (0.23)	-1.06* (0.01)	0.41* (0.02)

Notes:

Study Area
1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.

Table 5-10: Sugar Elasticities

Product	Study Area	Total Expend	Price Sugar	Price Tea	Mill's Ratio Signif?	Info Accuracy
Sugar	1	0.19* (0.08)	-0.26 (0.40)		no	0.0012
	2	0.58* (0.04)	-0.62* (0.21)			
	3	0.70* (0.03)	-0.72* (0.15)			
	4	0.43* (0.06)	-0.48 (0.28)			

Notes:

Study Area
1 = urban Sidi Kacem
2 = rural Sidi Kacem
3 = Marrakech
4 = Casablanca

* indicates significant at least at the 5% level.
a "yes" if significant at least at the 10% level, "no" if not.
figures in parentheses are standard errors

Discussion

Inverse Mill's Ratio

The inverse Mill's ratio was significant in only two demand equations. The Mill's ratio was included, however, even when its coefficient was insignificant. Dropping the Mill's ratio substantially altered the estimates of the other coefficients in the equations, and in some cases made the coefficients unreasonable. The insignificance of the inverse Mill's ratio is probably due to correlation between the Mill's ratio and the other variables in the equations, since the Mill's ratio is itself a function of those variables. Since a large proportion of households reported zero consumption of most of the goods (see table 3-2), the censoring problem is probably more important than the multicollinearity that arises by including the inverse Mill's ratio.

Cereals

Soft Wheat

Soft wheat is a necessity in all four study areas but is least sensitive to changes in income in Casablanca (expenditure elasticity of 0.42). Casablanca has the highest total annual expenditure per capita of all four study areas and thus as income increases households may switch out of cereal consumption into the consumption of meats. The regional expenditure elasticities are inversely related to their respective income levels (see table 4-2). Casablanca has the highest total annual expenditure per capita and the lowest expenditure elasticity for soft wheat. Marrakech and rural Sidi Kacem have similar low total annual expenditure per capita and similar high expenditure elasticities.

Consumers in all four study areas are quite sensitive to the price of soft wheat (own price elasticities in all four study areas are greater than 1 in absolute value); households are the most sensitive in Casablanca and urban Sidi Kacem. Since these are both urban areas, households in these may be more sensitive to price changes since they may have access to more variety of foods in the markets. Both barley and hard wheat are substitutes for soft wheat, although this relationship was not captured in the equations for barley or hard wheat.

A breakdown of the elasticities by income quartile within each study area (table 5-2) shows that the wealthy households in all four areas are more sensitive to changes in soft wheat prices than are the poor. The difference between the own-price elasticity of the lowest income quartile and the highest is most pronounced in urban Sidi Kacem and Casablanca. The wealthy also have smaller income elasticities of demand for soft wheat than do the poor in all study areas. The response to income changes is almost the same among the poor and the wealthy.

Hard wheat

Hard wheat is a necessity in all four areas. It is also a normal good in all four areas, i.e., as the price goes up, consumption declines. But the elasticities vary not only by urban/rural breakdown but also by study area. Households in Casablanca have the highest expenditure elasticity; those in urban Sidi Kacem have the lowest.

What these figures do not capture, however, is how consumption changes within a study area by income. Table 4-8b shows that as income increases within the study areas, not only does per capita consumption of hard wheat increase, but the number of households consuming hard wheat also increases. Table 5-3 shows the breakdown of elasticities by income quartile within each study area. Households in all study areas except Marrakech become less sensitive to own-price changes as income increases.

Barley

Barley is an inferior good in Casablanca and urban Sidi Kacem but a necessity in the both rural areas. In rural Sidi Kacem, barley has an income elasticity of 0.13. The only area where barley is a strong necessity is Marrakech. Barley is the main cereal consumed in Marrakech, the study area with the highest per capita consumption and the highest percentage of the population reporting positive consumption of barley. Unlike the consumption of soft wheat, the consumption of barley is not clearly delineated by urban/rural distinction, but rather seems to be distinguished by particular area of the country.

Although barley is a normal good in rural Sidi Kacem and Marrakech, it is a Giffen good in urban Sidi Kacem and Casablanca. This is probably because the income effect is so strong (highly negative income elasticities in the urban areas) and the substitution effect is probably weak.

The breakdown of elasticities by income quartile within each zone (table 5-4) shows barley is an inferior group for the four income quartiles in all study areas except Marrakech, the second quartile in rural Sidi Kacem, and the fourth quartile in Sidi Kacem where the elasticities could not be calculated. This means that a subsidy on barley or an income enhancement will successfully increase the consumption of barley by the poor. Since barley is a necessity for all income quartiles in Marrakech and a normal good, a price decrease on barley would lead to increased consumption of barley by all income groups. Since Marrakech is the poorest study area in the subsample, this could be an effective targeting commodity.

The own-price elasticities of barley in urban Sidi Kacem and Casablanca indicate that barley is a Giffen good for all four income quartiles. This is highly suspect since Giffen goods are rare, especially for the low-income quartiles. These data should therefore be interpreted with caution.

Oils

Vegetable oil and olive oil are both necessities in all study areas; butter is a luxury in all study areas. It was not possible to estimate significant expenditure elasticities for olive oil in any study area, but households appear to be sensitive to the price of olive oil, with little variation by study area. Olive oil, vegetable oil, and butter were not found to be substitutes or complements.

The first stage (probit) of the Heckman model (table 5-11) for vegetable oil has some interesting implications. It suggests that the price of olive oil is an important determinant of whether or not a household consumes vegetable oil. The higher the price of olive oil, the more likely a household is to consume vegetable oil. But once a household has decided to consume vegetable oil, the price of olive oil is not a significant determinant of how much vegetable oil it consumes. This suggests that households would prefer to consume olive oil, but its price may be too high to be considered a substitute for vegetable oil.

Table 5-11: Probit Results from the First Stage of Heckman's Two Stage Procedure

Dependent Variable: Dummy variable: 1 if household consumed vegetable oil, 0 if not.		
Independent Variable	**Coefficient**	**Standard Error**
Constant	-3.04	1.35
Price of vegetable oil	0.26	0.47
Price of olive oil	1.33	0.37
Total expenditure	-0.11	0.11
Household size	0.44	0.13
Dummy - Casablanca	1.20	0.25
Dummy - rural Sidi Kacem	0.48	0.18
Dummy - urban Sidi Kacem	0.72	0.25

Meats

Chicken and beef are necessities in all four study areas; mutton is a luxury in all study areas. There is very little difference between the expenditure elasticities in the four study areas, confirming the hypothesis presented in chapter 4 that expenditure elasticities would not vary significantly by study area. Surprisingly, beef is a complement to chicken in the urban areas but a substitute in the rural areas. These relationships hold even when elasticities are calculated by income quartile in each zone (table 5-8). Beef and mutton are substitutes in all four study areas. Households in rural Sidi Kacem are more sensitive to the own price of chicken than households in other areas; chicken and beef are strong complements in urban Sidi Kacem.

Sugar

Sugar is a necessity in all four study areas. However, the expenditure elasticity varies significantly by study area. In urban Sidi Kacem, for example, the elasticity is only 0.19, while it is 0.70 in Marrakech. This is not surprising considering that households in Marrakech spend a larger percentage of their food budget on sugar than do households in other study areas. Households in Marrakech also have higher per capita consumption of sugar than households in all other study areas except Casablanca. The own-price elasticity also varies by study area with urban Sidi Kacem being the least sensitive to own-price changes (-0.26) and Marrakech being very sensitive (-0.72). Tea was not found to be a complement to sugar although sugar would probably have been a complement to tea.

Other Studies

The Groupe de Travail Pour l'Estimation des Elasticites de Demande des Produits Agro-Alimentaire (1990), undertook a study of food consumption in Morocco using the same data set used in this study. The study compared the results from a double-log specification of demand with those from a modified AIDS for the same commodities studied here. Although the estimated coefficients were not highly sensitive to the specification, the inverse Mill's ratio was not included in the final analyses. Given the large number of households that reported non-consumption of several goods (see table 3-2), it is critical to account for the resulting bias when the censored sample is used. Furthermore, although elasticities were calculated by urban/rural distinctions using the results from the double-log specification, the elasticities were not reported by specific area, nor were the elasticities by area reported for the AIDS.

The elasticities from the double-log specification by urban/rural breakdown are reported in table 5-12 through 5-15.

Table 5-12: Cereal Elasticities from Groupe de Travail (1990)

Product	Model	Total Expend	Price Soft Wheat	Price Barley	Price Hard Wheat
Hard Wheat	Double Log	.537			-1.004
	AIDS	.497			-.839
Soft Wheat	Double Log	.468	-1.535		.304
	AIDS	.530	-1.211		.188
Barley	Double Log	.372		-.861	
	AIDS	.574		-.705	

Table 5-13: Oil Elasticities from Groupe de Travail (1990)

Product	Model	Total Expend	Price Olive Oil	Price Vegetable Oil	Price Butter
Olive Oil	Double Log	.827	-.158	-1.078	.559
	AIDS	.685	-.642	-.643	.395
Vegetable Oil	Double Log	.475		-.935	
	AIDS	.303		-.900	
Butter	Double Log	.659			-.813
	AIDS	.618			-.862

Table 5-14: Meat Elasticities from Groupe de Travail (1990)

Product	Model	Total Expend	Price Beef	Price Mutton	Price Chicken
Beef	Double Log	.793	-1.410		
	AIDS	.863	-1.310		
Mutton	Double Log	.947		-.986	.312
	AIDS	.957		-1.006	.310
Chicken	Double Log	.641	-.436		-.532
	AIDS	.756	-.345		-.643

Table 5-15: Beverage Elasticities from Groupe de Travail (1990)

Product	Model	Total Expend	Price Tea	Price Coffee	Price Sugar	Price Milk
Tea	Double Log	.508	-.685	-.129	-.006	
	AIDS	.581	-.737	-.089	-.060	
Coffee	Double Log	.832	.227	-.665	-.778	
	AIDS	.732	.140	-.781	-.816	
Sugar	Double Log	.514	-.034		-.519	
	AIDS	.581	-.036		-.634	
Milk	Double Log	.952				-.752
	AIDS	.849				-1.231

The expenditure elasticities estimated in this thesis tend to be slightly higher than those estimated by the AIDS and double log specifications of the Groupe de Travail. This is probably due to the inclusion here of the inverse Mill's ratio. The estimates of the expenditure elasticities for barley in the Groupe de Travail models, however, seem to be an average of the estimates here, illustrating the importance of estimating elasticities by area; the Groupe de Travail estimates mask inter-regional differences in elasticities.

For chicken, mutton, and beef, the price elasticities estimated here are close to those of the Groupe de Travail. This is especially true for beef, where the price elasticities do not vary much by study area. The own-price elasticity for chicken in the Groupe de Travail models is roughly the average of those estimated here, again suggesting the importance of estimating elasticities by area. This is also true of the sugar own-price elasticity.

CHAPTER 6: CONCLUSIONS AND POLICY IMPLICATIONS

Policy Implications

The income and price elasticities presented in chapter 5 indicate that there are regional differences in how households respond to income and price changes. This implies that the effect of a uniform national food policy will vary by region.

Since barley is an inferior good in urban Sidi Kacem and Casablanca, it is suitable for self-targeting in these areas. It is also a Giffen good in these areas so the poorest of the poor should benefit if it is subsidized. A price subsidy will result in decreased barley consumption, even for the poor. But the consumption of other foods would presumably increase. Barley is a necessity in Marrakech and rural Sidi Kacem, although households in Marrakech are more income and price sensitive than those in rural Sidi Kacem. Since Marrakech and rural Sidi Kacem are poor areas, a subsidy on barley in these areas would benefit most households (especially in Marrakech where barley is heavily consumed) with negligible leakage to non-needy households.

Three caveats regarding a subsidy on barley are necessary. If a household is a net buyer of barley, that household will benefit from a subsidy on barley to the extent that the household has access to the subsidized barley. A net seller of barley, however, may be hurt from a subsidy on barley if the producer price is suppressed to keep the consumption price of barley low. Furthermore, many households acquire their barley from home production and do not currently participate in the barley market. A barley subsidy may then have little effect if the consumption price is not low enough or the producer price high enough to lure them into the market. In that case, barley marketing reform and/or a complimentary producer price policy may be necessary to bolster market activity.

Second, a subsidy on barley may induce livestock producers to use barley as animal feed, thus funneling the benefit of the subsidy to a non-target population.

Third, since barley is mostly nontradable, implementation of the subsidy is difficult.

A subsidy on hard wheat would also have distributional consequences by region. Households in Marrakech are the most sensitive to the price of hard wheat. Presumably, as the price declined with a subsidy, households in Marrakech would increase their consumption of hard wheat the most. Furthermore, even if hard wheat is subsidized, the subsidy will benefit wealthier households since they consume more hard wheat than do the poor, and the percentage of wealthy households that consume hard wheat is higher than the percentage of poor households that consume hard wheat. A subsidy on hard wheat will also leak more than does the subsidy on soft wheat because there is a larger increase in the consumption of hard wheat as incomes increase than the increase in soft wheat.

Soft wheat is a necessity in all four study areas, for all income quartiles. Furthermore, households in all four study areas and in all income quartiles are highly sensitive to the price of soft wheat. Although some benefits probably accrue to the higher-income households, these results, coupled with those from chapter 4 that show the importance of soft wheat to low-income households, suggest that the poor are probably benefiting from the subsidy on soft wheat. Although the cost of the subsidy program is high, it may be effective in reaching the poor. A further advantage of subsidizing soft wheat is that it is fairly easy to subsidize imports and thus lower domestic prices to consumers.

If the subsidy on soft wheat is removed, however, it should be removed gradually and replaced with a highly visible, better-targeted program. This could include a subsidy on barley, or a non-price food program such as supplemental feeding program or food-for-work. Morocco probably does not have the infrastructure to support a food stamp program, but the program type could vary by region depending on the infrastructure available.

Since income and price response does change for some commodities by study area and by income quartile, a regional analysis of the these responses using the whole sample should be undertaken. Target populations can then be easily identified and their responses to price and income changes anticipated.

Although the subsidies on vegetable oil and sugar are less costly and less contentious than the subsidy on soft wheat, some discussion of the effects of removing these subsidies is warranted. A large percentage of the population, even among the lower-income households, consume both sugar and vegetable oil. Sugar is an especially important budgetary item in Marrakech, where 10 percent of the household food budget is spent on sugar. Marrakech also has the highest own-price elasticity of sugar, so a change in the price of sugar will lead to the largest change in the consumption of sugar. The poor in Marrakech will probably be hurt the most if the sugar subsidy is removed.

The expenditure elasticity for olive oil is not significantly different from zero in urban Sidi Kacem and Casablanca. The own-price elasticity of olive oil is large in absolute value, so a subsidy on olive oil would lead to large increases in consumption of olive oil in all four areas. The results from the probit analysis in chapter 5 indicate that households may prefer olive oil to vegetable oil, but given the substantially higher price of olive oil, households are forced to consume vegetable oil.

Methodological Conclusions

Unit Values

As described in chapter 3, using unit values as proxies for prices in cross-sectional data analysis leads to several problems. The problems outlined by Deaton (1988b) are:

1) Consumers choose the quality of their purchases, and the unit values reflect this choice;

2) Quality choice may itself reflect the influence of prices, as consumers respond to price changes by altering both quantity and quality; and

3) Measured unit values are contaminated by errors of measurement in expenditures and in quantities and are likely to be spuriously negatively correlated with measured quantities.

The Groupe de Travail (1990) tested the importance of the "quality effect" by regressing unit values on per capita income, adult equivalent per person, and study area dummy variables. The results indicated the quality elasticity is not significantly different from zero in most cases.

To test whether there were any within-cluster effects of income on unit values, the same regression as above was run but with deviations from cluster means for the independent and dependent variables. This is a more detailed analysis than that of the Groupe de Travail. The results indicate no significant within-cluster effects of income on unit values.

From both of these tests, one can conclude that the quality effect described by Deaton is not significant and that unit values are safe to use as proxies for prices.

This analysis is fairly crude, however. The quality effect may be masked by the fact that all of the variables for all of the commodities are the result of aggregation. Soft wheat, for example, comprises soft wheat flour, bread made of soft wheat, and other products made of soft wheat, all converted to a "grain equivalent." The unit value is therefore an average unit value for grain products. But this unit value does not account for the cost of converting grain into the various products. The unit value is a function of not only the quality, but also of the aggregation process. The income effect on unit values may therefore be obscured.

Zero Consumption

The inverse Mill's ratio was included to account for the otherwise nonzero mean of the disturbance term that results when the sample is censored. Despite the large percentage of households reporting zero consumption of most of the goods (see table 3-2), the inverse Mill's ratio was significant in only two demand equations (hard wheat and butter). Although these are products for which less that 50 percent of households sampled reported positive consumption, the Mill's ratio was insignificant for other products with similar percentages of consuming households (mutton and olive oil, for example). The Mill's ratio was included, however, even when its coefficient was insignificant.

Dropping the Mill's ratio substantially altered the estimates of the other coefficients in the equations, and in some cases made the coefficients unreasonable. The insignificance of the inverse Mill's ratio is probably due to high correlation between the Mill's ratio and the other variables in the equations, since the Mill's ratio is itself a function of those variables. Since a large proportion of households reported zero consumption of most of the goods, the censoring problem is probably more important than the multicollinearity that arises by including the inverse Mill's ratio.

Model Specification

A functional form similar to that of the AIDS was used here to estimate demand parameters. It has the advantabe over the double log that interaction terms are not necessary to do a regional analysis. This can reduce significantly the number of coefficients to be estimated. The modifications were the following: 1) the expenditure term was not deflated by a price index, 2) the expenditure term itself represented expenditure on all goods rather than expenditure on the goods in the system, 3) unit values were used as proxies for price, and 4) the system was estimated equation by equation using OLS rather than as a complete system of demand equations. Several additional variables other than those specified by the AIDS were included in the model. These included a squared income term (when significant), regional dummy variables, interaction terms on the price and expenditure variables (when significant), the inverse Mill's ratio, and household size. The diversions of the model here from the AIDS make it difficult to justify the model based on the theoretical soundness of the AIDS. The AIDS was, however, the theoretical starting point for estimating the model in this way. The modifications made were ones to make the model more realistic and feasible. The addition of the squared income term, for example, allowed goods to be necessities for one group and luxuries or inferior for another, a distinction not possible with the AIDS. Barley was found to be a necessity for some groups and inferior for others. Although the theoretical soundness of the AIDS is not preserved, the modified linear AIDS can be considered an alternative functional form whose coefficients may be compared to those from other functional forms.

There are several advantages and disadvantages to the modified linear AIDS. One of the disadvantages is that since the elasticities are a function of the coefficients of the model, the estimation of the elasticities requires additional calculations. If the theoretical soundness of the AIDS is not preserved, it is not clear that the modified AIDS yields any benefits that warrant the cost of the extra calculations required.

The modified AIDS is, however, another functional form that can be used to estimate elasticities. These can then be compared to estimates from other specifications such as the double-log to test the robustness of the elasticities. This may be the major benefit of using the AIDS or a functional form similar to the AIDS, since it is difficutl to estimate slope dummies very well with the double log because there are so many variables.

GAUSS Program

Although the model can be estimated using any standard statistical package such as SAS or SPSS, it is more expedient to use a flexible program such as GAUSS. The additional calculations can be coded into the program to be updated automatically. Calculation of the elasticities by study area, by income quartile, by both, or by any other criterion is simple once the program has been written. Furthermore, the variance-covariance matrix of the coefficients needs to be adjusted when the Mill's ratio is included to account for the fact that the Mill's ratio is a predicted variable, not an observed one. This adjustment is not possible using SAS or SPSS but is easily coded into the GAUSS program. Further modifications or respecifications can be easily accomplished using the GAUSS program. GAUSS can also be used to estimate a nonlinear system in the case of imposing symmetry and homogeneity. It can be used to do maximum likelihood estimation instead of Heckman's two stage procedure. GAUSS is time consuming to learn, but powerful once mastered.

Regional Analysis

Accounting for regional differences in consumption patterns was accomplished by three means: 1) including regional dummy variables in the regression equations, 2) including regional interaction terms on price and income to allow the slope coefficients to vary by study area, and 3) estimating elasticities with study area budget shares.

The interaction terms were insignificant for all commodities except chicken and hard wheat. Regional dummy variables were significant in all equations. The major source of difference in elasticities between the study areas was the different budget shares in each study area.

The greatest difference in price and expenditure elasticities by study area was for barley, hard wheat, and sugar. If further analysis is done using the whole national sample, detailed regional analysis would be advised.

Further Research

The National Household Budget Survey of 1984/85 is a rich data set that provides many opportunities for further research. The following is a non-exhaustive list of exercises that could be done using either the subsample used here or the national sample.

The data could be used to estimate the tobit model using maximum likelihood estimation. The results could be compared to the those from the Heckman two-stage procedure to see how divergent the results are.

One could also estimate a true AIDS and compare the results with the modified version. Homogeneity and symmetry could be imposed and compared with a system without homogeneity and symmetry imposed. Estimating the AIDS would require calculating the price index and using non-linear estimation techniques on the system of demand equations. It would also require including the prices of all goods in the system in each equation, and recalculation of the budget shares and expenditure term. This exercise would best be done on the entire data set.

This analysis assumes that the coefficients of items such as shelter, education, and clothing that are not in the system are not significantly different from zero. It would be interesting to see how the results change if these consumption goods are included in the model.

This analysis has ignored the production or supply side of the economy. Since many households are producers of the products they consume, it would be more thorough to have an analysis of how producers would be affected by changes in food prices. The net effect on households could then be determined.

Deaton (1988a, 1988b) discusses the problems associated with using unit values as proxies for prices. He argues that the measurement problem is the most important problem resulting from using unit values as proxies for prices. Correction for the measurement error could be done following the methods employed by Laraki (1988).

The National Household Budget Survey of 1984/85 was sampled with a complex sampling design including both stratification and clustering. Yet the formulas used here to calculate the standard errors of the coefficients assumes simple random sampling. One could use a program such as PC CARP that accounts for the sampling design to see if it made any difference in the standard errors.

Finally, the elasticity estimates calculated here could be used to do a more formal welfare analysis of the subsidy programs. Compensating and equivalent variation could be calculated to see how much households would be willing to pay, or be compensated, for alternative programs.

APPENDIX 2-1: "ADDING-UP" RESTRICTION WRITTEN IN TERMS OF BUDGET SHARE AND ELASTICITY

The "adding-up" restriction implies that

$$\sum_k p_k q_k = x$$

Taking the derivative of this budget constraint with respect to x:

$$\sum p_k \frac{\delta q_k}{\delta x} = 1$$

Multiplying the left-hand side by

$$\frac{\frac{q_k}{q_k}}{\frac{x}{x}}$$

yields:

$$\sum p_k \frac{\frac{q_k \delta q_k}{q_k}}{\frac{x \delta x}{x}} = 1$$

since

$$\frac{\frac{\delta q_k}{q_k}}{\frac{\delta x}{x}} = \epsilon_k$$

we can see that:

$$\sum w_k \epsilon_k = 1$$

APPENDIX 3-1: OTHER DEMAND MODELS

The plethora of demand models available makes the choice of functional form an extremely difficult one for the researcher. Each functional form offers certain advantages over others, but all entail some restrictions. The discretion of the practitioner must be used in deciding which characteristics are most important. This section briefly outlines some commonly used models and highlights their advantages and disadvantages. While the list is in no way exhaustive, it may be useful as a sampling with which to compare the AIDS. The double logarithmic approach represents a single equation approach while the LES, the indirect translog and the Rotterdam models all generate complete systems of demand equations.

Double Logarithm

The double logarithm is a member of the single equation category and is usually expressed as:

$$\log q_i = \alpha_i + e_i \log x + \sum_{k=1}^{n} e_{ik} \log p_k \tag{5-13}$$

where e_i is the total expenditure elasticity and e_{ik} is the cross-price elasticity of the kth price on the ith demand.

Although the double logarithmic equation is easy to estimate and yields coefficients that are easy to interpret, it violates "adding-up," and testing symmetry is not possible. Furthermore, the justification for the choice of functional form is ad hoc. The double log specification can, however, be made more flexible by adding a quadratic income term and income price interaction terms.

Linear Expenditure System (LES)

The LES is a complete system of demand equations and is derived by maximizing a particular utility function subject to the budget constraint. The specific utility function is the Klein-Rubin utility function given by:

$$U=\sum_{i=1}^{n}\beta_i\log(q_i-\gamma_i) \tag{5-14}$$

where β_i and γ_i are parameters.

Maximization of this utility function subject to a budget constraint yields the following demand equation:

$$q_i=\gamma_i+\left(\frac{\beta_i}{p_i}\right)\left(y-\sum_{j=1}^{n}p_j\gamma_j\right) \tag{5-15}$$

Written in expenditure form, this becomes:

$$p_i q_i = p_i \gamma_i + \beta_i (y - \sum_{j=1}^{n} p_j \gamma_j) \qquad (5\text{-}16)$$

where:

p_i = price of commodity i,
q_i = quantity of commodity i,
γ_i = subsistence or committed quantities of commodity i,
y = total expenditure,
β_i = marginal share of the budget spent on commodity i.

The LES may be interpreted as follows: the γ_i are the minimum quantities of good i. Expenditure on the ith commodity thus consists of some minimum expenditure ($p_i\gamma_i$) after which the minimum expenditure on all other j goods ($\sum p_j\gamma_j$) is subtracted from total income. The remainder is spent on the ith good according to the marginal share of the budget spent on commodity i (the β_i's).

Because the model is derived from a direct utility function, all the classical restrictions on the demands will hold. Namely, they will satisfy "adding-up," "homogeneity," and "symmetry." Yet it must be noted that the choice of this particular utility function has several implications. No two goods may be complements, every good must be a substitute for every other good, and inferior goods cannot be modeled.

Indirect Translog

The indirect translog is obtained by specifying the indirect utility function and deriving the demand equations by applying Roy's Identity[21] The indirect translog is the second-order approximation to an arbitrary, twice differentiable indirect utility function.

This model is flexible and is consistent with demand theory. However, the derived demand equations are non-linear in their parameters and estimation requires sophisticated software. Furthermore, the number of unrestricted and unknown structural parameters is high and may pose estimation problems (Johnson, et al., 1984).

Rotterdam

The Rotterdam model is a flexible specification of demand equations based on the direct differentiation of the general form of Marshallian demand equations to which the results of utility theory are then applied.

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[21] Roy's Identity allows one to obtain the Marshallian demand functions from the indirect utility function by the following:

$$-\frac{\frac{\partial v}{\partial p_i}}{\frac{\partial v}{\partial x}}=q_i(x,p)$$

where:
v is the indirect utility function

One of the restrictive features of the Rotterdam model is that it implies that the income elasticities for necessities increase as the expenditure share decreases.

APPENDIX 3-2: TRANSFORMING THE AIDS COST FUNCTION INTO BUDGET SHARES

Shephard's Lemma states that, where they exist, the partial derivatives of the cost function with respect to prices are the Hicksian demand functions, that is:

$$\frac{\delta c(u,p)}{\delta p_i} = h_i(u,p) = q_i$$

multiplying both sides by

$$\frac{p_i}{c(u,p)}:$$

yields:

$$\frac{\frac{\delta c(u,p)}{c(u,p)}}{\frac{\delta p}{p_i}} = \frac{p_i q_i}{c(u,p)}$$

This may also be written as:

$$\frac{\delta \log c(u,p)}{\delta \log p_i} = w_i$$

Taking the derivative of the AIDS cost function in the text with respect to log p_i will yield w_i.

APPENDIX 3-3: CALCULATION OF EXPENDITURE AND PRICE ELASTICITIES

Expenditure Elasticities

The estimated equation for the AIDS without squared income term is:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(x) + \sigma \frac{\phi(x'\beta)}{\Phi(x'\beta)} + \pi_i \log CU + \delta_{i1} D_1 + \delta_{i2} D_2 + \delta_{i3} D_3$$

or

$$\frac{p_i \, q_i}{x} = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(x) + \sigma \frac{\phi(x'\beta)}{\Phi(x'\beta)} + \pi_i \log CU + \delta_{i1} D_1 + \delta_{i2} D_2 + \delta_{i3} D_3$$

taking the derivative with respect to x:

$$\frac{\delta\left(\frac{p_i q_i}{x}\right)}{\delta x} = \beta_i \frac{\delta x}{x}$$

$$\frac{p_i \; x \; \delta q_i \; - \; p_i \; q_i \; \delta x}{x^2} = \beta_i \frac{\delta x}{x}$$

$$\frac{p_i \; (x \; \delta q_i \; - \; q_i \; \delta x)}{x} = \beta_i \; \delta x$$

$$p_i\,\delta q_i - \frac{p_i\,q_i\,\delta x}{x} = \beta_i\,\delta x$$

$$p_i\,\delta q_i = \frac{p_i\,q_i\,\delta x}{x} + \beta_i\,\delta x$$

$$\frac{\delta q_i}{q_i} = \frac{\delta x}{x} + \frac{\beta_i\,\delta x}{p_i\,q_i}$$

$$\frac{\frac{\delta q_i}{q_i}}{\frac{\delta x}{x}} = 1 + \frac{\beta_i}{w_i}$$

The standard error of the expenditure elasticity without squared term:

$$S_{e_i} = \sqrt{var(\frac{\beta_i}{w_i} + 1)}$$

$$= \sqrt{var(\frac{\beta_i}{w_i}) + var(1) + 2cov(\frac{\beta_i}{w_i})(1)}$$

$$= \sqrt{var(\frac{\beta_i}{w_i})}$$

$$= \frac{S_{\beta_i}}{w_i}$$

The estimated equation for the AIDS with squared income term is:

$$\begin{aligned} w_i &= \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_{i1} \log(x) + \beta_{i2}[\log(x)]^2 + \sigma \frac{\phi(x'\beta)}{\Phi(x'\beta)} \\ &+ \pi_i \log CU + \sum_{z=1}^{3} \delta_{iz} D_z + \sum_j \sum_{z=1}^{3} \zeta_{iz} D_z \log p_j + \sum_{z=1}^{3} \tau_{iz} D_z \log x \end{aligned}$$

$$\begin{aligned} \frac{p_i q_i}{x} &= \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_{i1} \log(x) + \beta_{i2}[\log(x)]^2 + \sigma \frac{\phi(x'\beta)}{\Phi(x'\beta)} \\ &+ \pi_i \log CU + \sum_{z=1}^{3} \delta_{iz} D_z + \sum_j \sum_{z=1}^{3} \zeta_{iz} D_z \log p_j + \sum_{z=1}^{3} \tau_{iz} D_z \log x \end{aligned}$$

taking the derivative with respect to x:

$$\frac{\delta\left(\frac{p_i\, q_i}{x}\right)}{\delta x} = \beta_{i1}\, \frac{\delta x}{x} + 2\beta_{i2}\, (\log x)\, \frac{\delta x}{x}$$

$$\frac{p_i\, x\, \delta q_i - p_i\, q_i\, \delta x}{x^2} = \beta_i\, \frac{\delta x}{x} + 2\beta_{i2}\, (\log x)\, \frac{\delta x}{x}$$

$$\frac{p_i\, (x\, \delta q_i - q_i\, \delta x)}{x} = \beta_i\, \delta x + 2\beta_{i2}\, (\log x)\, \delta x$$

$$\frac{p_i\, x\, \delta q_i}{x} - \frac{p_i\, q_i\, \delta x}{x} = \beta_i\, \delta x + 2\beta_{i2}\, (\log x)\, \delta x$$

$$p_i\, \delta q_i = \frac{p_i\, q_i\, \delta x}{x} + \beta_i\, \delta x + 2\beta_{i2}\, (\log x)\, \delta x$$

$$\delta q_i = \frac{q_i\, \delta x}{x} + \frac{\beta_i\, \delta x}{p_i} + \frac{2\beta_{i2}\, (\log x)\, \delta x}{p_i}$$

$$\frac{\delta q_i}{q_i} = \frac{\delta x}{x} + \frac{\beta_i\, \delta x}{p_i\, q_i} + \frac{2\beta_{i2}\, (\log x)\, \delta x}{p_i\, q_i}$$

$$\frac{\frac{\delta q_i}{q_i}}{\frac{\delta x}{x}} = 1 + \beta_i \left(\frac{x}{p_i\, q_i}\right) + 2\beta_{i2}\, (\log x)\left(\frac{x}{p_i\, q_i}\right)$$

$$\frac{\frac{\delta q_i}{q_i}}{\frac{\delta x}{x}} = 1 + \frac{\beta_i}{w_i} + \frac{2\beta_{i2}}{w_i} \log x$$

The standard error of the expenditure elasticity with squared term:

$$S_{e_i} = \sqrt{var\left(\frac{\beta_i}{w_i}\right) + var\left(\frac{2\beta_{i2}}{w_i} \log x\right) + 2cov\left(\frac{\beta_i}{w_i}\right)\left(\frac{2\beta_{i2}}{w_i} \log x\right)}$$

$$= \sqrt{\frac{1}{w_i^2} var(\beta_i) + \frac{4}{w_i^2} (\log x)^2\, var(\beta_{i2}\,) + \frac{4 \log x}{w_i^2} cov(\beta_{i1}\,)(\beta_{i2}\,)}$$

$$= \frac{1}{w_i^2} \sqrt{var(\beta_i) + 4(\log x)^2\, var(\beta_{i2}\,) + 4 \log x\; cov(\beta_{i1}\,)(\beta_{i2}\,)}$$

Own- and Cross-Price Elasticities

The estimated equation for the modified AIDS when the income term is not deflatd by the price index is:

$$w_i=\alpha_i+\sum_j \gamma_{ij}\log p_j+\beta_i\log(x)+\sigma\frac{\phi(x'\beta)}{\Phi(x'\beta)}+\pi_i\log CU+\delta_{i1}D_1+\delta_{i2}D_2+\delta_{i3}D_3$$

$$\frac{p_i q_i}{x} = \alpha_i+\sum_j \gamma_{ij}\log p_j+\beta_i\log(x)+\sigma\frac{\phi(x'\beta)}{\Phi(x'\beta)}+\pi_i\log CU+\delta_{i1}D_1+\delta_{i2}D_2+\delta_{i3}D_3$$

$$\frac{\delta(\frac{p_i q_i}{x})}{\delta p_i} = \frac{\delta(.)}{\delta p_i}$$

$$\frac{1}{x}(p_i\delta q_i + q_i\delta p_i) = \gamma_{ii}\frac{\delta p_i}{p_i}$$

$$(p_i\delta q_i + q_i\delta p_i) = (\gamma_{ii}\frac{\delta p_i}{p_i})x$$

$$\frac{p_i\delta q_i}{\frac{\delta p_i}{p_i}} + q_i p_i = \gamma_{ii}x$$

$$\frac{\frac{p_i \delta q_i}{\delta p_i}}{p_i} = \gamma_{ij} x - q_i p_i$$

dividing both sides by $q_i p_i$:

$$\frac{\frac{\delta q_i}{q_i}}{\frac{\delta p_i}{p_i}} = \frac{\gamma_{ii}}{w_i} - 1$$

By similar calcuation, the cross-price elasticity is ϵ_{ij} :

$$\frac{\gamma_{ij}}{w_i}$$

The standard error of the own-price elasticity is:

$$\frac{1}{w_i}\sigma_{ii}$$

where σ_{ii} is the standard error of the own-price coefficient from the original equation.

The standard error of the cross-price elasticity is:

$$\frac{1}{w_i}\sigma_{ij}$$

where σ_{ij} is the standard error of the cross-price coefficient from the original equation.

APPENDIX 3-4: GROUPE DE TRAVAIL RESULTS

Table A3-4: Regressions of Unit Values

Unit Value	Log of Per Cap Expend.	Log of Household Size in Adult Equiv.	Dummy Var. CASA	Dummy Var SKR	Dummy Var. SKU
Hard Wheat	0.028 0.028	0.027 0.034	0.138* 0.053	-0.127* 0.060	-0.172* 0.045
Soft Wheat	0.006 0.023	-0.112* 0.027	0.301* 0.037	-0.152 0.050	-0.365* 0.034
Barley	0.039 0.025	-0.034 0.029	0.140* 0.035	0.201* 0.067	-0.059 0.066
Mutton	0.023* 0.012	0.008 0.014	-0.083* 0.018	-0.029 0.023	0.000 0.017
Beef	0.023 3.580	-0.008 0.011	-0.088* 0.015	-0.032 0.019	-0.014 0.015
Chicke n	0.041* 0.017	0.047* 0.020	-0.248* 0.028	-0.059 0.036	0.224* 0.025
Veg Oil	0.007 0.008	-0.010 0.009	-0.148* 0.013	-0.033 0.018	-0.026* 0.012
Olive Oil	0.012 0.012	-0.024 0.013	-0.073* 0.018	-0.099* 0.027	-0.102* 0.018
Butter	0.036* 0.018	0.003 0.022	-0.277* 0.028	-0.172* 0.037	0.021 0.029
Tea	0.048* 0.013	0.005 0.015	-0.045* 0.020	0.127* 0.028	0.020 0.018
Coffee	0.052* 0.016	0.046* 0.019	-0.187* 0.026	0.033 0.035	0.005 0.024
Sugar	0.021* 0.008	-0.011 0.010	-0.179* 0.013	-0.228* 0.019	-0.117* 0.012
Fresh Milk	-0.017 0.011	-0.010 0.012	-0.092* 0.029	0.063* 0.028	-0.172* 0.013

Note: Standard error is below coefficient.
CASA = Casablanca
SKR = rural Sidi Kacem
SKU = urban Sidi Kacem
* indicates significant at least at the 5% level.

APPENDIX 3-5: CLUSTERING AND STRATIFICATION

The simplest type of sampling is simple random sampling (SRS) in which every element in the population has an equal chance of being selected for inclusion in the sample. The sampling error of survey estimators reported in textbooks and calculated by computer programs are based on the assumption of simple random sampling (with replacement) of the population. Simple random sampling is rarely used in practice, however, usually due to its high costs of implementation. Sampling errors based on SRS may thus over- or understate the true sampling error, depending on the type of sampling used.

Two other types of commonly used sampling procedures are stratification and clustering.

Stratification

Stratification involves the classification of the population into subpopulations, or strata, based on supplementary information about the population. A sample is then drawn from each stratum. It is desirable that each stratum be internally homogeneous since only a portion of each stratum will be included in the sample.

The sample may be drawn by either proportionate sampling, in which the sample drawn is proportional to the size of the stratum, or disproportionate sampling, in which the sampling fraction varies across strata. Proportionate stratification generally yields estimators which are more precise than those from SRS because stratification ensures that the different strata in the population are accurately represented in the sample. Disproportionate sampling is used when some strata are much more variable than others. Higher-variability strata would be sampled at a higher rate to capture the diversity, while a smaller fraction of more homogeneous strata would suffice. The cost of sampling the different strata also influences the sampling rate; higher cost strata are sampled at a lower rate, lower cost strata at a higher rate. While proportionate sampling must lead to estimators which are no less precise than those from SRS, disproportionate sampling may or may not lead to more precise estimators. Standard errors based on proportionate sampling will tend to overestimate the standard error, while those based on disproportionate sampling may be over- or underestimated.

Clustering

Clustering involves the division of the population into groups from which a sample of groups will be drawn. All elements of a selected group will then be included in the sample. If the groups are further divided into smaller groups from which a selection is made, the process is called two-stage cluster sampling. Multi-stage cluster sampling involves the division into several layers.

Clustering is usually undertaken as a means of economizing on resources. If clusters are delineated geographically, for example, choosing a sample of clusters will require less geographic coverage by enumerators than would a SRS of the same size. However, clustering leads to a loss in precision compared to SRS. The loss of precision arises because clusters tend to miss whole groups of elements. If the population is the population of a state, for example, and the clusters are counties from which a selection of counties will be drawn, people living in the same county are more likely to be like each other than they are to be like people in the rest of the state. The more heterogeneous the population within the cluster, the less will be the loss of precision; the less heterogeneous the greater will be the loss of precision. In general, however, clustering tends to underestimate the standard error of the estimators.

When clusters are different sizes, if each cluster has the same probability of being drawn, the size of the final sample is largely dependent upon which clusters are drawn. If the cluster sizes are substantially different, this could result in a wide range of possible sample sizes. In order to reduce the variability in sample size, probability proportional to size (PPS) is often used in selecting clusters. The probability of choosing any one cluster is proportional to its size. Thus if one cluster is twice the size of another, the probability of choosing the former is twice that of choosing the latter.

Design Effect

The design effect is a measure of the divergence between the variance of an estimator based on a particular survey design to the variance of the estimator based on a SRS of the same size. The design effect of any estimator z is designated $D^2V(z)/V(z_0)$. A sample estimate of the design effect for z is designated $d^2(z)$. A design effect greater than one implies that the variance of the estimator is greater with the particular survey design than it would have been under SRS.

Most surveys employ a combination of both stratification and clustering, in which case the effect on the precision of the estimators is ambiguous since stratification leads to equal or more precision than SRS while clustering leads to less. However, Kalton (1983, p. 77) advises that empirical findings from sampling error computations that have been performed for estimates based on complex survey designs demonstrate that the loss of precision from clustering tends to outweigh the gains from proportionate stratification, so that complex sample design provides less precise estimators than an unrestricted sample of the same size; that is, the design effects are greater than 1. The use of sampling error formulae thus tend to overstate the precision of survey results based on complex survey design.

APPENDIX 3-6: SAMPLING METHODS USED FOR THE MOROCCAN DATA SET

Urban Areas

The primary sampling units for the urban areas (PSU-U) were defined as geographical zones delimited by natural borders, each containing 3-4 districts from the 1982 population census. Each PSU-U has an average of 600 households.

After stratification by type of dwelling (luxury, modern, new medina, medina, shantytown, douars, small center), a sample of 536 primary units was chosen by a PPS selection procedure.

Each urban primary unit chosen was divided into secondary sampling units (SSU-Us) with an average size of 50 households and having well defined boundaries. Each PSU-U had an average of 12 SSU-Us. Three SSU-Us were chosen from each PSU-U using PPS selection process.

A list of households in each secondary unit was established with the address of the household, first and last names of head of household, size of household, professional situation of head (working salaried, working non-salaried, unemployed having never worked, unemployed). The households lists were then stratified by profession of the head of household and size of household. Five households were chosen from each SSU-U following the principles of proportionate sampling.

Rural Areas

The primary sampling unit in the rural areas (PSU-R) is a zone formed by a number of douars[22] and has an average size of 1000 households. These units are based on the 1982 census. Stratification of the PSU-Rs was done using geographic and agro-economic criteria. 432 PSU-Rs were then selected using PPS.

Douars were chosen as secondary sampling units for the rural areas (SSU-R).

Three douars were chosen in each PSU with PPS. As in the urban areas, households in the chosen douars were listed with information on the first and last name of the head of household, the size of household, the first and last name of the eldest son or daughter, and profession of the head of household. After stratification of households of each douar of the sample according to the profession of the head of household and the size of household, five of households were chosen using a system of proportionate sampling.

In order to capture the effects of seasonal fluctuations on the structure of consumption, the data collected covered an entire year (each household was surveyed over a one week period) with the survey equally spread over the course of the year.

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[22] A douar is defined as a group of households connected by social factors (tribe, extended family, etc.) or economic factors (agriculture, sharing land worked on) and are under the authority of one person, the moqadem.

The entire survey consisted of 14,520 households in seven different economic regions. The analysis in this thesis uses a subsample of the original survey. The subsample contains approximately 1000 households in 3 provinces.

APPENDIX 4-1: UNIT VALUES

Table A4-1: Unit Values by Study Area[23]

Product	Urban Sidi Kacem	Rural Sidi Kacem	Marrakech	Casablanca
Mutton (DH/kg)	31.8 (1.4)	32.4 (1.8)	32.6 (3.6)	31.2 (7.1)
Beef (DH/kg)	41.8 (3.6)	41.8 (2.8)	42.5 (3.7)	40.7 (9.1)
Chicken (DH/kg)	23.6 (7.8)	31.3 (10.0)	24.3 (6.4)	19.5 (4.6)
Hard Wheat (DH/kg)	2.1 (0.9)	1.9 (0.9)	2.3 (0.9)	2.6 (0.9)
Soft Wheat (DH/kg)	1.9 (0.9)	1.4 (0.7)	2.1 (0.9)	2.7 (0.9)
Barley (DH/kg)	2.1 (0.3)	1.6 (0.5)	2.0 (0.9)	2.2 (0.7)
Vegetable Oil (DH/kg)	6.3 (0.4)	6.3 (0.4)	6.5 (0.5)	5.8 (1.3)
Olive Oil (DH/kg)	15.7 (1.8)	15.7 (3.2)	17.2 (1.6)	16.6 (3.9)
Butter (DH/kg)	23.9 (4.8)	28.8 (5.1)	28.1 (5.1)	22.1 (6.2)
Coffee (DH/kg)	41.4 (8.9)	39.2 (7.3)	38.7 (6.8)	35.7 (12.1)
Tea (DH/kg)	56.5 (9.8)	49.8 (9.9)	48.2 (7.3)	49.4 (13.6)
Fresh Milk (DH/litre)	3.3 (0.3)	2.6 (0.5)	3.1 (0.2)	2.8 (0.3)
Sugar (DH/kg)	3.5 (0.5)	3.8 (0.5)	4.2 (0.2)	3.7 (0.8)

Figures in parentheses are standard errors.

[23] Unit values are calculated by dividing expenditure on a commodity by the quantity consumed of that commodity.

APPENDIX 4-2: HOUSEHOLD SIZE BY STUDY AREA AND INCOME QUARTILE

Table A4-2: Households Size by Study Area and Income Quartile

Study Area	Income Quartile	Mean Number of Persons in Household
Urban Sidi Kacem	1	5.9 (2.2)
	2	5.0 (3.2)
	3	5.1 (2.3)
	4	4.0 (3.0)
Rural Sidi Kacem	1	8.1 (3.3)
	2	7.4 (3.6)
	3	6.8 (3.1)
	4	5.9 (4.3)
Marrakech	1	6.8 (2.7)
	2	6.9 (3.7)
	3	6.0 (3.0)
	4	4.6 (2.8)
Casablanca	1	7.1 (3.2)
	2	6.7 (3.3)
	3	5.6 (2.9)
	4	4.2 (2.7)

Note: Standard errors are in parentheses.

APPENDIX 4-3: CONVERSION FACTORS

Cereals

Soft Wheat:	grain	= 1.00
	bread	= 1.00
	flour	= 0.76
	semoule	= 0.68
	couscous	= 0.68
	pasta	= 1.00
Hard Wheat:	grain	= 1.00
	bread	= 1.00
	flour	= 0.79
	semoule	= 0.68
	couscous	= 0.68
Barley:	grain	= 1.00
	bread	= 1.00
	flour	= 0.79
	semoule	= 0.68
	couscous	= 0.68

Meat

Beef:	boned	= 1.00
	with bones	= 0.75
	minced	= 0.75
Chicken:	live	= 0.50
	not live	= 1.00
	roasted	= 1.00

APPENDIX 5-1: VARIANCE-COVARIANCE MATRIX WHEN MILL'S RATIO INCLUDED

Tobit model:

$$Y_i = \begin{cases} Y_i^* & if\ Y_i^* > 0 \\ 0 & otherwise \end{cases} \qquad Y_i^* = X_i'\beta + u_i\ ,\ u_i \sim N(0,\sigma^2)$$

$$\begin{aligned} E(Y_i \mid Y_i>0) &= X_i'\beta + \sigma\frac{\phi(X_i'\gamma)}{\Phi(X_i'\gamma)} \\ &= X_i'\beta + \sigma r_i \\ &= g_i'\theta \end{aligned}$$

where

$$\gamma = \frac{\beta}{\sigma}$$

$$r_i = \frac{\phi(X_i'\gamma}{\Phi(X_i'\gamma)}$$

$$g_i = \begin{bmatrix} X_i \\ r_i \end{bmatrix}$$

$$\theta = \begin{bmatrix} \beta \\ \sigma \end{bmatrix}$$

$$asyVar(\hat{\theta}_2sls) = \sigma^2 A$$

where

$$A = (G_1'G_1)^{-1} - (G_1'G_1)^{-1}G_1'[\Lambda_1 - \Lambda_1 X_1(X'\Omega X)^{-1}X_1'\Lambda_1]G_1(G_1'G_1)^{-1}$$

$$\Lambda_1 = \begin{bmatrix} 1-\lambda_1 & 0 & \cdots & 0 \\ 0 & 1-\lambda_2 & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & 1-\lambda_{N_1} \end{bmatrix}$$

$$\Omega = \begin{bmatrix} \gamma_1\gamma_1^* & 0 & \cdots & 0 \\ 0 & \gamma_2\gamma_2^* & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & \gamma_N\gamma_N^* \end{bmatrix}$$

$$let \lambda_i = 1 - r_i(X_i'\gamma) - r_i^2$$

$$G_1 = \begin{bmatrix} g_i' \\ \vdots \\ g_{N_1}' \end{bmatrix}$$

$$X = \begin{bmatrix} X_1 \\ X_0 \end{bmatrix} = \begin{bmatrix} x_1' \\ \vdots \\ x_{N_1}' \\ \vdots \\ x_N' \end{bmatrix}$$

$$\gamma_i^* = \frac{\phi(X_i'\gamma)}{1-\Phi(X_i'\gamma)}$$

$$N_1 = \#(Y_i > 0)$$
$$N_0 = \#(Y_i = 0)$$
$$N = N_1 + N_0$$

APPENDIX 5-2: PROBIT RESULTS FROM FIRST STAGE OF HECKMAN PROCEDURE

SOFT WHEAT

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.5480	0.0589
LZABT	-0.0286	0.0010
LZABD	0.0182	0.0012
LZAOR	0.0079	0.0017
LDPTP	-0.0905	0.0128
LDTPER2	0.0039	0.0007
LUNICON	-0.0082	0.0012
SIGMA	0.0088	0.0056

BARLEY

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.3058	0.0253
LZORGE	0.0134	0.0023
LDPTP	-0.0283	0.0015
LUNICON	-0.0131	0.0042
DUMCASA	-0.0264	0.0065
DUMSKR	-0.0332	0.0136
DUMSKU	-0.0303	0.0081
DUMXOR	0.0246	0.0119
SIGMA	-0.0257	0.0177

HARD WHEAT

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.6368	0.0200
LZABD	-0.0311	0.0053
LDPTP	-0.0625	0.0020
LUNICON	-0.0280	0.0027
DUMSKU	-0.2531	0.0227
DUMSKR	-0.0926	0.0210
DUMCASA	-0.3600	0.0198
DUMXBD	0.0267	0.0046
OWNPSKU	0.0447	0.0052
OWNPSKR	0.0579	0.0032
OWNPCASA	0.0479	0.0045
LDTPSKU	0.0269	0.0025
LDPTPSKR	0.0091	0.0026
LDPTPCASA	0.0399	0.0021
SIGMA	-0.0137	0.0065

VEGETABLE OIL

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.1116	0.0195
LZHLT	0.0057	0.0067
LDPTP	-0.0115	0.0009
LUNICON	-0.0108	0.0025
DUMCASA	0.0080	0.0051
DUMSKR	0.0146	0.0035
DUMSKU	0.0110	0.0037
SIGMA	0.0182	0.0181

OLIVE OIL

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.2878	0.1681
LZHLO	-0.0001	0.0056
LDPTP	-0.0220	0.0145
LUNICON	-0.0317	0.0158
DUMSKU	0.0210	0.0439
DUMSKR	0.0144	0.0218
DUMCASA	0.0206	0.0436
SIGMA	-0.0546	0.0560

BUTTER

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	-0.0606	0.0791
LZBR	0.0015	0.0024
LDPTP	0.0057	0.0070
LUNICON	0.0062	0.0071
DUMCASA	-0.0001	0.0058
DUMSKR	0.0040	0.0015
DUMSKU	-0.0009	0.0043
SIGMA	0.0306	0.0161

CHICKEN

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.0109	0.0049
LZPOUL	0.0175	0.0003
LZVNDB	0.0185	0.0022
LDPTP	-0.0101	0.0003
LUNICON	-0.0097	0.0004
DUMSKU	0.2099	0.0069
DUMSKR	0.0209	0.0005
DUMCASA	0.1364	0.0088
CP1SKU	-0.0582	0.0020
CP1CASA	-0.0372	0.0024
SIGMA	-0.0010	0.0013

BEEF

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.1280	0.0561
LZVNDB	-0.0183	0.0073
LZVNDM	0.0133	0.0070
LDPTP	-0.0069	0.0044
LUNICON	0.0022	0.0056
DUMCASA	0.0139	0.0067
DUMSKR	0.0011	0.0017
DUMSKU	0.0121	0.0052
SIGMA	-0.0144	0.0227

MUTTON

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	-0.4059	0.0478
LZVNDM	-0.0025	0.0004
LZPOUL	0.0183	0.0009
LDPTP	0.0964	0.0088
LDTPER2	-0.0055	0.0004
LUNICON	-0.0049	0.0008
DUMCASA	-0.0089	0.0017
DUMSKR	-0.0014	0.0013
DUMSKU	-0.0145	0.0020
SIGMA	0.0031	0.0032

SUGAR

PARAMETER	ESTIMATE	STANDARD ERROR
CONSTANT	0.1773	0.0185
LZSUCRE	0.0152	0.0083
LDPTP	-0.0167	0.0017
LUNICON	-0.0115	0.0026
DUMCASA	-0.0137	0.0027
DUMSKR	-0.0111	0.0029
DUMSKU	-0.0249	0.0035
SIGMA	0.0319	0.0295

LIST OF VARIABLES

CP1CASA	Interaction between LZPOUL and DUMCASA
CP1SKU	Interaction between LZPOUL and DUMSKU
DUMCASA	Dummy variable for Casablanca
DUMSKR	Dummy variable for rural Sidi Kacem
DUMSKU	Dummy variable for urban Sidi Kacem
DUMXBD	Dummy variable for own production of hard wheat
DUMXOR	Dummy variable for own production of barley
LDPTP	Per capita total expenditure
LDPTPCASA	Interaction between LDPTP and DUMCASA
LDPTPSKR	Interaction between LDPTP and DUMSKR
LDPTPSKU	Interaction between LDPTP and DUMSKU
LDTPER2	Per capita total expenditure squared
LUNICON	Log of number or adult equivalents
LZABT	Log of unit value for soft wheat
LZABD	Log of unit value for hard wheat
LZAOR	Log of unit value for barley
LZBR	Log of unit value for butter
LZHLO	Log of unit value for olive oil
LZHLT	Log of unit value for vegetable oil
LZPOUL	Log of unit value for chicken
LZSUCRE	Log of unit value for sugar
LZVNDB	Log of unit value for beef
LZVNDM	Log of unit value for mutton
OWNPCASA	Interaction between LZABD and DUMCASA
OWNPSKR	Interaction between LZABD and DUMSKR
OWNPSKU	Interaction between LZABD and DUMSKU
SIGMA	Coefficient on inverse Mill's ratio

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