PN-ACM-087

Factors affecting urban demand for live sheep: The case of Addis Ababa, Ethiopia

Socio-economics and Policy Research Working Paper 31

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ISBN 92–9146–089–3

Correct citation: Ehui S.K., Benin S. and Nega Gebreselassie. 2000. *Factors affecting urban demand for live sheep: The case of Addis Ababa, Ethiopia.* Socio-economics and Policy Research Working Paper 31. ILRI (International Livestock Research Institute), Nairobi, Kenya.32 pp.

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Acknowledgements

The authors would like to thank Mohammed Mussa for his valuable contributions during the survey, Yigezu Atnafe for help in data organisation, and Mohammad Jabbar and Steve Staal for their valuable comments on earlier drafts. Kindly address all correspondence to s.ehui@cgiar.org.

Abstract

As the share of small ruminant meat, especially sheep, in the demand and consumption of meat in general grows, information about consumer expenditure behaviour and demand parameters for live sheep will be valuable for several interest groups in the sheep industry. Using the Heckman two-stage approach, this study shows that sheep prices and household income, as well as socio-demographic factors, including household size and composition, significantly affect the likelihood of buying live sheep and expenditures on live sheep. Projections of live sheep demand and supply in Addis Ababa in 2010 and 2020 show that sheep producers in Addis Ababa alone will be able to meet up to only 27% of the demand.

1 Introduction

Small ruminant (sheep and goat) meat accounts for about 30% of total meat consumption in sub-Saharan Africa (SSA) and is an important marketable commodity. Between 1975 and 1995, total consumption of mutton and goat meat grew at an average annual rate of 2.42%.[1] This compares favourably with the annual growth rate of total meat (beef, pork, mutton, goat meat and poultry) consumption of 2.2% in SSA between 1982 and 1994 (Delgado et al. 1999).

As urbanisation, population and incomes increase, the demand for food of animal origin will rise and create markets for animal products and encourage commercialisation of agriculture. In SSA, the urban population grew at 5.0% a year between 1970 and 1995, a rate almost twice as fast as total (urban and rural) population growth (Delgado et al. 1999). Urban areas now account for nearly 30% of the population of SSA and by 2025, more than one-half of the population is expected to live in urban areas (Winrock 1992). Delgado et al. (1999) project for SSA that total meat consumption will grow at an annual rate of 3.5% between 1993 and 2020 and reach 12 million tonnes (11 kg per capita) in 2020. The role of small ruminants in meeting this demand cannot be overemphasised. For example, compared to other livestock, sheep and goats are fed very little grain, but they return more human food (meat and milk) per unit of human-edible feed consumed, because most of their feed is obtained from materials that cannot be used directly by humans (CAST 1999). In much of SSA, most of the household's consumption of mutton and goat meat, unlike beef and pork, is undertaken by first buying live animals and then slaughtering them at home for consumption. Thus, it is important to examine the factors that determine the demand for live animals. Knowing the effect of economic (price and income) and socio-demographic (e.g. household size and composition, degree of urbanisation, occupation and religion) factors on consumption demand, can guide producers and traders to target buyers.

The main objective of this paper is to determine the major economic and demographic factors that affect urban demand for live sheep in Ethiopia. Price and income elasticities obtained from this research may play a major role in policy analysis. SSA is the only region of the world where per capita food production and consumption has steadily declined over the past three decades and the chronic food deficit problem prevailing on the continent has prompted many nations to undertake policy reforms. Thus, a good information base for anticipating responses to the policy initiatives is needed. An important set of parameters that determine the outcome of changes in food and income transfer policies are consumer demand elasticities. The importance of a demand study also stems from the fact that consumption is the beginning of production (in the sense of being the driving point) and, therefore, knowledge of consumption patterns may be helpful in orienting production and research planning. Furthermore, given the dramatic changes in the economic and socio-demographic structure of the

1. Annual aggregate consumption of mutton and goat meat were estimated by adding up production and net trade figures for small ruminant meat that were obtained from various issues of FAO production (1978–1998) and trade (1978–1998) yearbooks.

population of SSA, a demand study would offer insight about future changes in consumer demand for small ruminants.

We focus on Ethiopia for two main reasons. Livestock production is a major activity in the country and contributes about 40% to agricultural gross domestic product (GDP) (Winrock 1992). Second, sheep contribute about 20% of all domestic meat consumption and are a major source of earnings through the sale of live animals and skins. On the farm, sheep rank second to cattle in their contribution to both subsistence and cash income generated from livestock production (Shapiro 1991); sheep also provide security in bad crop years. We focus on Addis Ababa because urbanisation is one of the major factors identified to increase the demand for meat (Delgado et al. 1999) as urban consumers, compared with their rural counterparts, have more diverse dietary patterns. Therefore, urban consumers are more likely to diversify their diet into meat in general and mutton in particular. Estimates of share of mutton that comes from live sheep purchases are not available. However, according to the data from this study the share of live sheep expenditure in total mutton expenditure is about 87%.

This paper presents a model of the household consumption expenditures on live sheep in Chapter 2, the survey design and data in Chapter 3, and the empirical analysis, results and policy implications in Chapter 4. The conclusions are found in Chapter 5.

2 Model specification

To date, the most widely used models in estimating the relationship between expenditure (or quantity) and income include the linear (Allen and Bowley 1935), double logarithmic (Schultz 1938; Wold and Jureen 1953; Stone 1954; Prais and Houthakker 1971), semi-log, log-reciprocal and hyperbolic (Goreux 1960; Prais and Houthakker 1971) forms. In SSA, a large number of the food demand studies are centred on the Engel relation (which describes the relation between quantity of a good purchased and income) between food expenditures and income. More recent studies, however, have used flexible functional forms such as the Almost Ideal Demand System (e.g. Savadogo and Brandt 1988). This paper uses a double logarithmic function as the hypothesised form of the expenditure function. The double logarithmic function is chosen because it provides a satisfactory description of the curvature found in most commodities (Prais and Houthakker 1971). In addition, it is more appropriate than other functions when the income range is narrow and consumption is expressed in terms of expenditure rather than quantity of the commodity in question (Goreux 1960). A major advantage of using expenditure rather than quantity is that we are able to capture the quality aspect of the product. Since quality and price vary directly higher income households would presumably purchase both larger quantity and better quality (higher priced) products than lower income households would. Hence, expenditures are more responsive than quantities to income changes. The double-logarithmic function is given by:

$$(1) \quad LnEXP_h = \alpha_h + \sum_j \beta_j LnP_j + \mu_h LnX_h$$

where EXP_h denotes household expenditure for live sheep by the *h*th household, P_j is the market price of the *j*th commodity, and X_h is the income level of the *h*th household. The parameter α represents the average value of the logarithm of expenditure in the absence of price and income effects. The parameters μ and β represent the effects on live sheep expenditures of a 1% change in income and prices of commodity *j*, respectively. The own price elasticity of demand implied by equation 1 is given by $\eta_p = \beta - 1$. This implies that if $0 < \beta_i \leq 1$, the demand for live sheep is price inelastic. A negative value of β_i indicates the demand for live sheep is price elastic. The larger the elasticity, the more responsive expenditure on live sheep is to changes in price. If $\beta_i > 1$, then $\eta_p > 0$. Consequently, live sheep would be considered a giffen good.[2] The income elasticity measures the percentage change in consumption expenditure due to a 1% change in household income. The income elasticity implied by equation 1 is given by $\eta_I = \mu$, since prices are held constant. The interpretation follows conventional demand theory.

Demographic factors also affect household expenditures on small ruminants. The notion is that consumers respond to changes in income and prices as well as demographic factors. Furthermore, households may not face the same prices and changes in demographic factors may cause price-like effects (Barten 1964). This is because socio-

2. A giffen good is an inferior good whose demand increases with an increase in its price. An inferior good is one whose demand decreases with an increase in income.

demographic characteristics capture expenditure shifts that are caused by life cycle, differences in tastes and preferences, and infrastructure of households. Household and individual characteristics, such as urbanisation, size, age and gender composition, marital status and occupation, are used here as proxies for tastes and preferences in the expenditure function. Household characteristics are incorporated into the model using demographic scaling. This implies replacing the market price P_j in equation 1 by scaled prices P_{jh}, where the scale is a function of household characteristics (see Ray 1980; Ray 1982; Savadogo and Brandt 1988). Setting $P_{jh} = K_{jh}(\theta) \cdot P_j$, and substituting P_{jh} for P_j in equation 1 gives:

$$(2)\quad LnEXP_h = \alpha_h + \sum_j \beta_j LnP_j + \sum_j \beta_j LnK_{jh}(\theta) + \mu_h LnX_h$$

where θ is the demographic profile of the household and $K_{jh}(\theta)$ is the scale function. Keeping K_{jh} as commodity dependent (as reflected by the subscript j), requires that equation 2 be solved as a set of simultaneous equations. Here we assume that the scale factor is commodity-independent. That is, $K_{jh}(\theta) = K_h(\theta)$. Therefore, equation 2 becomes:

$$(3)\quad LnEXP_h = \alpha_h + \sum_j \beta_j LnP_j + \delta LnK_h(\theta) + \mu_h LnX_h$$

where $\delta = \Sigma_j \beta_j$. Note that the demographic factors exert price-like effects on the expenditure function, since δ measures the effects of the scale factor. A common specification of $K(\theta)$ is a log-linear form of the type:

$$(4)\quad K = \prod_{r=1}^{R} \theta_{rh}\sigma_r$$

where θ_{rh} represents the level of household characteristics (or socio-demographic variables). Since some characteristics may take on zero values (e.g. binary variables) the log-equation 4 is modified as follows:

$$(5)\quad K = \prod_{r=1}^{R} \theta_{1r}\sigma_{1r} \prod_{s=1}^{S} e^{\sigma_{2s}\theta_{2s}}$$

where the first product on the right-hand side represents continuous variables and the second represents binary variables. Substituting equation 5 into equation 3 gives:

$$(6)\quad LnEXP_h = \alpha_h + \sum_j \beta_j LnP_j + \mu_h LnX_h + \sum_r \tau_{1rh} Ln\theta_{1rh} + \sum_s \tau_{2sh}\theta_{2sh}$$

where $\tau = \delta \cdot \sigma$ measures the expenditure elasticity of demographic variables for live sheep.

3 The data

3.1 Data collection

Household surveys, organised by the International Livestock Research Institute (ILRI), were conducted between May 1992 and August 1993 in Addis Ababa, Ethiopia. Two steps were followed in the sampling procedure. In the first stage, a subpopulation of 600 households was randomly selected from district *(kefitegna)* household listings that were obtained from the City Council of Addis Ababa. A one-page census questionnaire on demographic characteristics and income of households was designed to conduct a preliminary survey. When the household representative agreed to participate in the survey, he or she was asked to indicate the household's income interval and household size and composition by age and sex. Households that refused to participate in the survey and those that were not residences or were diplomatic houses were dropped from the second part of the survey. We believe that diplomats and other international personnel, as foreigners, display characteristics and consumption habits that are different from the rest of the population. Given that these expatriates constitute a relatively small fraction of the urban population, their exclusion will have little or no significant impact on the overall results. Thus, out of the 600 households, 422 (70.3%) remained for subsequent surveys.

In the second stage of the survey, the 422 households were stratified by monthly income level and 200 of them were randomly, but proportionately, selected. The income distribution in the first stage shows that households with a monthly income of less than 50 Ethiopian birr (EB) constitute 25% of the total households. The majority of the households (40.5%) lie in the income range of EB 51–200. Nearly 30% of the households fall within the range of EB 201–500, and only 6.0% of the households reported incomes more than EB 501 per month.[3]

A three-part structured and detailed survey was then administered to the 200 households. The survey included:

- A weekly household expenditure survey on food items including purchases of live and butchered sheep. The survey was filled out daily by a household member and was collected weekly.
- A monthly survey on prices of major food items in markets frequently used by the households.
- A one-time income and demographic characteristics survey.

Where none of the household members was able to do the daily recordings, the recall method was used. Next, the enumerators summarised the weekly household expenditure on food commodities.

The income and demographic surveys were conducted during the 60th week of the survey period. Realising the sensitive nature of this type of information, towards the end of the survey period was chosen for the income survey so that households would have

3. At the time of the survey US$ 1 ≈ EB 5.55.

gained confidence in us and consequently would provide us with reliable information. Data collected include household size and composition by age and sex and ethnic group, marital status, religion, number of years of residence in the city, occupation status, and education of the head of the household.

3.2 Problems with the survey and data

Initially, the plan was to conduct the survey for 12 months. However, due to logistical problems during the first few weeks of the survey, we extended the survey period by 12 weeks. Therefore, the survey was conducted for 64 successive weeks. During the first 7 weeks, some households dropped out of the sample for various reasons. For example, some of them were not willing to keep the daily records and were therefore replaced by others from the remaining 222 of the 422 subpopulation of households based on their income distribution. For this reason, the first 7 weeks of data were omitted from the analysis, and after deleting observations with missing data on relevant variables, 159 households remained for analysis.

Another problem is associated with incomes and expenditures. There was considerable divergence between the income and expenditure of some households to the extent that the actual food expenditure of 44% of the households exceeded their income declared. Given that household expenditure includes not only food items but also non-food items, current household expenditure may not truly reflect the current income of households, but it could be used as a proxy for permanent income. This is because households are likely to protect their consumption from short-term income fluctuations (Behrman and Deolalikar 1990). Current income, however, may bias the expenditure elasticity with respect to income.

3.3 Descriptive analysis

3.3.1 Socio-demographic factors

For analysis, the sample was stratified into three income groups to isolate the effects of income. The first group corresponds to the lowest category of the income distribution, which includes households with a monthly income of less than EB 201 (US$ 36), and is hereafter referred to as the 'low' income group. The middle and upper categories correspond to households with total monthly incomes between EB 201 and EB 500 (US$ 36–90) and more than EB 500 (US$ 90), respectively. These two groups are referred to as 'middle' and 'high' income group, respectively. About 46% of the households are in the low income range, while 30% and 24% are in the middle and high income ranges, respectively.

Table 1 shows demographic characteristics of households by income category. The average household size is 6.7 members and is made up of 1.7 children (less than 13 years old) and 4.9 adults (13 years or older). Household size varies positively with total monthly income. The cause–effect relationship is not apparent. Either households with

more members have more income earners, or higher income leads to better nutrition and health and, therefore, more adult children. These are both supported by the statistics in Table 1.

Table 1. *Demographic characteristics of households by income in Addis Ababa, Ethiopia, 1992–93.*

		Income category[1]		
	Total sample	Low	Middle	High
Household (number)				
Size	6.68	5.67	7.04	8.16
Children (less than 13 years)	1.75	1.59	1.90	1.87
Adults (13 years or older)	4.93	4.08	5.15	6.29
Income earners	1.53	1.15	1.63	2.13
Household head				
Religion (% Orthodox Christian)	89	90	85	89
Married (%)	64	48	83	71
Gender (% male)	64	47	81	74
Employed (%)	62	56	60	76
Education (number of school years)	5.22	3.32	6.15	7.71
Years resident in Addis Ababa	29.81	28.68	29.50	32.34
N (households)	159	73	48	38

1. Low refers to households with monthly income less than EB 201; middle refers to households with monthly income between EB 201 and EB 500; and high refers to households with monthly income greater than EB 500 (US$ 1 ≈ EB 5.55 between May 1992 and August 1993).

Religious affiliation of the head of the household shows the predominance of the Orthodox Christians. Most of the total sampled household heads are Orthodox Christians. Muslims, Protestants, Catholics and others make up 11% of represented religions. About two-thirds of the household heads are married, with a relatively higher representation in the middle income group (83%). Households headed by females are dominant in the low income group (53%), compared with only 19% and 26% in the middle and high income categories, respectively. Not surprisingly, the highest employment rate is observed in the high income category and the lowest in the low income category. The average number of school years attended is 5.22. Generally, the data show a positive correlation between education level and income categories. The illiterate group of household heads are more represented in the low income group while household heads with the highest average number of school years are in the high income category.

3.3.2 Household expenditures

The distribution of expenditure on aggregated food items by income group is given in Table 2. While all households spent a big chunk of their expenditures on cereals, those in the low income group spent the most, followed by those in the middle and high income groups. The opposite pattern is observed for expenditure on meat, suggesting

that meat is a luxury commodity. About 21% of the total expenditure in the high income group was spent on meat, while the middle and low income groups spent 12% and 8%, respectively. Most of the households bought beef and chicken, with most of the purchases being undertaken by high income households followed by middle and then low income households. All the high income households bought beef. The high shares of beef and chicken in total meat expenditure show the preference of households for these types of meat (Table 2). In Ethiopia, fish and mutton are more of ceremonial foods, with fish being eaten mainly during fasting periods and mutton during festivals (e.g. Ethiopian New Year and Easter, and Ramadan). On average most of the meat budget was spent on beef, followed by chicken and mutton. Purchases of goat meat and pork were negligible. Only two house- holds in the entire sample are reported to have bought goat meat and pork. This is probably because both Muslims and Orthodox Christians in Ethiopia do not eat pork for religious reasons. The low number of house- holds that bought goat meat is probably because goat, like sheep, is bought live for slaughter and so is rarely sold by butchers in Ethiopia. Furthermore, goat is more prevalent in the lowland areas and more likely to be consumed there than in highland areas such as Addis Ababa.

Table 2. *Percentage distribution of annual household expenditure on food items by income category in Addis Ababa, Ethiopia, 1992–93.*

		Income category[1]		
Food item	Total sample	Low	Middle	High
All foods	100.00	100.00	100.00	100.00
Cereal	41.35	45.29	42.05	32.90
Meat	12.43	8.12	12.08	21.12
Other food	46.22	46.59	45.87	45.98
N (households)	159	73	48	38
Meat	100.00	100.00	100.00	100.00
Beef	55.22	56.67	54.74	53.14
Chicken	25.73	32.87	25.67	12.84
Sheep meat (live)	15.67	7.77	16.89	28.57
Mutton (butchered)	2.40	1.19	2.21	4.80
Other (pork and goat meat)	0.98	1.50	0.49	0.65
N (households)	159	73	48	38
Sheep meat	100.00	100.00	100.00	100.00
Live	86.97	89.84	82.94	88.99
Butchered	13.03	10.16	17.06	11.01
N (households)	65	12	22	31

1. Low refers to households with monthly income less than EB 201; middle refers to households with monthly income between EB 201 and EB 500; and high refers to households with monthly income greater than EB 500 (US$ 1 ≈ EB 5.55 between May 1992 and August 1993).

Table 3 shows that annual patterns of per capita expenditure and per capita kilogram purchases of different types of meat follow the income categories of the households. On average the per capita kilograms of beef and mutton bought were 2.9 and 2, respectively. These amounts are lower for beef but higher for sheep meat than the average in developing countries in 1993, which were 5 and 1 kg per capita for beef and mutton eaten, respectively (Delgado et al. 1999). Note that meat purchases do not necessarily equal meat consumption, as especially meat bought during festivals may be eaten with people from outside the household. Estimates of per capita kilograms of chicken, goat meat and pork purchases could not be calculated since there was no information on prices per kilogram paid by households.

Table 3. *Annual per capita expenditure and kilogram purchases of meat by income category in Addis Ababa, Ethiopia, 1992–93.*

		Income category[1]		
Item	Total sample	Low	Middle	High
Per capita expenditure (EB)				
Beef	38.76	17.47	34.93	71.37
Chicken	9.36	5.83	9.24	14.22
Sheep meat (live)	20.51	4.56	17.35	45.26
Mutton (butchered)	4.08	0.75	2.02	10.77
Other (pork and goat meat)	0.44	0.01	0.25	1.24
Per capita kilogram purchases[2]				
Beef	2.91	1.27	2.50	5.46
Sheep meat (live)[3]	1.66	0.44	1.40	3.58
Mutton (butchered)	0.35	0.06	0.17	0.43

Per capita estimates are for all households and members.

1. Low refers to households with monthly income less than EB 201; middle refers to households with monthly income between EB 201 and EB 500; and high refers to households with monthly income greater than EB 500 (US$ 1 ≈ EB 5.55 between May 1992 and August 1993).
2. Per capita kilogram purchases of chicken, goat meat and pork could not be calculated as information on prices per kilogram paid was not available.
3. Carcass weight is estimated at 48% of the live weight. This information was obtained at the Addis Ababa abattoir.

3.3.3 Household expenditures on live sheep

For the 159 households, the pattern in the number of sheep bought is consistent with their income categories. Households in the middle and high income categories bought 25% and 62.5% of the total number of sheep, respectively, while low income category households bought only 12.5% of the total 120 sheep. Most of the live sheep, about 38% and 32%, were bought during the first (August–October) and fourth (May–July) quarters of the survey, respectively (Table 4). Some of the most popular holidays in Ethiopia in 1992/93 were celebrated in these two periods: Ethiopian New Year on 11 September 1992, Meskel on 27 September 1992, and Id al Adaha on 31 May 1993. The third quarter (February–April), within which Ramadan and Id al Fitr (24 March 1993) and Ethiopian

Easter (18 April 1993) fell, attracted 18% of the total live sheep purchases. Although these two holidays are celebrated widely, the low purchases may be because about 2 months before the actual holidays are marked by fasting. During this period, less food is eaten in general, while meat and dairy products in particular are not eaten by most Orthodox Christians. The period of Christmas (November–January) attracted the least (12%) purchases. The quarterly trend of purchases was the same for all income groups.

Table 4. *Number of live sheep bought and prices paid by income category in Addis Ababa, Ethiopia, 1992–93.*

		Income category[1]		
	Total sample	Low	Middle	High
Number of households buying	59	11	18	30
% of total households in income category	37.1	15.1	37.5 5	79
Total number of sheep bought	120	15	30	75
August–October	45	6	14	25
November–January	14	1	1	12
February–April	22	2	7	13
May–July	39	6	8	25
Prices paid per animal (EB)	129.11	113.28	122.61	139.85
August–October	128.53	93.50	144.00	128.95
November–January	109.55	70.00	85.00	120.24
February–April	132.06	122.50	131.00	134.72
May–July	150.12	140.33	131.88	158.63

1. Low refers to households with monthly income less than EB 201; middle refers to households with monthly income between EB 201 and EB 500; and high refers to households with monthly income greater than EB 500 (US$ 1 ≈ EB 5.55 between May 1992 and August 1993).

Out of the 159 households, 41% bought either live sheep or mutton or both. Among these households, the share of live sheep in total sheep meat purchases was 87% (Table 2), suggesting that mutton is mainly eaten after buying the live animal from the market and slaughtering it at home. In fact, only 24 (15%) households purchased mutton, with only 6 of them not purchasing any live sheep.

Table 4 shows that, on average, low income households paid 7% and 19% less for one live sheep than their middle and high income counterparts, respectively. This may be because low income households bought smaller animals (averaging 6–8% difference in live weight) than those bought by higher income households. On the whole, the highest prices were paid in the fourth quarter, followed by the third, first and second quarters of the survey. Similar to prices of most items in the open market in SSA, agreement on live sheep prices is reached by a one-on-one bargaining between seller and buyer.

4 Estimation and results

Household expenditure on live sheep as modelled here is observed only after the decision to buy sheep has been made. We therefore do not observe sheep expenditures for households that do not buy sheep. In this instance, if only non-zero expenditure observations are used in parameter estimation of equation 6, ordinary least squares (OLS) estimators would yield biased and inconsistent estimates due to sample selection bias (Heckman 1979; Maddala 1983; Greene 1993). Furthermore, the information about non-purchasers is equally important from a policy perspective. Thus, we are interested in factors that determine both urban live sheep purchases and those that affect the lack of purchase by households.

Heckman's two-step estimation procedure (Heckman 1979) is used here.[4] In the first step, a probit analysis over the entire sample (including both purchasers and non-purchasers of sheep) is used to estimate a participation equation. The results of this estimation are then used to calculate an 'inverse mills ratio' (IMR), which is used in a second OLS estimation of household live sheep expenditures, using the truncated data of non-zero live sheep expenditures. The IMR, which is defined as the ratio of the value of the standard normal density function to the value of the cumulated normal distribution function at a given point, links the participation and expenditure decisions steps. If the estimated parameter associated with the IMR is statistically significant, then sample selection bias is present and inferences about live sheep expenditures of the population cannot be made using the truncated data.

4.1 The empirical model

The model that is used to analyse consumer expenditure, as specified by equation 6, is estimated by:

$$(7) \qquad LnEXP_h = \alpha + \gamma_t + \sum_j \beta_j LnP_{jh} + \mu_h LnX_h + \sum_r \tau_{1rh} Ln\theta_{1rh} + \sum_s \tau_{2sh}\theta_{2sh} + \eta\lambda_h + \varepsilon_{ht}$$

where $\lambda_h = \dfrac{\phi(X_h, \theta_h; \kappa)}{\Phi(X_h, \theta_h; \kappa)}$.

Equation 7 is a fixed-effect model with a time-specific (quarter) dummy variable represented by γ_t, where $t = 1, 2, 3$, λ is the IMR obtained from the first stage probit estimation for households that bought live sheep; ϕ and Φ are the density and cumulative functions of the probability of buying live sheep, respectively. *EXP*, *P*, X and θ, as

4. Other models, such as the Tobit model, restrict the effects on the dependent variable to be the same for both the participation and expenditure decisions, while the double-hurdle model is more appropriate for short time periods to remove the effects of purchase infrequency.

defined previously, are expenditures on live sheep, prices, income, and socio-demographic variables, respectively. In the first stage probit, the dependent variable is equal to one if the household bought sheep and zero otherwise. The independent variables are income, size and age and income-earning composition of the household, years of residence in Addis Ababa, marital status, gender and employment status of the household head, and a dummy for the quarter in which the decision on whether or not to buy live sheep is made. In the second-stage, t varies across households, since some households did not buy sheep in certain quarters and so we have an unbalanced panel. The estimates are still unbiased and consistent despite the unbalanced panel (see Greene 1993). The error term, ε_{ht}, which represents unobservable random variables, is assumed to be independently distributed over the sample. The parameters to be estimated are κ in the first stage and α, γ, β, μ, and η in the second stage. The data were organised by quarter to yield a panel data of 636 observations (159 households). As with all panel data, the disturbance term of the second stage estimator is potentially heteroscedastic and autocorrelated. This means that ignoring these two problems, if they exist, results in inconsistent and inefficient estimates. Thus, hypothesis will lead to misleading inferences about the parameter estimates. The Goldfeld–Quandt and Durbin–Watson tests are used to test for heteroscedasticity and autocorrelation, respectively, in the error term, under the null hypothesis of homoscedatic and non-autocorrelated error term.[5] Even in the absence of the above problems, the standard error of the second stage is biased, as the IMR that is used in the second stage is estimated from the first stage probit (Maddala 1983). This bias can be corrected by using the asymptotic covariance matrix of the probit coefficients as weights to estimate unbiased standard errors of the OLS coefficients (see Maddala 1983 for details on how to estimate unbiased standard errors).

Table 5 describes the variables used in the estimation. Prices and income represent our economic variables that are hypothesised to influence household live sheep expenditures. We expect the income elasticity to be positive, since live sheep is a normal good. We also expect positive elasticities for the prices of other types of meat, as they are substitutes for sheep meat. Here, beef is used to represent other types of meat, as beef is the most commonly consumed of all types of meat, including mutton. The own-price elasticity is ambiguous. By our specification in equation 7, if β_j (i.e. the coefficient with respect to the logarithm of the price of live sheep) is negative, then the demand for live sheep is elastic; if it is positive but less than one, then the demand is inelastic; otherwise, it will be considered a giffen good.

The socio-demographic variables account for differences in household taste and preference. We expect positive effects with respect to family size, proportion of income earners, employment and quarters in which popular religious celebrations occur (August to October and May to July). Proportion of children, however, is expected to have a negative effect, as children tend to influence expenditures towards other foods such as milk (Hassan and Babu 1991).

5. We failed to reject both hypotheses of homoscedasticity and no autocorrelation in the error term.

Table 5. *Description of explanatory variables.*

Variable	Description
Log sheep price	Logarithm of average price of live sheep paid by the household per quarter
Log beef price	Logarithm of average price/kg of beef paid by the household per quarter
Log quarterly income	Logarithm of household quarterly income
Low income	Dummy variable equal to one if household monthly income is less than EB 201 and zero otherwise
Middle income	Dummy variable equal to one if household monthly income is between EB 201 and EB 500 and zero otherwise
High income	Dummy variable equal to one if household monthly income is greater than EB 500 and zero otherwise
Log annual food expenditure	Logarithm of annual food expenditure
Low expenditure	Dummy variable equal to one if household quarterly total expenditure is less than EB 501 and zero otherwise
Middle expenditure	Dummy variable equal to one if household quarterly total expenditure lies between EB 501 and EB 1000 and zero otherwise
High expenditure	Dummy variable equal to one if household quarterly total expenditure is greater than EB 1000 and zero otherwise
Log family size	Logarithm of household size
Proportion of income earners	Ratio of number of income earners to household size
Dependency ratio	Ratio of number of children less than 13 years to household size
Log residence	Logarithm of number of years of residence in Addis Ababa of the household head
Employment	Dummy variable equal to one if household head is employed and zero otherwise
Married	Dummy variable equal to one if household head is married and zero otherwise
Quarter 1	Dummy variable equal to one if sheep was purchased between August and October and zero otherwise
Quarter 2	Dummy variable equal to one if sheep was purchased between November and January and zero otherwise
Quarter 3	Dummy variable equal to one if sheep was purchased between February and April and zero otherwise
Quarter 4	Dummy variable equal to one if sheep was purchased between May and July and zero otherwise
IMR	Inverse mills ratio obtained from first stage probit estimation of probability that the household purchases sheep

4.2 Results

In each stage of the estimation, we used four models based on the specification of income, given our expectation that current income may not truly reflect the expenditure patterns of households. Therefore, in addition to quarterly income (Model I), we use as an instrument, annual food expenditures (Model III), and then dummy variables for income groups (Model II) and expenditure groups (Model IV).[6] Since food forms a large proportion of total expenditure, we believe that food expenditure is a good instrument for total expenditures. Note that even though reported incomes and expenditures differ, we still use income for comparative analysis. Furthermore, expenditures are also subject to measurement errors, and there was no significant difference between income and expenditure groups.

4.2.1 To buy or not to buy live sheep?

Table 6 shows probit estimates (coefficients and asymptotic t-ratios) of the probability that the household buys live sheep in a particular quarter. The magnitudes of the coefficients do not reflect marginal effects. However, their signs indicate the directional effects. The overall model statistics (Maddala R^2, Likelihood Ratio Test and percentage of correct predictions) indicate a good fit of the model. Furthermore, most of the variables have the expected signs and are statistically significant at the 1% level of significance. Increase in income, family size and employment increase the probability of buying live sheep. The two lower income and expenditure groups are significantly less likely to buy live sheep than their respective upper group. The dependency ratio, as expected, reduces the likelihood of buying live sheep. This supports the hypothesis that children tend to influence expenditure towards other foods such as cereals and milk. Households are more likely to buy live sheep in the quarter with a significant holiday, such as Ethiopian New Year and Meskel in September and Ethiopian Easter in May. Marital status of the household head and proportion of income earners have the expected positive signs, but they are not statistically significant. Proportion of income earners is significant in Model I only. Similarly, number of years of residence in Addis Ababa has the expected positive sign, but it is not statistically significant. It may be that whether one lives in an urban or rural area may be a better measure to capture the effects of urbanisation than years of residence in an urban area is. However, since all households in this survey are in Addis Ababa, we are unable to use and test the former variable.

6. For the income groups, we use low income = 1 if household monthly income is less than EB 201 and 0 otherwise; middle income = 1 if household monthly income is between EB 201 and EB 500 and 0 otherwise; and high income = 1 if household monthly income is greater than EB 500 and 0 otherwise. For the expenditure groups, low expenditure = 1 if household quarterly total expenditure is less than EB 501 and 0 otherwise; middle expenditure = 1 if household quarterly total expenditure is between EB 501 and EB 1000 and 0 otherwise; and high expenditure = 1 if household quarterly total expenditure is greater than EB 1000 and 0 otherwise. In each of these models, one group is omitted to avoid the dummy variable trap and the omitted group is treated as the base case.

Table 6. *Probit estimates of the probability of household purchases of live sheep in a paticular quarter in Addis Ababa, Ethiopia, 1992–93.*

	Model			
Variable[1]	I	II	III	IV
Constant	-7.3871***	-0.5300	-10.346***	-1.6986***
	(7.9007)	(0.7216)	(8.7094)	(2.5933)
Log quarterly income	0.7653***			
	(6.3668)			
Low income group		-1.2506***		
		(6.1679)		
Middle income group		-0.7456***		
		(4.2775)		
Log annual food expenditure			1.0479***	
			(7.4097)	
Low expenditure group				-1.4816***
				(6.7119)
Middle expenditure group				-0.5928***
				(3.5690)
Log family size	0.4831**	0.3534*	0.2300	0.4346**
	(2.3990)	(1.6679)	(1.4265)	(2.1208)
Proportion of income earners	0.9871*	0.0550	0.6067	0.8731
	(1.8907)	(0.0928)	(1.2089)	(1.5627)
Dependency ratio	-0.8283**	-0.9235***	-0.6854*	-0.7750**
	(2.1570)	(2.4448)	(1.7410)	(2.0186)
Log years of residence in Addis Ababa	0.0762	-0.0323	0.0920	0.0997
	(0.6233)	(0.2619)	(0.7509)	(0.7987)
Employment (1 = employed; 0 = not employed)	0.2699*	-0.0316	0.2720*	0.2522*
	(1.7577)	(0.2016)	(1.7219)	(1.6462)
Married (1 = married; 0 = not married)	0.1755	0.1613	0.1566	0.1884
	(1.0918)	(0.9780)	(0.9502)	(1.1601)
	0.4274***	0.1438	0.1387	0.4515***
Quarter 1 (1 if August–October; 0 otherwise)	(2.4037)	(0.8492)	(0.7889)	(2.5058)
	-1.0040***	-1.0152***	-1.0449***	-0.9950***
Quarter 2 (1 if November–January; 0 otherwise)	(4.3872)	(4.4765)	(4.5313)	(4.3225)
	-0.4329***	-0.4615***	-0.4962***	-0.4662***
Quarter 3 (1 if February–April; 0 otherwise)	(2.2843)	(2.4562)	(-2.5627)	(-2.4401)
Maddala R^2	0.1831	0.1751	0.2101	0.1885
Likelihood ratio test	128.66***	122.43**	150.02***	132.82***
% of correct predictions	84.75	84.91	86.79	85.38

Absolute t-statistics are in parentheses.

* = significant at 10%; ** = significant at 5%; *** = significant at 1%.

1. Low income group = 1 if household monthly income is less than EB 201 and 0 otherwise; middle income group = 1 if household monthly income is between EB 201 and EB 500 and 0 otherwise; high income group, with monthly income greater than EB 500, is the base. Low expenditure group = 1 if household quarterly total expenditure is less than EB 501 and 0 otherwise; middle expenditure group = 1 if household quarterly total expenditure lies between EB 501 and EB 1000 and 0 otherwise; and high expenditure group, with household quarterly total expenditure greater than EB 1000, is the base (US$ 1 ≈ EB 5.55 between May 1992 and August 1993). Quarter 4 (May–July) is the base for the quarterly dummies.

4.2.2 Expenditures on live sheep

Table 7 shows second stage OLS estimates for household expenditures on live sheep. In this stage, middle and low income and expenditure groups and the second (November–January) and third (February–April) quarters are combined as one, due to lack of variability in the data set for these variables. The resulting combined dummy variables are treated as the base case in the analyses. The statistically insignificant coefficient associated with the inverse mills ratio suggests that there is no sample selection bias arising from using households that only bought live sheep in estimating household live sheep expenditure behaviour and making inferences about the population. That only the economic variables, with the exception of beef price, are statistically significant suggests that the socio-demographic factors and the quarterly dummies are more relevant in the decision on whether or not to buy live sheep rather than on how much to spend.

Live sheep price and income elasticities are both statistically significant. Live sheep is a normal good. The income elasticity is 0.38 in Model I and 0.44 in Model III. Models II and IV show that high income and expenditure households spend more on live sheep purchases than their relatively low income and expenditure households. The coefficient with respect to the logarithm of the price of live sheep ranges from 0.80 to 0.88 with corresponding own-price demand elasticity ranging from -0.12 to -0.20.[7] That the demand for live sheep is price inelastic suggests that the demand may be driven by factors other than the price of live sheep. However, this result does not mean that the demand for mutton (or butchered sheep) is price inelastic. Nevertheless, our results compare favourably with those of Delgado et al. (1999) for meat in general in developing countries between 1970 and 1995. Our results find that the income and own-price elasticities for beef, pork, mutton and poultry range from 0.28 to 0.96 and -0.14 to -0.39, respectively. The logarithm of beef price is positive in three of the models, suggesting that beef is a substitute, but it is not statistically significant.

4.3 Discussion and implications

Potential production and market opportunities for small ruminant meat have not been exploited because of scant knowledge of small ruminant demand patterns, especially live animals in SSA, and the factors underlying them. Both economic and demographic factors examined here significantly affect the likelihood of buying live sheep, while only economic factors (price of live sheep and income) significantly affect expenditures on live sheep.

Although high income and expenditure households are more likely to buy live sheep than their lower income and expenditure counterparts are, incomes generally have a positive and significant impact on the probability of households buying live sheep. For example, a 1% increase in household quarterly income raises the likelihood of buying live sheep by more than 8%.[8] Among sheep buyers, however, high income households

7. Own-price demand elasticity is given by the coefficient of logarithm of sheep price minus one.
8. The elasticity is estimated at the sample means of other explanatory variables.

Table 7. *Ordinary least squares of household expenditures on live sheep in Addis Ababa, Ethiopia, 1992–93.*

Variable[1]	Model I	Model II	Model III	Model IV
Constant	-2.2190 (1.2141)	0.4323 (0.5347)	-3.0937 (1.3365)	0.2329 (0.2821)
Log live sheep price	0.8084*** (8.8698)	0.8715*** (9.5000)	0.7958*** (8.4964)	0.8791*** (9.2946)
Log beef price	0.0005 (0.0040)	0.0933 (0.7706)	-0.0014 (0.0121)	0.0240 (0.1929)
Log quarterly income	0.3816** (2.3548)			
High income group		0.2531* (1.8803)		
Log annual food expenditure			0.4370** (2.1002)	
High expenditure group				0.1841* (1.9306)
Log family size	-0.0128 (0.0992)	-0.0578 (0.5500)	-0.0330 (0.3072)	-0.0313 (0.2867)
Proportion of income earners	0.3243 (1.0403)	0.0533 (0.1200)	0.2365 (0.8176)	0.1691 (0.6009)
Dependency ratio	0.0244 (0.1005)	0.0958 (0.4514)	0.0518 (0.2266)	0.2044 (1.1003)
Log years of residence in Addis Ababa	0.0420 (0.6516)	0.0069 (0.1029)	0.0364 (0.5566)	0.0598 (0.9079)
Employment (1 = employed; 0 = not employed)	0.0360 (0.4392)	-0.1543** (2.1102)	0.0384 (0.4621)	-0.0430 (0.6315)
Married (1 = married; 0 = not married)	0.0322 (0.4153)	0.0909 (1.2033)	0.0456 (0.5963)	0.0636 (0.8406)
Quarter 1 (1 if August–October; 0 otherwise)	0.2389 (1.0834)	-0.0535 (0.4387)	0.0698 (0.4105)	0.0308 (0.2479)
Quarter 4 (1 if February–April; 0 otherwise)	0.0956 (0.6811)	-0.0224 (0.2125)	0.1110 (0.7580)	0.0032 (0.0331)
Inverse mills ratio	0.2160 (0.8331)	0.0327 (0.1900)	0.2357 (0.9374)	0.0393 (0.3091)
Adjusted R^2	0.5584	0.5251	0.5529	0.5010
Rho	-0.083	-0.008	-0.090	-0.0220

Absolute t-statistics are in parentheses.

* = significant at 10%; ** = significant at 5%; *** = significant at 1%.

1. High income group = 1 if household monthly income is greater than EB 500 and 0 otherwise. Combined low and middle income groups, with monthly income up to EB 500, is the base. High expenditure group = 1 if household quarterly total expenditure is greater than EB 1000 and 0 otherwise. Combined middle and low expenditure groups, with household quarterly total expenditure up to EB 1000, is the base (US$ 1 ≈ EB 5.55 between May 1992 and August 1993). Combined quarters 2 (November–January) and 3 (May–July) is the base for the quarterly dummies.

spend about 29% more on live sheep than their relatively lower income households.[9] These results indicate that an increase in incomes among 'richer' households will have a greater impact on live sheep purchases than the same increase will have amongrelatively 'poorer' households. However, these relative impacts may mask the impact on the overall dietary protein consumed by the different income groups,when allocations to different types of meat are taken into account. Therefore, the key message from these results is that rising incomes will increase the likelihood of households to buy live sheep and further increase their expenditure on live sheep.

Now let us look at demand for live animals in Addis Ababa within the next 10 and 20 years (Table 8). With the population of Addis Ababa expected to reach 3.3 million

Table 8. *Projections for demand and supply of live sheep in Addis Ababa.*

	Year		
	1992/93	2010	2020
Population			
Number of persons[1]	2,213,300	3,328,000	4,246,000
Number of households[2]	331,332	498,203	635,629
Demand[3]			
Number of households demanding (37% of total households)[4]	122,593	184,335	235,183
Number of live sheep per household	2.0	3.4	3.7
Number of live sheep (all households)	245,186	626,739	870,177
Kilograms of of sheep meat per capita (from live sheep)	1.7	2.0	2.2
Production			
Private holdings of live sheep[6]	n.a.	97,608	773,636
Supply of live sheep[7]	n.a.	29,282	232,091
Supply as percentage of demand of live sheep	n.a.	4.7	26.7

1. Source: CSA (1998).
2. Used 6.68 persons/household, which was obtained from the survey.
3. Used OLS estimates of Model I with income growing at an annual rate of 3.12% (which is the annual growth rate in real GDP of Ethiopia between 1980 and 1998; Befekadu Degefe and Berhanu Nega 1999). Other explanatory variables are held constant at their mean values.
4. Used assumption that 37% of total households will purchase at least one live sheep within the year (obtained from the survey).
5. Carcass weight is estimated at 48% of the live weight. This information was obtained at the Addis Ababa abattoir.
6. Based on an annual growth rate of 23% between 1994 and 1998 (obtained from CSA 1987–1991). The short time series was used because data for earlier years were unreliable or not available.
7. Estimated as the offtake of private holdings for sale. Some documented offtake rates are 25–36% (Senait Seyoum 1992) and 35–39% (Ikwuegbu et al. 1994). Here, we use 30% to represent a low average.

9. The percentage change in sheep expenditure of high income households relative to low income households is given by $(e^{\text{coefficient of 'high' income}} - 1)*100$. The same formula is applicable to all dummy variables.

and 4.3 million in 2010 and 2020, respectively, and given a 3.12% annual growth in household income, the demand for sheep will reach 3.4 and 3.7 live animals per household in 2010 and 2020, respectively.[10] This means that sheep meat from live sheep purchases will reach 2 and 2.18 kg/capita in 2010 and 2020, which represent increases of about 20% and 30%, respectively, from the level (1.66 kg/capita; Table 3) in 1992/93 during the survey. On the whole, the total demand for live sheep will reach about 0.6 and 0.8 million in 2010 and 2020, respectively.

Two issues are raised by these projections that have implications for producers and breeding programmes targeting buyers in Addis Ababa. The first is: will live sheep purchases continue to dominate total sheep meat purchases with continued economic and urban growth? Without evidence on past trends, it is difficult to say. However, based on the tradition of buying live sheep for religious and other occasions, we can expect live sheep purchases to continue to dominate. Nevertheless, given that per capita kilogram of total sheep meat purchases (2 kg; Table 3) were about 50% higher than the average per capita kilogram sheep meat consumption in developing countries (1 kg; Delgado et al. 1999), the role of live sheep to meet the increasing demand for meat in Addis Ababa cannot be neglected. Delgado et al. (1999) project the annual demand for meat in SSA will reach 11 kg/person. Assuming that live sheep purchases will continue to dominate total sheep meat purchases, the second issue arises. Will current sheep production trends be able to meet the increasing demand? Sheep supply by Addis Ababa producers alone will not be able to meet total demand in 2010 and 2020 (Table 8). However, with the expected increase in population in Addis Ababa, the traditional low-intensity sheep production, which mainly relies on grazing systems, is likely to come under pressure. This means that sheep production in Addis Ababa in the future is likely to be lower than projected. Therefore, as small ruminants in general and sheep in particular can be transported over long distances, policies relating to sheep imports and increased production in surrounding rural areas will be important to meet the increasing demand for live sheep in Addis Ababa.

10. See Table 8 for details on forecasts. Population information was obtained from CSA (1998) and growth in income is based on the anual growth rate in real GDP of Ethiopia between 1980 and 1998 (Befekadu Degefe and Berhanu Nega 1999).

5 Conclusions

Little information exists on expenditure behaviour and demand patterns for small ruminants. To enhance research, production and marketing programmes to meet the growing demand for meat in general, and small ruminants in particular, this study investigated the nature and magnitude of the impacts of prices, household income and household size and composition on urban demand for live sheep. The Heckman two-stage approach was used on a data set from a survey of urban households in Addis Ababa, Ethiopia, conducted by ILRI between May 1992 and August 1993.

As expected, income, household size and employment increased the probability of buying live sheep, while the dependency ratio reduced the likelihood. Households were more likely to buy live sheep during the quarters in which the Ethiopian New Year and Easter fell (August–October and May–July, respectively). Expenditure on live sheep, however, was only significantly determined by price and income. The demand for live sheep is price inelastic, probably due to the seasonal nature of demand and prices peaking simultaneously.

Using a modest 3.12% annual growth in household income, the demand for live sheep in Addis Ababa was projected to reach 3.4 and 3.7 animals per household in 2010 and 2020, respectively. Given the current trend in sheep holdings and offtake for sale, sheep supply by Addis Ababa producers alone will be able to meet only 5% and 27% of the total demand in 2010 and 2020, respectively.

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