Meat demand flexibilities for Tanzania: Implications for the choice of long-term investment

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Abstract

This study uses the inverse almost ideal demand system (IAIDS) to estimate demand flexibilities for beef, small ruminant (sheep and goat) meat, pork and poultry in Tanzania. Own uncompensated price flexibilities were less than one in absolute value, implying that both direct and indirect induced price effect through a change in total expenditure have little impact on budget shares. Estimated scale flexibilities were all negative, suggesting that increases in income will increase the quantities of meat consumed. Production of small ruminant meat was the most attractive investment compared to other meat commodities.

Key words: IAIDS; Meat demand; Flexibilities; Two-stage budgeting; Tanzania

JEL codes: Q11; Q18

Cette étude se sert du système de demande inverse à différentielle presque idéale (IAIDS en anglais) pour évaluer la flexibilité des demandes concernant la viande de boeuf, celle des petits ruminants (ex. moutons et chèvres), de porc et de volaille en Tanzanie. La flexibilité des prix propres non compensés s'est avérée moindre que celle en valeur absolue. Ceci laisse entendre que l'effet-prix induit à la fois direct et indirect, en raison d'un changement dans la dépense totale, n'a que peu d'impact sur les parts du budget. Les échelles de flexibilité évaluées se sont révélées toutes négatives, suggérant ainsi que l'augmentation des revenus augmentera la quantité de viande consommée. La production de viande issue des petits ruminants a représenté un investissement plus intéressant que celui des autres viandes.

Mots-clés : *IAIDS ; Demande en viande ; Flexibilités ; Prévisions budgétaires en deux étapes ; Tanzanie*

Catégories JEL : *Q11 ; Q18*

1. Introduction

After independence, Tanzania's agricultural price policies could be divided into two phases: the non-market-based policy from the mid-1960s to the mid-1980s, and the free market policy

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thereafter. In the first phase, the objective was to modernize the agricultural sector by facilitating the adoption of improved agricultural innovations. This would be done by providing free agricultural extension services, subsidizing farm inputs and instituting price support. For example, the government would set the price floor for most agricultural consumer goods at the retail level. However, although beef was affected by price control, small ruminant (i.e. sheep and goat) meat and pork and poultry were not. Economic inefficiencies experienced during the first phase led Tanzania to shift towards a free market economy and less public support for the agricultural sector. Price controls were eliminated in the 1980s.

As Tanzania opened its domestic market to foreign investment, one of the highest priorities was to attract foreign investment in the agricultural sector, which employs more than 85% of the national labor force. Tanzanian policy regarding foreign investment in the agricultural sector consists of a zero tariff on all imported capital and durable goods relating to agricultural production or development, zero subsidies on agricultural input, and market competition for output. To date, the policy has attracted few private investors in poultry and in non-traditional livestock such as crocodile and ostrich. This has been a disappointment given that Tanzania has vast pasture resources suitable for ranching and intensive dairy farming (TIC, 2008). Tanzania is among the top five countries in sub-Saharan Africa in terms of livestock numbers. According to estimates by the Ministry of Agriculture in 2002/03, Tanzania had 17 million head of cattle, 12 million head of goats and four million head of sheep (Wint & Robinson, 2007).

The literature on direct foreign investment suggests a wide range of factors that influence investment decisions. However, market information plays a central role in the decision-making process. Investors depend on elasticities or flexibilities to assess market stability. Stability or lack of volatility is vital for long-term investment planning for any investor. The objective of this study was to estimate meat demand flexibilities for Tanzania. The inverse almost ideal demand system (IAIDS) was used to estimate own-price, cross-price, and scale flexibilities for beef, small ruminant meat, pork and poultry. The findings are related to market stability and investment opportunities. The information is important for investors who wish to target the domestic meat market. Apart from providing market information, estimated own-price and cross-price flexibilities are also used for impact assessment, predicting demand and supply and addressing other issues related to public policies.

2. Conceptual issues

Deaton & Muellbauer's almost ideal demand system (1980a) and Eales & Unnevehr's inverse almost ideal demand system (1994) are standard models used to estimate demand elasticities and flexibilities, respectively. Both models provide estimates that are consistent with economic theory with flexible representation of consumer preferences. The almost ideal demand system (AIDS) is based on the notion that prices of goods are predetermined in the market and that supply adjusts to the existing price. The inverse almost ideal demand system (IAIDS), on the other hand, is based on the notion that for perishable agricultural goods such as meat, quantities are predetermined and prices adjust to existing quantities. The IAIDS model provides a first-order approximation of demand systems and satisfies perfect aggregation conditions to allow the creation of a representative consumer (Park et al., 2004). In this study, the IAIDS model is used

for several reasons. First, meat is a perishable good and is produced with biological lag. Second, in Tanzania, more than 95% of the meat consumed is produced locally and only small amounts of meat are processed or stored for future consumption (MoAC, 1993). Hence, quantities are predetermined and the price adjusts to the available quantities.

In practice, households or consumers allocate their income over several commodities. Estimation of a full demand system that incorporates all consumed commodities is not practical, especially for developing countries where time-series data is sparse. In addition, for a full demand system, the number of own-price and cross-price elasticities to be estimated would be equal to the square of the number of commodities consumed. To overcome these difficulties, two-stage budgeting and price aggregation procedures are commonly used to develop demand systems that are consistent with constrained utility maximization. A two-stage budgeting procedure allows consumers to allocate their income in two stages (Deaton & Muellbauer, 1980b). In the first stage, total expenditure or income is allocated to broad groups of composite goods. In the second stage, a budget for each group is allocated to commodities consumed. This is achieved by allowing weak separability of the direct utility function over broad categories of goods. 'Composite goods' are defined as close substitutes that have similar quantity or quality characteristics, while 'commodities' are specific varieties or brands sold at a single price and are indistinguishable in their use. Moreover, if groups of prices move in parallel, the corresponding group of commodities can be treated as a single good. Each budgeting stage is therefore sufficient for model specification and analysis (Edgerton, 1997).

In this study, it is therefore assumed that in the first stage consumers allocate a proportion of their total expenditure or income to three composite goods, namely meat, pulses (i.e. beans and all kinds of peas) and all other goods. In the second stage, expenditures are allocated to individual commodities within each group, and the budget share allocated to meat as a good is reallocated to specific meat commodities, namely beef, small ruminant meat, pork and poultry. This implies that a change in the price of beef will influence pork consumption (for example) directly by changing the pork budget share through budget redistribution (in the second stage) and indirectly through changes in the price of meat products. In Tanzania, pulses are a major source of protein for more than 95% of households (Due, 1986). In addition, food expenditure accounts for more than 85% of the total expenditure (Weliwita et al., 2003). A two-stage budgeting procedure is therefore appropriate since composite goods can be divided into meat, pulses and all other goods; and meat commodities can be divided into beef, small ruminant meat, pork and poultry without much loss of information.

Assuming a two-stage budgeting process that divides total expenditures between composite goods (i.e. meat, pulses and all other goods) and meat commodities (i.e. beef, small ruminant meat, pork and poultry), the IAIDS model can be specified as follows:

$$w_{i,t} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln q_{j,t} + \beta_i \ln Q^*_{i,t} + \nu_t. \quad (1)$$

In equation (1), $w_{i,t}$ is the expenditure share of the ith good or commodity in period t, ln is the natural logarithm, $q_{j,t}$ is the per capita quantity of the ith good or commodity consumed in

kilograms, α_i, γ_{ji}, and β_i are parameters to be estimated, t is the time trend, v_t is the error term, n is the number of goods or commodities within the demand system (n = 1,2,3) for the first stage, (n = 1,2,3,4) for the second stage, and Q^* is the quantity index such that

$$\ln Q^*_{i,t} = \alpha_0 + \sum_{j=1}^{n} \alpha_j \ln q_{j,t} + 0.5 \sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{ij} \ln q_{i,t} \ln q_{j,t}. \quad (2)$$

In equations 1 and 2, symmetry and homogeneity conditions imply $\gamma_{ij}=\gamma_{ji}$ and $\sum_{ij}=\gamma_{ij}=0$. The adding-up condition implies $\sum_i\alpha_i = 1$, $\sum_{ij}\gamma_{ij} = 0$, and $\sum_i\beta_i = 0$. For details on model formulation see Deaton & Muellbauer (1980a,b).

Scale flexibility indicates the extent to which marginal valuations are affected when consumption of all goods is increased by one percent. Consequently, scale flexibility measures the effect on quantity demanded from an increase in consumer welfare. It measures the potential price response of individual goods or commodities to a proportionate increase in all goods or commodities consumed (Park & Thurman, 1999; Goodwin et al., 2003). Scale flexibilities should therefore be negative, to indicate that increased consumption lowers the marginal valuation of all goods (i.e. proportional increase in consumption of all commodities reduces the willingness to pay for each individual commodity). Scale flexibilities greater than one in absolute value correspond to 'necessities', while scale flexibilities less than one in absolute value correspond to 'luxuries'. The adding-up condition implies that the weighted sum of the scale flexibilities must be equal to negative one. Under homothetic preferences, scale flexibilities are equal to expenditure elasticities in the AIDS model (Park & Thurman, 1999; Huang, 2006), otherwise they are different.

Price flexibilities measure the percentage change in the marginal value of a good or commodity (i.e. it is a normalized price or price divided by expenditure) that occurs in response to a one percent change in the consumption of the commodity (Park et al., 2004). If the estimated price flexibility is greater than one in absolute value, the normalized price is flexible. Conversely, if the estimated flexibility is less than one in absolute value, the normalized price is inflexible. Goods or commodities are termed 'q-complements' if cross-price flexibilities are positive and 'q-substitutes' if the cross-price flexibilities are negative (Hicks, 1956). Smaller cross-price flexibility implies that goods or commodities are in essence substitutes. Conversely, relatively larger price flexibility implies that goods are complements.

Two types of price flexibility can be calculated. The first is the normal uncompensated price flexibility that contains both the direct and indirect quantity-induced price effect through changes in total expenditure. The second is the compensated price flexibility that measures the response of the normalized price of a commodity to a change in the own-quantity or quantity of another good or commodity consumed, while holding the scale of consumption constant. In fact, compensated cross-price flexibilities show the substitution effects of normalized price changes (Park et al., 2004). Compensated own-price should therefore be negative, to indicate a downward sloping demand curve. If the cross-price flexibilities are negative, then goods are termed net

substitutes, to indicate substitutability between goods or commodities. Knowing the magnitude of scale and price flexibility is important for investors considering investing in the livestock sector as well as for deciding how to allocate their investment resources between alternative ventures. Under low income levels, it is intuitive to invest initially in 'necessities' rather than 'luxuries', as the demand for the former would probably be more stable than for the latter. Moreover, producing goods that are 'q-complements' would stabilize markets for all goods. Conversely, production of 'q-substitutes' may destabilize the markets of competing goods. However, small investments targeting luxury markets could be perfectly viable.

Although the IAIDS model explained above is static in its construction, there is a general agreement that dynamics in the model may be an issue when the interest is focused on short-run flexibilities (Godwin et al. 2000). On the other hand, the IAIDS model in equations (1) and (2) represents the long-run relationship within the demand system (Asche, 1997). Since investments in livestock production are characterized by sunk costs – that is, after investment has been undertaken the cost cannot be fully recovered through transfer or resale (Barham & Chavas, 1997) – investors are often interested in flexibilities under market equilibrium conditions. It is the market equilibrium condition that determines the long-term return from an investment rather than the dynamic market adjustments captured by short-run flexibilities. Furthermore, as shown by Klonaris (2001), a change in demand through budget reallocation does not statistically affect the magnitude of the model parameters that are used to estimate flexibilities.

3. Data and estimation procedure

Data on yearly quantities of meat and pulses consumed (i.e. production plus imports minus exports) and price data from 1961 to 2001 were obtained from the Tanzania Ministry of Agriculture and Cooperatives annual reports (MoAC, 1993, 1996; FAOSTAT, n.d.). Population , consumer price index, exchange rate and real per capita income were obtained from the 2002 World Bank Development Indicators CD-Rom. Quantities were in metric tons and included quantities for pulses (i.e. dry beans, cowpeas, chickpeas, pigeon peas and other pulses), beef, small ruminant meat, pork and poultry. Prices were converted from dollars to Tanzanian shillings using the appropriate exchange rate and were then deflated using the Tanzania consumer price index.

The budget shares of goods (i.e. meat, pulses and any other goods) and commodities (i.e. beef, small ruminant meat, pork and poultry) were calculated as per capita quantities consumed multiplied by their real prices and divided by per capita income. Following Brester & Schroeder (1995), the price and quantity of any other goods was derived as:

$$Q_{n,t} = \frac{\left(Y_t - \sum_{i=1}^{N-1} EX_{i,t}\right)}{\left(CPI_t - \sum_{i=1}^{N-1} (w_{i,t} P_{i,t})\right)} \qquad i = 1, 2, 3. \tag{3}$$

In equation (3), $Q_{n,t}$ is the quantity of any other goods, Y_t is the real income, $EX_{i,t}$ is the total real expenditure on meat and pulses, CPI_t is the consumer price index, $w_{i,t}$ is the budget share, $P_{i,t}$ is the real average price of goods i, and i = 1,2 for meat and pulses. In equation (3) the numerator and denominator are, respectively, expenditure on, and the average price of, any other goods.

Based on equations (1) and (2), the first stage equations were specified for three goods (i.e. meat, pulses and any other goods) and the second stage equations were specified for four commodities (i.e. beef, small ruminant meat, pork and poultry). Because of singularity imposed on the covariance matrix by the adding-up restriction, the other goods and poultry equations were not estimated. The parameters for the dropped equations were recovered residually using the imposed adding-up restrictions. Consequently, two equations for the first stage and three equations for the second stage were estimated as non-linear Zellner's seemingly unrelated regression (SUR) models (Zellner, 1962; Heien & Wessels, 1988).

Serial correlation within equations was corrected during the estimation process using the AUTO command in SHAZAM version 10 (Whistler et al., 2004). This means that for each good or commodity, equation (1) was specified as a model with serial correlation of order k (i.e., $v_{i,t}= \sum_i \rho_i v_{i,t-i} + \varepsilon_{it}$), where $v_{i,t}$ is as explained in equation (1), ρ is the correlation parameter, $\varepsilon_{i,t}$ is the uncorrelated random error term with mean zero, and i = 1,.., k, where k is the order of autocorrelation. An optimal k for each equation was chosen such that the estimated generalized Durbin-Watson statistics (Savin & White, 1978) was close to 2. The parameter (α_0) in the quantity index (equation 2) is difficult to estimate and is sensitive to the equation dropped. Following Eales & Unnevehr (1994), the parameter α_0 was set to zero. As noted by Alston et al. (1990), the SUR estimators have the same asymptotic properties as maximum likelihood. Moreover, estimates are invariant to the equation deleted (Barten, 1969). Own, cross and scale flexibilities were calculated using formulas presented in Eales & Unnevehr (1994).

4. Results and discussion

Summary statistics for the variables used in the demand models are presented in Table 1. The average per capita consumption of beef was 8.9 kg. The corresponding per capita consumption of small ruminants, poultry and pork was 5.8, 5.9 and 5.3 kg, respectively. Consumption of all commodities had little variation over the study period. The mean real prices of beef, small ruminant meat, poultry and pork were 1,516, 732, 595 and 1,001 Tanzanian shillings (Tshs)/kg respectively. The average prices of pulses and any other goods were 81 and 219 Tshs/kg, respectively. The proportion of per capita income devoted to pulses and meat consumption amounted to 15% and 8%, respectively. About 51% of the meat budget was allocated to beef, 20% to pork, 16% to small ruminant meat, and 13% to poultry.

Table 1: Summary statistics of variables used in the analysis (1961–2001)

Variable	Mean	Std. dev.	CV
Per capita consumption of beef in kg	8.89	0.43	0.05
Per capita consumption of small ruminant in kg	5.80	0.81	0.14
Per capita consumption of poultry in kg	5.86	0.98	0.17
Per capita consumption of pork in kg	5.26	0.89	0.17
Per capita consumption of pulses in kg	15.92	2.88	0.18
Per capita consumption of all other goods	80.27	38.98	0.49
Real per capita income in thousand Tanzanian shillings	24,945.56	33,897.90	1.36
Real price of beef in Tanzanian shillings	1,516.75	516.99	0.34
Real price of small ruminant in Tanzanian shillings	733.46	275.80	0.38
Real price of pork in Tanzanian shillings	1,000.88	354.66	0.35
Real price of poultry in Tanzanian shillings	594.88	212.87	0.36
Real price of pulses in Tanzanian shillings	82.46	101.12	1.23
Real price of other goods in Tanzanian shillings	219.46	270.99	1.23
Proportion of income allocated to pulses consumption	0.02	0.02	0.91
Proportion of income allocate to meat consumption	0.08	0.08	0.89
Proportion of meat budget allocated to beef	0.60	0.10	0.17
Proportion of meat budget allocated to small ruminant meat	0.20	0.10	0.48
Proportion of meat budget allocated to poultry	0.04	0.01	0.27
Proportion of meat budget allocated to pork	0.16	0.02	0.15

Source: MoAC, 1993, 1996; FAOSTAT, n.d.; World Bank, 2002
Note: Std.dev = standard deviation; CV = coefficient of variation.

Figure 1 presents a trend of budget shares for goods relative to real per capita income. It is obvious that Tanzania's real income has been declining over time (from above 300,000 Tshs in the 1960s to about 100,000 Tshs in 2001), hitting a bottom in 1986. Notice that a rapid fall in income from 1970 to 1986 caused a reallocation of budget from all other goods to meat and pulses, most of the additional budget being allocated to meat. A slight increase in income (after 1986) stabilized the budget shares, with the budget for meat being slightly higher than in the 1961–1976 period. The budget reallocation coincides with the transition period from price control (1961–1976) to the transition period toward market liberalization policies of the 1980s.

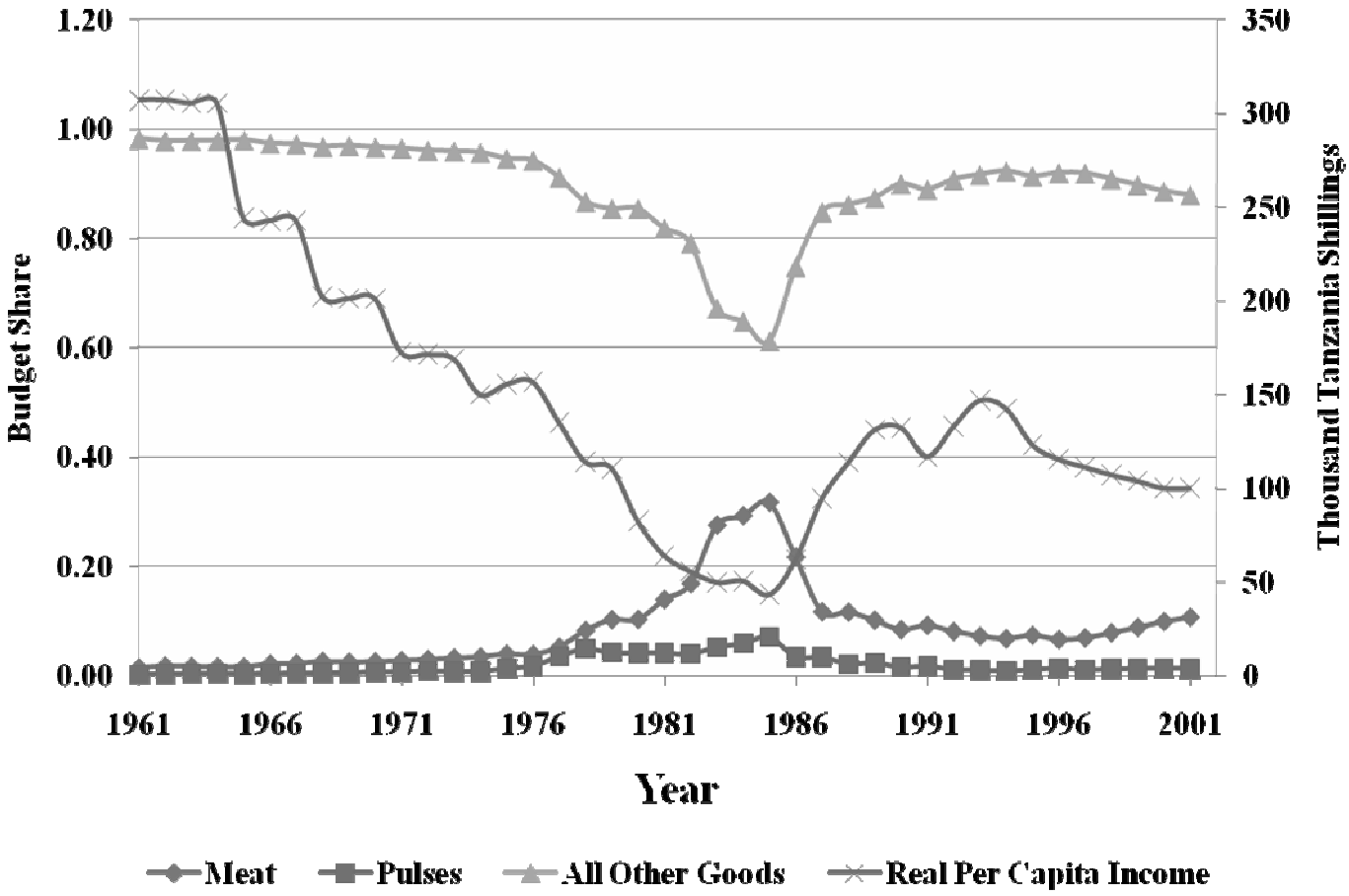

Figure 1: Evolution of composite goods expenditure shares relative to per capita income (1961–2001)

Fluctuation in per capita income also influenced budget allocation among meat commodities. As illustrated in Figure 2, overall, a decrease in income reduces the budget share for poultry in favor of beef. After 1986, a slight increase in income caused a movement towards beef and away from all other kinds of meat.

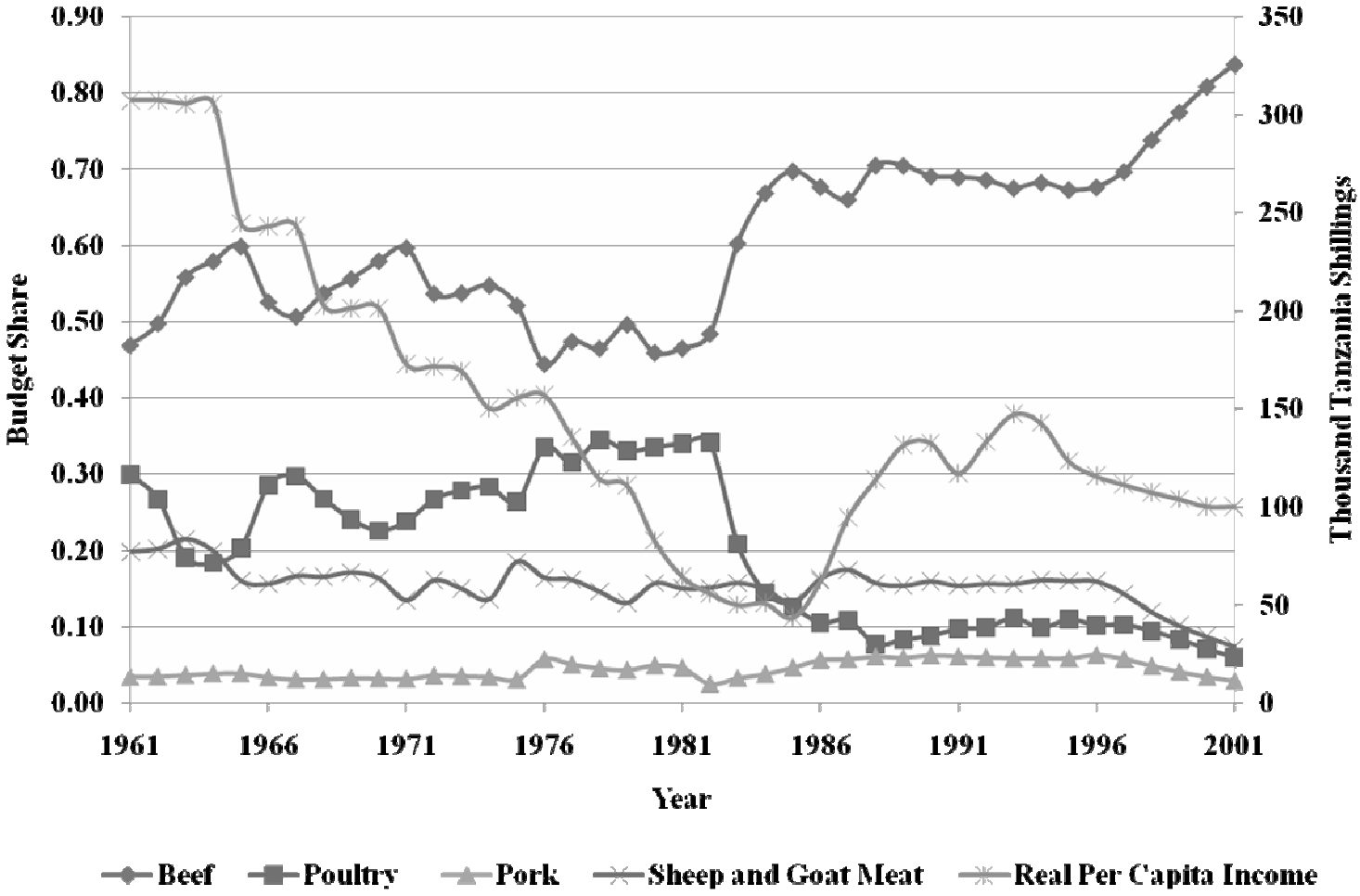

Figure 2: Evolution of meat expenditure shares relative to per capita income (1961–2001)

The estimates of the model parameters are presented in Table 2. The estimated single equation coefficient of determination (R^2) ranged between 78% for pork and 97% for meat. These results imply that the independent variables included in the models explained more than 78% of the variation in budget shares allocated to goods and meat commodities. As we are dealing with systems of equations, single equation R^2 statistics may have no clear meaning as regards to the performance of the demand system. The system R^2 that compares the models with a benchmark (i.e. a model with intercept only) was calculated as in Burton & Young (1992). The system R^2 for goods was 96.8%, and the system R^2 for meat commodities was 81.3%, which are quite satisfactory in terms of model prediction power.

Table 2: Results of the inverse almost ideal demand systems for meat in Tanzania

Goods/	Estimated coefficients									
Commodities	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	ρ_1	ρ_2	ρ_3	R^2	**D**
Goods										
Meat	0.358	-0.277	0.154	0.014	-	0.324	-0.856	0.393	97.61	2.82
	(0.115)**	(0.034)**	(0.052)**	-0.015	-	(0.112)**	(0.171)**	(0.103)**		
Pulses	0.187	-0.057	0.014	0.063	-	0.999	-0.319	0.168	97.36	2.16
	(0.102)*	-0.646	-0.019	(0.021)**	-	(0.143)**	-0.221	-0.136		
All other goods[a]	0.455	0.334	-0.168	-0.077	-					
	(0.168)**	(0.112)**	(-0.07)**	(-0.03)**	-					
Commodities										
Beef	0.291	0.063	0.246	-0.081	-0.095	0.534	-0.283	-	82.10	2.18
	(0.170)**	-0.084	(0.047)**	(0.013)**	(0.023)**	(0.169)**	(0.125)**			
Small ruminant	0.173	0.019	-0.081	0.166	-0.024	0.516	-0.453	-	83.98	2.30
	(0.054)**	-0.007	(0.013)**	(0.027)**	-0.027	(0.196)**	(0.193)**			
Pork	0.262	-0.012	-0.109	-0.022	0.029	0.588	-0.339	0.147	78.89	2.23
	(0.093)**	-0.047	(0.123)**	-0.032	-0.059	(0.166)**	(0.111)**	(0.103)*		
Poultry[a]	0.274	-0.070	-0.056	-0.063	0.090					
	(0.107)**	(-0.05)**	(-0.047)	(-0.031)*	(0.029)**					

Notes: R^2=Coefficient of determination, D=Durbin-Watson statistics, ρ= autocorrelation parameter.
Numbers in parenthesis are standard errors.
* denotes statistical significance at 1% level and ** at 5% level.
[a] Recovered using the adding-up conditions (i.e. $\sum_i \alpha_i = 1$, $\sum_{ij} \gamma_{ij} = 0$, and $\sum_i \beta_i = 0$).

Signs on the estimated coefficients of the demand system for meat commodities are as expected (i.e. coefficients on own-quantities are positive and on cross-quantities are negative). This implies that an increase in the quantity consumed increases the budget share of the good, while an increase in consumption of substitutes decreases the budget share of the good. The cross-coefficients of the meat and pulses were neither positive nor statistically significant. It was therefore not possible to directly conclude whether meat and pulses are substitutes or complements.

The calculated scale and uncompensated and compensated own-price and cross-price flexibilities evaluated at the data mean are presented in Table 3. Scale flexibility is the proportionate change in normalized price resulting from a scale expansion in the consumption bundle. For both goods and commodities, all estimated scale flexibilities are negative as expected. This implies that as aggregate consumption increases, the normalized price (i.e. price over expenditure) goes down. In the goods model, for example, the calculated scale flexibility for meat is -4.27 (Table 3), which indicates that if the quantities of all goods consumed increase by 1%, the willingness to pay for meat will drop by 4.27%. Theoretically, this suggests that, at the prevailing level of income, pulses are preferred to meat products. This could be due to the high prices of meat products relative to pulses and the low level of income that prevailed during the study period.

Table 3: Estimated meat demand flexibilities for Tanzania

		Uncompensated				Compensated			
Goods	**Scale**	**Meat**	**Pulse**	**Others**		**Meat**	**Pulse**	**Others**	
Meat	-4.267	-0.115	-0.446	-3.706		-0.247	0.187	-0.043	-
Pulse	-1.382	-0.010	-0.649	-0.723		0.107	-0.443	0.038	-
Others	-0.565	-0.096	-0.019	-0.450		-0.048	0.050	-0.017	-
Commodities	**Scale**	**Beef**	**SRM[a]**	**Pork**	**Poultry**	**Beef**	**SRM[a]**	**Pork**	**Poultry**
Beef	-0.878	-0.474	-0.139	-0.158	-0.107	-0.021	0.001	0.014	0.007
Small ruminant	-0.955	-0.491	-0.053	-0.138	-0.379	0.001	-0.205	0.049	0.254
Pork	-1.281	-0.383	-0.097	-0.901	0.099	0.165	0.072	-0.692	0.238
Poultry	-1.442	-0.739	-0.542	0.599	-0.760	0.003	0.313	0.883	-0.573

[a] SRM is small ruminant meat

For the commodity demand system, estimated scale flexibilities suggest that beef and small ruminant meat are preferred to pork and poultry. Note that apart from poultry, scale flexibilities for meat commodities are close to one. These results indicate that the marginal rate of substitution among meat commodities is relatively constant (i.e. near homothetic preferences). At a given price level, a constant proportion of expenditure is allocated to each meat commodity. This is not surprising, since the model captures the market equilibrium conditions (i.e.

consumption trend rather than deviations from the equilibrium). The results of scale flexibilities for both goods and commodity models suggest that Tanzanian consumers change the quantities of meat consumed by changing budgetary allocations during the first stage of the budgeting process rather than by reallocating expenditures among meat commodities. In other words, changes in quantities consumed are mainly through a change in budget share allocated to goods not commodities. For example, an increase in income will increase beef demand through an increase in the budget share allocated to meat as a group of commodities, which will also increase total expenditure on beef.

Estimated uncompensated own-price flexibilities for both models are negative and less than one in absolute value. In the goods model, demand for meat was relatively inflexible (i.e. –0.12) as compared to pulses (i.e. –0.65). Except for the cross-price uncompensated flexibility for meat and any other goods, which is greater than one in absolute value (–3.71), other estimated cross-price flexibilities are less than one in absolute value, indicating an inflexible demand. Pulses and meat are relatively perfect q-substitutes, but consumers are more willing to trade pulses for meat than meat for pulses. In the commodity model, the uncompensated own-price flexibilities for beef, small ruminant meat, pork and poultry were -0.47, -0.05, -0.90 and -0.76, respectively. These flexibility values are plausible for staple food items, indicating highly inflexible demands. As an example, a 1% increase in the quantity of beef consumed is associated with a 4.7% decline in willingness to pay for beef. A 1% increase in the quantity of small ruminant meat consumed is associated with a 0.5% decline in willingness to pay for small ruminant meat. Demand for small ruminant meat is relatively stable compared to other commodities. Such information is helpful to an investor thinking about investing in the domestic market. Whereas poultry and pork appear to be q-complements (i.e. there is positive uncompensated cross-price flexibility), other commodities appear to be perfect substitutes (i.e. there is negative uncompensated cross-price flexibility). Note that there is no perfect complementarity between pork and poultry as the cross-price flexibility is less than one.

As indicated earlier, compensated own-price flexibilities and compensated cross-price flexibilities indicate price and substitution effects, respectively. All own-price compensated flexibilities are negative and less than one in both models, indicating inflexible demands. Compensated cross-price flexibilities involving meat and any other goods in the goods demand system are perverse in sign (i.e. negative). Nevertheless, the estimated flexibilities are near zero. It may be concluded that all 'goods' and commodities are net substitutes, in the Hicksian sense The estimated results of uncompensated and compensated flexibilities indicate that investment in small ruminant meat production that targets the domestic market may therefore be more attractive than investment in beef, pork and poultry production.

5. Summary and conclusion

Since the late 1980s, Tanzania has been gradually opening up its domestic market to foreign investment and one of its first priorities was to attract foreign investment into the agricultural sector. Disappointingly, however, little investment has taken place in the livestock sector. Coupled with other factors that attract foreign direct investment, lack of market information is one of the factors contributing to this problem. The objective of this paper was to provide information on meat demand flexibilities under long-run market equilibrium conditions. For

agricultural goods, flexibility estimates are indicators of market stability and are used for impact assessment and policy analysis.

The estimated uncompensated own-price flexibilities for beef and small ruminant meat were inflexible and small ruminant meat had the lowest own-price flexibility in absolute value. These results indicate that willingness to pay for small ruminant meat will not be significantly affected by increases in the quantity consumed. The estimated scale flexibilities indicate that increase in demand was influenced primarily through budget allocation to goods rather than commodities. As a result, an increase in income will be associated with an increase in the budget share allocated to meat commodities as a group. Given the prevailing level of income and if meat production is to target the Tanzania domestic market, investment in small ruminant meat production may be preferred to investment in beef, pork or poultry. Stability in the small ruminant meat market is indicated by a relatively smaller uncompensated price flexibility. Moreover, an increase in income is associated with an increase in the consumption of small ruminant meat. As the economy grows, demand for small ruminant meat is likely to increase. Because of price policy changes, and for forecasting purposes, future studies will have to include variables that capture possible structural changes in the meat demand systems in Tanzania.

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References

Alston, JM, Carter, CA, Green, R & Pick, D, 1990. Whither Armington trade models? American Journal of Agricultural Economics 72 (3), 456–67.

Asche, F, 1997. Dynamic adjustment in demand equations. Marine Resource Economics 12 (3), 221–37.

Barham, BL & Chavas, JP, 1997. Sunk costs and resource mobility: implications for economic and policy analysis. Staff Paper 410, University of Wisconsin, Madison, US.

Barten, AP, 1969. Maximum likelihood estimation of a complete system of demand equations. European Economic Review 1 (1), 7–73.

Brester, GW & Schroeder, TC, 1995. The impacts of brand and generic advertising on meat demand. American Journal of Agricultural Economics 77 (4), 969–79.

Burton, M & Young, T, 1992. The structure of changing tastes for meat and fish in Great Britain. European Review of Agricultural Economics 19 (2), 165–80.

Deaton, A & Muellbauer, J, 1980a. An almost ideal demand system. American Economic Review 70 (3), 312–26.

Deaton, A & Muellbauer, J, 1980b. Economics and consumer behaviour.: Cambridge University Press, Cambridge.

Due, JM, 1986. Summary of farming systems: Bean research in Tanzania, 1982/85. In Minjas, AN & Salema, MP (Eds), Proceedings of the 4th Bean Research Workshop. Inter Press of Tanzania, Dar es Salaam.

Eales, JS & Unnevehr, LJ, 1994. The inverse almost ideal demand system. European Economic Review 38 (1), 101–15.

Edgerton, DL, 1997. Weak separability and the estimation of elasticities in multistage demand Systems. American Journal of Agricultural Economics 79 (1), 62–79.

FAOSTAT, (n.d.). Online FAO (Food and Agriculture Organization) statistical database. http://faostat.fao.org/site/339/default.aspx Accessed January 2007.

Goodwin, BK, Harper, D & Schnepf, R, 2003. Short-run demand relationships in the US fats and oils complex. Journal of Agricultural & Applied Economics 35(1), 171–84.

Heien, DM & Wessels, CR, 1988. The demand for dairy products: Structure, prediction, and decomposition. American Journal of Agricultural Economics 70 (2), 219–28.

Hicks, JR, 1956. A Revision of Demand Theory. Oxford University Press, Oxford.

Huang, KS, 2006. A look at food price elasticities and flexibilities: Can inverted price elasticities be used as price flexibilities? Poster paper presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia.

Klonaris, S, 2001. Structural change in Greek meat demand. Agricultural Economics Review 2 (2), 31–41.

MoAC (Ministry of Agriculture and Cooperatives), 1993. Basic data on the agriculture and livestock sector, 1986/92. Statistics Unit, Dar es Salaam, Tanzania.

MoAC (Ministry of Agriculture and Cooperatives), 1996. Basic data on agriculture and livestock sector, 1993/96. Statistics Unit, Dar es Salaam, Tanzania.

Park, H & Thurman, WN, 1999. On interpreting inverse demand systems: A primal comparison of scale flexibilities and income elasticities. American Journal of Agricultural Economics 81 (4), 950–8.

Park, H, Thurman, WN & Easley, JE, 2004. Modeling inverse demands for fish: Empirical welfare measurement in Gulf and South Atlantic fisheries. Marine Resource Economics 19, 333–51.

Savin, NE & White, KJ, 1978. Estimation and testing for functional form and autocorrelation: A simulation approach. Journal of Econometrics 8 (1), 1–12.

TIC (Tanzania Investment Centre), 2008. Tanzania Investment Incentives. www.tic.co.tz Accessed July 2008.

Weliwita, A, Nyange, A & Tsujii, H, 2003. Food demand patterns in Tanzania: A censored regression analysis of microdata. Sri Lankan Journal of Agricultural Economics 5 (1), 9–36.

Whistler, D, White, KJ, Wong, SD & Bates, D, 2004. SHAZAM Econometric Software: User's Reference Manual Version 10. Northwest Econometrics, Vancouver, BC, Canada.

Wint, W & Robinson, 2007. Gridded livestock of the world. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy.

World Bank, 2002. Africa database for 2002. World Bank, Washington, DC.

Zellner, A, 1962. An efficient method of estimating seemingly unrelated regressions and test for aggregation bias. Journal of the American Statistical Association 57, 348–68.