



Changing demand for livestock food products: An evidence from Indian households

P G CHENGAPPA¹, M UMANATH², K VIJAYASARATHY³, PRADEEPA BABU⁴ and A V MANJUNATHA⁵

Institute for Social and Economic Change, Nagarabhavi, Bengaluru 560 072 India

Received: 27 November 2015; Accepted: 2 February 2016

ABSTRACT

Evidence was established for changing consumption trends towards livestock products making use of the consumer expenditure survey data pertaining to the periods, 2004–05 and 2011–12. The large database of National Sample Survey Organisation was used for estimation of income and demand elasticities through the Quadratic Almost Ideal Demand System (QUAIDS). The results provided useful insights into the increasing domestic demand for livestock products in Indian households. The estimated expenditure elasticities for livestock products such as milk and milk products, chicken, fish and prawn were positive and significant in both rural and urban India. This implied that as the per capita income of the households increased, the proportion of expenditure on these products were much higher than other livestock products. Furthermore, own price elasticities for most of the livestock products, except egg and mutton, were highly elastic indicating the price sensitiveness of demand for these food products among the Indian households.

Key words: Consumption pattern, Demand elasticity, Income, Livestock products, Price

In India, households are witnessing significant changes in their dietary pattern from cereals towards high value food commodities such as meat, milk and milk products, fruits and vegetables. These dietary changes are documented in several studies (Kumar *et al.* 2011, Chatterjee *et al.* 2006, Bansil 1999 and Radhakrishna 2005). The underlying reasons for such changes are related to factors such as increased disposable household incomes, changing life styles, increasing health consciousness, availability of wide range of fresh and processed food products in the market, improvements in transportation and storage facilities and rise of supermarkets (Kumar *et al.* 2011, Vasileska and Rechkoska 2012, Birthal *et al.* 2006, Chengappa *et al.* 2007 and Kumar *et al.* 2014).

The per capita consumption of food grains in India has either stagnated or declined, whereas the per capita consumption of livestock derived products has significantly increased especially, in the recent years (Kumar *et al.* 2014). Livestock products are the second leading food products after cereals, providing the most amount of calories, protein and fat which accounted for more than 25% of total food expenditure of households (GoI 2012). Besides, it also provides economic value in terms of draught power, manure, fuel, hides and skin; the importance of livestock sector is known from the facts (i) It contributed 3.92% to the total

GDP and 25.82% to the agricultural GDP; (ii) The share of value of products (VoP) of livestock is to the tune of 25.41% in total agricultural VoP, which has surpassed the VoP of food grains (20.45%) in 2010–11; and (iii) Export of livestock products contributed 7.86% to the total agricultural export earnings of the country in 2011–12.

Although the market and demand are likely to play major role in the development of the livestock sector, the detailed information on the nature of demand by consumers is hardly available. Such information is useful for producers and market actors to take market oriented decisions to benefit from growing markets (Lapar *et al.* 2010). Given their essentiality in households diet, it is crucial for the stakeholders involved in production, processing and marketing to understand the factors determining the consumption of these products. Hitherto, most of the studies in India have largely focussed on crop based foods (Kumar *et al.* 2007, Mittal 2010, Bansil 1999). Hardly, few studies have comprehensively looked into the consumption of livestock products, Kumar *et al.* (2014) estimated the trends in the consumption of milk and milk products in India. The demand for livestock products is insufficiently understood in general, and rural and urban areas in particular. Therefore, understanding of consumption dynamics of livestock products to the changes in income and prices is crucial for policy formulation. This study focussed on changes in the consumption of livestock products of Indian households and estimation of the demand elasticities of livestock products.

Present address: ¹National Professor of ICAR (chengappagp@gmail.com), ²⁻⁴Research Associate (umanatheconomics@gmail.com, vijarsaac@gmail.com, pradeepagecon2006@gmail.com), ⁵Assistant Professor (manjublore@yahoo.com).

MATERIALS AND METHODS

Materials: The household data on dietary pattern and consumer expenditures were collected by National Sample Survey Organization (NSSO) at national level, particularly pertaining to the periods 2004–05 (61st round) and 2011–12 (68th round) has been used for this study to capture both spatial (rural and urban) and temporal variations in the consumption pattern of livestock food products. These comprehensive National Sample Survey (NSS) data with sample size of over 100,000 households covering both rural and urban households has high acceptance in research and policy. The data pertains to the average per capita consumption of all food and non-food commodities following the accepted classification. The total per capita expenditure was considered as a proxy for total per capita income, and therefore is used interchangeably in the study. The sample households were categorized into 2 groups based on the location of dwelling as rural and urban households. The livestock food products included in the present analysis are milk and milk products, egg, fish, chicken, mutton, pork and beef.

Method of analysis: Price response of demand was obtained on the basis of unit values. The unit price for a particular food item was derived by dividing the value of the food item by total quantity consumed by a particular respondent in a region. Price for the food item which is not consumed by any respondent in a region was given the average price of the corresponding region. The use of the unit value prices for a food item have been widely applied by Deaton (1990,1997), Crawford *et al.* (2003) and Kedir (2005). The total expenditure and prices of the livestock food products were deflated with poverty line of respective years to convert them into constant prices.

Model Specification: Quadratic-Almost Ideal Demand System (QUAIDS): The Almost Ideal Demand System (AIDS) is used for estimating consumer demand systems in the present study. QUAIDS has distinct advantages as it allows non-linear Engel curves (Banks *et al.* 1997) and tests the restriction of homogeneity and symmetry through restriction of fixed parameters (Deaton and Muellbauer 1980). Our study followed the two-step estimation procedure given by Shonkwiler and Yen (1999) to estimate the demand elasticities of income and price, since there is a chance to have zero expenditure on some of the commodities. The first step involves estimating a probit regression function to estimate the probability of consumption of a particular food commodity and the specific form of the function is as under:

$$d_{ih} = \alpha_0 + \sum_j \alpha_{ij} \ln p_j + \alpha_x \ln x_h + \alpha_1 HHS_h + \alpha_2 UR_h + \alpha_3 SEX_h + \alpha_4 REF_h + \alpha_5 VEH_h + \mu_i \quad \dots(1)$$

where, d_{ih} = 1 if the h^{th} household consumes the i^{th} livestock product and 0 if the household does not consume the item in question. $\ln p_j$ are the log of prices of 7 livestock

products, x_h is total household consumption expenditure on livestock products, HHS is household size in numbers, UR is a dummy variable for urban (1 for urban; 0 for rural), SEX is a dummy variable for gender of household head (1 for the female headed households; 0 for male headed households), REF is dummy variable for ownership of refrigerator (1 for the household having refrigerator; 0 for household not having refrigerator), VEH is dummy variable for ownership of vehicles (1 for the household having vehicles; 0 for household not having vehicles) and μ_i is the residual term.

Prior to executing the probit function, the total expenditure function was regressed on its determinants and the residual error term was obtained to solve the endogeneity problem of total expenditure variable in the estimation of the QUAIDS model. The exact form of the function is as under:

$$\ln x_h = \alpha_0 + \sum_j \alpha_{ij} \ln p_j + \alpha_1 HHS_h + \alpha_2 UR_h + \alpha_3 SEX_h + \alpha_4 REF_h + \alpha_5 VEH_h + e_h \quad \dots(2)$$

The second step provides the estimated form of the Quadratic Almost Ideal Demand System (QUAIDS), which is represented as follows:

$$w_{ih} = \Phi(z_{ih} \hat{\theta}_i) \left\{ \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{x_h}{a(p)} \right] \right\} + \frac{\lambda_i}{b(p)} \left\{ \ln \left[\frac{x_h}{a(p)} \right] \right\}^2 + \tau_i e_h \hat{e}_h + \delta_i \Phi(z'_{ih} \hat{\theta}_i) + \xi_{ih} \quad \dots (3)$$

$w_{ih} = \frac{p_{in} q_{in}}{x} = i^{th}$ food product expenditure share for consumer h ; p_j , price of good i ; q_i = quantity of good i ; x , monthly household income (expenditure on livestock food commodities); \hat{e}_h , residual from the total expenditure regression; $\Phi(z_{ih} \hat{\theta}_i)$ and $\delta_i \Phi(z'_{ih} \hat{\theta}_i)$ are cumulative density function (CDF) and probability density functions (PDF), respectively obtained from the first stage probit regression. The parameters of the QUAIDS model are estimated using the Poi's Stata routine (Poi 2008). Adjustments are made to the original routine to include additional control variables in order to capture endogeneity and selectivity problems as appropriate.

Parameters in 3 levels; national, rural and urban were estimated separately by using Seemingly Unrelated Regression Estimation (SURE) method with symmetry and homogeneity simultaneously imposed. Budget-share equation for chicken was dropped to accommodate adding-up. The remaining six equations were estimated by iterated, feasible, generalized non-linear least squares which is equivalent to the maximum likelihood estimation (Poi 2008). Estimates of the dropped budget share equation (chicken) were recovered by exploiting the adding-up and homogeneity restrictions.

Estimation of elasticities: Using the method adopted by

Green and Alston (1990) and Hayes *et al.* (1990), the expenditure elasticity is estimated as under:

$$\varepsilon_{i,x} = \frac{x}{q_i} \frac{\partial q_i}{\partial x} = \frac{1}{w_i} \left\{ \beta_i + \frac{2\lambda_i}{b(p)} \ln x - \ln a(p) \right\} + 1 \quad (4)$$

The uncompensated own price and the cross price elasticities are estimated as:

$$\varepsilon_{i,p} = \frac{1}{w_i} \left\{ \gamma_{ii} - \left(\alpha_i + \sum_{k=1}^n \gamma_{ki} \ln p_k \right) \left[\beta_i + \frac{2\lambda_i}{b(p)} (\ln x - \ln a(p)) \right] + \frac{\beta_i}{b(p)} \lambda_i [\ln x - \ln a(p)]^2 \right\} - 1 \quad \dots(5)$$

$$\varepsilon_{i,p_j} = \frac{1}{w_i} \frac{p_j}{p_i} \left\{ \gamma_{ij} - \left(\alpha_i + \sum_{k=1}^n \gamma_{ki} \ln p_k \right) \left[\beta_i + \frac{2\lambda_i}{b(p)} (\ln x - \ln a(p)) \right] + \frac{\beta_i}{b(p)} \lambda_i [\ln x - \ln a(p)]^2 \right\} \quad \dots(6)$$

Standard error of the estimated elasticities were calculated by using the Delta method (Oehlert 1992). The delta method allows us to obtain the appropriate standard errors of any smooth function of the fitted parameters of the model. QUAIDS model analyses were accomplished using the statistical software, *Stata 13.0* version.

RESULTS AND DISCUSSION

Per capita expenditure on food groups in rural and urban households: The annual consumer expenditure on food groups presented in Table 1 indicated that in both 61st round (2004–05) and 68th round (2011–12), cereals dominated the budgetary allocation in the total food expenditure in both rural and urban households in India. The next higher allocation was witnessed for livestock products, which increased from 23.51% in 2004–05 to 24.70% in 2011–12. During the same period, the share of fruits and vegetables increased from 15.26 to 16.94%. Spices and condiments, and other food commodities (salt and sugar, beverages, and

served and packaged processed foods) also showed an increase in their share of expenditure. Interestingly, the share of expenditure on cereals, pulses and oil seeds showed a decline during the same period.

Overall, the trend in expenditure over two periods presented in Table 1 clearly reflected the consumption shift towards high value commodities such as livestock food products, fruits and vegetables, and spices and condiments in rural and urban households as observed by Kumar (2011) and Mittal (2010). Spatial comparison of expenditure between rural and urban, revealed that the per capita expenditure towards livestock products, fruits and vegetables was higher for urban households as compared to the rural households. Conversely, an opposite trend is witnessed for cereals, pulses and edible oils, where the per capita rural expenditure is higher as compared to per capita urban expenditure.

Per capita quantity consumption and annual expenditure on livestock food products in rural and urban households: The per capita quantity consumption of all the livestock products showed an increase in both rural and urban households (Table 2). Specifically, urban households consumed more quantity of livestock food products as compared to the rural households in both 2004–05 and 2011–12. Over the period, in quantity terms, the per capita consumption of chicken showed a sharp increase from 0.81 kg/annum in 2004–05 to 2.5 kg/annum in 2011–12. Across different meat categories, quantity consumption of chicken increased by 208.89% followed by pork (36.36%), beef (21.84%) and mutton (9.40%). Next to chicken, the per capita quantity consumption of egg almost doubled (87.23%). In the same manner, the quantity consumption of fish and prawn increased by 27.27% and milk and milk products by 8.69% in 2011–12 as compared with 2004–05.

The share of per capita annual consumer expenditure on individual livestock products to total livestock food expenditure presented in Table 3 indicate that milk and milk products accounted for highest expenditure share (around 70%) in both rural and urban households. Next to milk, fish and prawn constituted the important animal originated

Table 1. Per capita expenditure on food groups in rural and urban households in India

Food groups	Expenditure (₹/annum) at constant prices					
	2004–05 (61 st round)			2011–12 (68 th round)		
	Rural	Urban	All	Rural	Urban	All
Cereals	2206(32.78)	2194(23.65)	2200(27.49)	1835(20.21)	2086(15.51)	1960(17.40)
Pulses	393(5.83)	490(5.28)	441(5.51)	499(5.50)	644(4.79)	571(5.07)
Edible oils	564(8.38)	754(8.13)	659(8.23)	641(7.06)	840(6.25)	741(6.58)
Livestock products	1445(21.46)	2317(24.98)	1882(23.51)	2201(24.24)	3364(25.01)	2782(24.70)
Fruits and vegetables	1023(15.19)	1420(15.31)	1222(15.26)	1521(16.76)	2295(17.06)	1908(16.94)
Spices and Condiments	233(3.46)	272(2.94)	253(3.16)	601(6.62)	765(5.68)	683(6.06)
Other food commodities [#]	868(12.90)	1828(19.71)	1348(16.84)	1780(19.61)	3458(25.70)	2619(23.25)
Total	6732(100)	9276(100)	8005(100)	9079(100)	13451(100)	11264(100)

Source: Extracted from unit level data of 61st and 68th rounds of consumer expenditure survey of the NSSO. Figures in the parentheses are percentages to total; [#]Salt and sugar, beverages, served and packaged processed foods.

Table 2. Per capita quantity consumption of livestock food products in India

Livestock products	Consumption (kg/capita/annum)						% changes over the periods		
	2004–05 (61 st round)			2011–12 (68 th round)			Rural	Urban	All
	Rural	Urban	All	Rural	Urban	All			
Milk and milk products*	48.525 (75.01)	64.592 (71.47)	56.558 (72.95)	54.227 (64.52)	68.722 (59.98)	61.475 (61.9)	11.75	6.39	8.69
Eggs	12.108 (18.72)	20.688 (22.89)	16.398 (21.15)	23.244 (27.65)	38.16 (33.3)	30.702 (30.91)	91.97	84.45	87.23
Fish and prawns	2.412(3.73)	2.472(2.74)	2.442(3.15)	3.192(3.8)	3.024(2.64)	3.108(3.13)	32.34	22.33	27.27
Mutton	0.564(0.87)	0.84(0.93)	0.702(0.91)	0.588(0.7)	0.948(0.83)	0.768(0.77)	4.26	12.86	9.40
Beef	0.372(0.57)	0.672(0.74)	0.522(0.67)	0.504(0.6)	0.768(0.67)	0.636(0.64)	35.48	14.29	21.84
Pork	0.072(0.11)	0.06(0.07)	0.066(0.09)	0.108(0.13)	0.072(0.06)	0.09(0.09)	50.00	20.00	36.36
Chicken	0.6(0.93)	1.02(1.13)	0.81(1.04)	2.136(2.54)	2.868(2.5)	2.502(2.52)	256.00	181.18	208.89
Other meats	0.036(0.06)	0.024(0.03)	0.03(0.04)	0.048(0.06)	0.024(0.02)	0.036(0.04)	33.33	0.00	20.00
Total	64.69(100)	90.37(100)	77.53(100)	84.05(100)	114.59(100)	99.32(100)	29.93	26.80	28.11

Extracted from unit level data of 61st and 68th rounds of consumer expenditure survey of the NSSO. *Milk and milk products includes liquid milk, baby food, milk condensed powder, curd, ghee and butter.

Table 3. Per capita annual expenditure on livestock food products in rural and urban households in India

Livestock products	Expenditure (₹/annum) at constant prices					
	2004–05 (61 st round)			2011–12 (68 th round)		
	Rural	Urban	All	Rural	Urban	All
Milk and milk products	1038(71.83)	1726(74.49)	1382(73.43)	1379(62.65)	2212(65.75)	1796(64.56)
Egg	39(2.70)	63(2.72)	51(2.71)	83(3.77)	133(3.95)	108(3.88)
Fish and prawns	164(11.35)	197(8.50)	181(9.62)	273(12.40)	321(9.54)	297(10.67)
Mutton	95(6.57)	163(7.04)	129(6.85)	145(6.59)	261(7.76)	203(7.30)
Beef	29(2.01)	47(2.03)	38(2.02)	53(2.41)	79(2.35)	66(2.37)
Pork	9(0.62)	6(0.26)	7(0.37)	16(0.73)	11(0.33)	13(0.47)
Chicken	69(4.78)	114(4.92)	92(4.89)	248(11.27)	344(10.23)	296(10.64)
Others meats	2(0.14)	1(0.04)	2(0.11)	4(0.18)	3(0.09)	3(0.11)
Total livestock products	1445(100)	2317(100)	1882(100)	2200(100)	3364(100)	2782(100)

Extracted from unit level data of 61st and 68th rounds of consumer expenditure survey of the NSSO. Figures in the parentheses are percentages to total food expenditure.

food products whose share increased from 11.35 to 12.40% in rural households and 8.50 to 9.54% in urban households during the two periods. The share of expenditure on chicken increased tremendously from 4.78 to 11.27% in rural households and 4.92 to 10.23% in urban households in 2011–12 compared to 2004–05 consumption levels. In fact, chicken emerged as the most preferred meat product among both rural and urban households. The expenditure share of other livestock products such as egg, beef and pork increased marginally in both rural and urban households. From the above results, it is clear that the consumption of livestock products has increased over time in both rural and urban households. The per capita expenditure on livestock products was generally higher in case of urban households *vis-a-vis* rural households. However, in relative terms, rural households increased their expenditure by 52.25% on livestock food products compared to 45.19% in urban households in 2011–12 over 2004–05.

Expenditure (income) elasticities of demand for livestock food products: We have used the QUAIDS model for

estimating expenditure elasticities. The estimates presented in Table 4 indicate that expenditure elasticities were positive and highly elastic for milk and milk products, egg and chicken, implying that consumption demand for these livestock products in both rural and urban regions increased more than the proportionately to the increase in per capita income. For instance, a 10% increase in the income of the households led to an increase in the consumption of chicken by 35.55% in 2004–05 and egg by 14.7% in 2011–12. Comparing the magnitude of expenditure elasticity of livestock products between rural and urban households in 2004–05, consumption of chicken, egg, and milk and milk products were more elastic with respect to small changes in the per capita income of rural households, whereas, it was for egg, beef, milk and milk products, fish and prawn in urban India.

This pattern of consumption did not continue in the period of 2011–12, the expenditure elasticity of demand for milk and milk products was larger in urban households than rural households. The expenditure elasticities showed

Table 4. Expenditure elasticities of demand for livestock food products in India

Livestock products	Rural		Urban		All	
	2004–05	2011–12	2004–05	2011–12	2004–05	2011–12
Milk and milk products	1.28** (0.026)	1.19** (0.076)	1.24** (0.015)	1.32** (0.036)	1.09** (0.028)	1.25** (0.071)
Egg	1.91** (0.129)	2.64** (0.557)	1.69** (0.074)	2.1** (0.082)	1.17** (0.156)	1.47** (0.356)
Fish and prawn	0.95** (0.038)	0.55** (0.062)	1.07** (0.042)	0.78** (0.069)	0.66** (0.026)	0.33** (0.089)
Mutton	-1.93** (0.449)	-0.53** (0.234)	-1.24** (0.096)	-1.44** (0.253)	-0.71** (0.235)	-0.43 (0.277)
Beef	-1.01** (0.133)	-1.18** (0.171)	1.63** (0.278)	-2.06** (0.241)	-0.45** (0.15)	-1.03** (0.124)
Pork	-0.27 (0.337)	-0.99** (0.215)	-2.63** (0.639)	-0.16 (0.135)	-1.05** (0.194)	-0.27* (0.131)
Chicken	2.31** (0.317)	2.02** (0.51)	0.59** (0.194)	1.22** (0.148)	3.55** (0.123)	2.24** (0.468)

Figures in the parentheses indicate standard errors, ** and * indicated significance at 1 and 5% levels, respectively.

Table 5. Own price elasticities of demand for livestock food products in India

Livestock products	Rural		Urban		All	
	2004–05	2011–12	2004–05	2011–12	2004–05	2011–12
Milk and milk products	-1.43** (0.026)	-1.15** (0.074)	-1.04** (0.018)	-0.92** (0.072)	-1.26** (0.027)	-1.22** (0.042)
Egg	-4.71** (0.204)	6.45** (0.542)	-2.00** (0.27)	0.65 (0.396)	0.67** (0.141)	4.31** (0.422)
Fish and prawns	-1.52** (0.065)	-1.43** (0.1)	-1.28** (0.06)	-1.15** (0.094)	-1.6** (0.044)	-1.4** (0.106)
Mutton	-0.94** (0.212)	-0.39 (0.358)	-0.96** (0.225)	2.49** (0.47)	-0.28 (0.21)	-0.1 (0.286)
Beef	-1.36** (0.126)	0.65** (0.321)	-1.73** (0.379)	-0.87 (0.493)	-1.6** (0.135)	-0.01 (0.258)
Pork	-0.74** (0.234)	0.31 (0.622)	-1.67 (1.19)	0.86** (0.205)	-1.15** (0.224)	-0.24 (0.375)
Chicken	-1.45** (0.192)	-3.16 (1.706)	-3.64** (0.216)	-1.37** (0.27)	-2.38** (0.248)	-3.69** (1.281)

Figures in the parentheses indicate standard errors; ** and * indicated significance at 1 and 5% levels, respectively.

considerable variation across livestock products and, between rural and urban households. Specifically, income elasticities were higher for chicken followed by egg, and milk and milk products.

Price elasticities of demand for livestock food products:

The own price elasticities estimated through the QUAIDS model are on expected line with high values (Table 5). There is a considerable variation in the magnitude of the elasticities across livestock products in rural and urban households. Own price elasticities for milk, egg, fish and chicken were statistically significant with higher values in both rural and urban households indicating that increased prices of livestock food items will highly affect their quantity consumption and consequently the demand for them.

To conclude, there was a substantial increase in consumption of livestock food products in the food basket of both rural and urban households in India. The total expenditure on livestock food products and their share in total food expenditure was next to cereals. Our analysis demonstrated a transition in the consumption pattern from basic cereals to livestock products and other high value commodities. Of the livestock products, consumption of milk and milk products accounted for highest expenditure share in both rural and urban households followed by fish and prawn, and mutton. Interestingly, both the expenditure share and consumption quantity of chicken increased tremendously among the rural and urban households in 2011–12 compared to 2004–05. Thus, chicken meat emerged as the most preferred meat product compared to mutton, beef and pork among the households in India.

Increased trend in the consumption of livestock products is reflected in terms of high expenditure elasticities for milk and milk products, egg, fish and chicken. The change in the demand for these livestock products was highly responsive to the changes in the per capita income and prices. The Planning Commission of India, has estimated that an increase of one egg and 50 gm of meat per capita consumption in India would create an additional employment opportunity for about 25,000 and 20,000 persons, respectively (GoI 2012). Moreover, it will benefit most of the marginal, small and semi-medium farmers as more than 85% of the livestock occupation is embarked by them. Increase in consumption of livestock derived food items are advantageous as it helps in increasing the nutritional security as livestock products contain more amount of protein, fat, calcium and vitamins. The context of increasing demand and consumption of livestock food products necessitates improving the efficiency of production and marketing systems for these products.

REFERENCES

- Banks J, Blundell R and Lewbel A. 1997. Quadratic Engel curves and consumer demand. *Review of Economics and Statistics* 79 (4): 527–39.
- Bansil P S. 1999. *Demand for Food Grains by 2020 AD*. Observer Research Foundation, New Delhi.
- Birthal P S, Taneja V K and Thorpe W. 2006. *Smallholder livestock production in India-Opportunities and challenges*. Proceedings of an ICAR–ILRI international workshop, New Delhi, India, 31 January–1 February 2006.
- Chatterjee S, Rae A, Ray R and University M. 2006. *Food*

- consumption, trade reforms and trade patterns in contemporary India: How do Australia and NZ fit in? In Conference Paper, Massey University, New Zealand: Department of Applied and International Economics.
- Chengappa P G, Achoth L, Mukherjee A, Reddy B R, Ravi P C and Dega V. 2007. *Evolution of food retail chains in India. Agricultural Diversification and Smallholders in South Asia*. Academic Foundation, New Delhi.
- Crawford I, Laisney F and Preston I. 2003. Estimation of household demand systems with theoretically compatible Engel curves and unit value specifications. *Journal of Econometrics* **114** (2): 221–41.
- Deaton A. 1990. Price elasticities from survey data: extensions and Indonesian results. *Journal of econometrics* **44**(3): 281–309.
- Deaton A. 1997. *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*. World Bank Publications.
- Deaton A and Muellbauer J. 1980. An almost ideal demand system. *The American economic review*, **70**(3): 312–26.
- GoI. 2012. *Report of the Working Group on Animal Husbandry and Dairying*. 11th Five Year Plan (2007–12), Government of India, Planning Commission, New Delhi.
- Green R and Alston J M. 1991. Elasticities in AIDS Models: A clarification and extension. *American Journal of Agricultural Economics* **73** (3): 442–45.
- Hayes D J, Wahl T I and Williams G W. 1990. Testing restrictions on a model of Japanese meat demand. *American Journal of Agricultural Economics* **72** (3): 556–66.
- Kedir A M. 2005. Estimation of own- and cross-price elasticities using unit values: econometric issues and evidence from urban Ethiopia. *Journal of African Economies* **14** (1): 1–20.
- Kumar A, Joshi P K, Kumar P and Parappurathu S. 2014. Trends in the consumption of milk and milk products in India: implications for self-sufficiency in milk production. *Food Security* **6** (5): 719–26.
- Kumar P and Dey M M. 2007. Long-term changes in Indian food basket and nutrition. *Economic and Political Weekly* **42**(35): 3567–72.
- Kumar P, Kumar A, Parappurathu S and Raju S S. 2011. Estimation of demand elasticity for food commodities in India. *Agricultural Economics Research Review* **24** (1): 1–14.
- Lapar M L, Toan N N, Que N N, Jabbar M, Minot N, Tisdell C and Staal S. 2010. Technology adoption by smallholder pig producers in Vietnam: implications from a pro-poor perspective. Contributed paper presented at the AARES 2010 Conference, Adelaide, S. A., 10–12 February.
- Mittal S. 2010. Application of the QUAIDS model to the food sector in India. *Journal of Quantitative Economics* **8** (1): 42–54.
- Mittal S. 2010. Application of the QUAIDS model to the food sector in India. *Journal of Quantitative Economics* **8**(1), 42–54.
- Oehlert G W. 1992. A note on the delta method. *American Statistician* **46**: 27–29.
- Poi B P. 2008. Demand-system estimation: Update. *Stata Journal* **8**(4): 554–56.
- Radhakrishna R. 2005. Food and nutrition security of the poor: emerging perspectives and policy issues. *Economic and Political Weekly* **40** (18): 1817–21.
- Shonkwiler S J and Yen S T. 1999. Two-step estimation of a censored system of equations. *American Journal of Agricultural Economics* **81** (4): 972–82.
- Vasileska A and Rechkoska G. 2012. Global and regional food consumption patterns and trends. *Procedia - Social and Behavioral Sciences* **44**: 363–69.