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RESEARCH NOTE

Food Consumption Pattern and Nutrient Intake in Rural and Urban Karnataka

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ABSTRACT

The present study aims to estimate the income and price elasticities of demand for different food commodities and nutrients in the rural and urban regions of Karnataka. For the purpose, the Quadratic Almost Ideal Demand System is estimated. The study has used the National Sample Survey Organisation's household consumer expenditure data on food commodities for the years 2004-05 and 2011-12. The results of the study reveal that food consumption patterns and nutrient intakes in rural and urban areas are quite different. The per capita income of households and the price of rice emerge as the major determinants of the food consumption pattern and nutrient intake in both rural and urban regions of Karnataka.

Keywords: Food Consumption, Nutrient intake, Elasticity, Income, Price, Karnataka, Households.

JEL: Q11, Q18, R22

I

INTRODUCTION

India is one of the developing countries experiencing transformation in consumption pattern rapidly from staple food commodities, which are rich in energy to animal derived products, fruits and vegetables and edible oils, which are rich in protein, fat and vitamins. Bansil (1999), Radhakrishna (2005) and Chatterjee *et al.*, (2006) have reported that there has been a shift in consumption pattern from grain to non-grain food and animal products in India. Consequently, the transition in the food consumption behaviour changes the volume of different major and micronutrient intake. Over the years, due to urbanisation and sedentary lifestyle, there was a shift in diet towards fat and added sugars involving reduced intake of carbohydrate, dietary fibers as well as essential micro nutrients (Doak *et al.*, 2005; Elmadfa, 2005). Deaton and Dreze (2009) reported that in India there was a sustained decline in the per capita intake of energy, protein and other nutrients during the last 25 years, it was fat intake that had increased steadily during this period.

Literature review suggests that consumption pattern has changed during the period under review. These changes in a region are due to demographic and socio-economic factors, which include increasing number of working women, rise in income, changes in relative prices of commodities, dietary changes, emergence of

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middle income class, changes associated with lifestyles, urbanisation, improvements in transportation and storage facilities, rise of supermarkets, the aging population and rising importance of single person households. Besides these, tourism, international migration, hanker for soft drinks, concern about health and food safety are also the major drivers. More specifically, it is known that rising per capita household income and changes in the prices of food commodities tend to change considerably the composition of food consumption. During food inflation, the most frequent strategy of households is the substitution of low priced food commodities to high priced food ones with similar nutrient attributes. Nevertheless, such strategies seldom sustain a healthy diet, which leads to malnutrition. At present, malnutrition is a major public health concern in India with 32.7 per cent of the population suffering from it and Karnataka is no exception.

Karnataka is one of the emerging economies. With the seventh largest state gross domestic product (GDP), it accounts for 5.5 per cent of the national GDP. The state is the information technology hub of India and home to the fourth best technology cluster in the world after Silicon Valley, Boston and London. Despite the declining share of agriculture sector in gross state domestic product (GSDP), it remains a main source of livelihood for the majority of population in the state.

With ten agro-climatic zones, the state of Karnataka enjoys diversity in regional agricultural production. While the five dry zones of the state produce food grains, millets, oilseeds and some of the horticultural commodities, the transition and hilly zones are specialised in the production of commercial and plantation crops that are characterised by high value and high returns. The coastal zone of the state predominantly depends on the fishery and other non-agricultural commercial activities apart from the production of some of the cereals, pulses and plantation crops.

It is disheartening to note that though the state has made significant progress in agriculture, industry and service sectors, the state has failed to achieve similar drive on human development front. The prevalence of underweight children, under five mortality rate and percentage of under-three age stunted children is more in Karnataka compared to other south Indian states (International Institute for Population Sciences (IIPS) and Macro International, 2007). Therefore, the present study is undertaken to estimate the elasticity of demand for different food items and in turn nutrients in rural and urban Karnataka.

The remainder of the paper is structured into four sections. Section II discusses data and methodology, while Section III presents the results and discussion. The final section provides summary, conclusions and policy suggestions.

II

DATA AND METHODS OF ANALYSIS

2.1 *Data*

Consumer expenditure data on different food and non-food commodities from a large sample of households are collected by the National Sample Survey Organisation (NSSO) under the Ministry of Planning at quinquennial intervals as part of its “rounds”. The data have high acceptance in research and policymaking. This study is based on the 61st (2004-05) and 68th (2011-12) Rounds survey data. The detailed sampling procedure is given in the NSSO reports on *Household Consumption on Various Goods and Services in India, 2004-05 and 2011-12.*

For the purpose of analysis, we have chosen commodities such as rice, millets, wheat, pulses, milk and milk products, edible oils, egg, fish and prawn, meats, vegetables, fruits, nuts or dry fruits and spices. The quantities of nutrient and calorie intake by the household are calculated by multiplying the total consumption of a particular food item with conversion factors given by Gopalan *et al*. (2014). This is the same procedure used by the NSSO in its regular tabulation of calorie intake estimates.

In this paper, price response of demand is obtained on the basis of unit values. The unit price for a given food item is derived by dividing the value of the food item by the total quantity consumed in a region. As for food items not consumed by a household, average price observed for the corresponding region is taken as the relevant regressor. The use of the unit value as a price of a food item has been thoroughly examined by Deaton (1997) and more recently in Kedir (2005). The prices of the food commodities are deflated with the consumer price index (CPI) of the respective years to convert them into real terms.

2.2 *Model Specification*

The Almost Ideal Demand System (AIDS) is a well known dual approach to estimating consumer demand systems; linear approximate AIDS (LA/AIDS) and quadratic AIDS (QUAIDS) models belong to the same class of models. This study uses QUAIDS as it allows non-linear Engel curves (Banks *et al*., 1997) and tests the homogeneity and symmetry by verifying the validity of corresponding restrictions on parameters of the specification (Deaton and Muellbauer, 1980). Since there is a chance to have zero expenditure on some of the food commodities, our study followed the two-step estimation procedure given by Shonkwiler and Yen (1999) to estimate the demand elasticities of income and price. Accordingly, in the first stage, the probit function is used to capture the choices of income allocation to different kinds of food commodities that are available to households. In the second stage, the amount of allocation of total food expenditure across different food groups is captured by using the QUAIDS demand model. The estimation procedure used in the two stages is as follows.

The first step involves estimating a probit regression function to estimate the probability of consumption of a particular food commodity and the function is specified as follows:

$$d_{ih} = \theta_0 + \sum_j \theta_{ij} \ln p_j + \theta_x \ln x_h + \theta_1 HHS_h + \theta_2 RSE_h + \theta_3 R_h + \theta_4 S_h + \theta_5 OWL_h + \theta_6 Age_h + \theta_7 V_h + \theta_8 DU_h + \mu_i \quad ....(1)$$

From this estimated probit regression function, normal probability density function (PDF) and normal cumulative density function (CDF) are obtained and used in QUAIDS model in the second step.

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

$$\ln x_h = \theta_0 + \sum_j \theta_{ij} \ln p_j + \theta_1 HHS_h + \theta_2 RSE_h + \theta_3 R_h + \theta_4 S_h + \theta_5 OWL_h + \theta_6 Age_h + \theta_7 V_h + \theta_8 DU_h + e_i \quad ....(2)$$

where d_{ih} =1 if the h-th household consumes i-th food commodity and 0 if the household does not. lnp_j' are the prices of 13 food commodity groups (see Table 1), x_h is total household consumption expenditure on food commodities. Description of the other explanatory variables and their units used in the above two equations are presented in Table 1.

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

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

where $w_{ih} = \frac{p_{in} q_{in}}{x}$ = the i-th food product expenditure share for consumer h; p_i=the price of good i; q_i = quantity of good i; x=monthly household income (total monthly food expenditure); $\hat{e}_h$ is the residual from the total expenditure regression; and

$\Phi(\hat{z_{ih}}\hat{\theta_i})$ and $(\delta_i\phi(z'_{ih}\hat{\theta_i})$ are CDF and PDF obtained from the first stage regression. The parameters of the QUAIDS model are estimated using 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.

TABLE 1. EXPLANATORY VARIABLES USED IN THE PROBIT AND QUAIDS MODELS

S.No. (1)	Variables (2)	Units (3)
I. Price variables(p_j)		
1.	Price of rice	Rs./kg
2.	Price of millets	Rs./kg
3.	Price of wheat	Rs./kg
4.	Price of pulses	Rs./kg
5.	Price of milk and milk products	Rs./kg
6.	Price of fish	Rs./kg
7.	Price of edible oils	Rs./kg
8.	Price of egg	Rs./kg
9.	Price of meat	Rs./kg
10.	Price of vegetables	Rs./kg
11.	Price of fruits	Rs./kg
12.	Price of nuts	Rs./kg
13.	Prices of spices	Rs./kg
II. Expenditure variables		
14.	Total expenditure (X_h)	Rs./month
15.	Square of total expenditure	
III. Household character variables		
16.	Household size (HHS)	in numbers
17.	Regular salary earners in household (RSE)	1 if there is RSE in household; 0 if there is no RSE in household
18.	Sex (S)	1 for the female headed households; 0 for male headed households
19.	Presence of own land (OWL)	1 for the household having own land, 0 for household not having own land
20.	Age	in years
21.	Presence of refrigerator (R)	1 for the household having refrigerator, 0 for household not having refrigerator
22.	Presence of vehicles (V)	1 for the household having vehicles, 0 for household not having vehicles
23.	Ownership of dwelling unit (DU)	1 for the household owning dwelling unit, 0 for household not owning dwelling unit

Parameters for rural and urban regions are estimated separately by using the Seemingly Unrelated Regression Estimation (SURE) method with symmetry and homogeneity simultaneously imposed. The budget-share equation for spices is dropped to accommodate adding-up restriction. The remaining twelve equations are estimated by an iterated, feasible, generalised non-linear least square, which is equivalent to the maximum likelihood (Poi, 2008). Estimates of the omitted budget share equation (spices) are recovered by exploiting the adding-up and homogeneity restrictions. All the analyses are done by using statistical software Stata13.1 version.

2.3 *Estimation of Elasticities*

Using the method adopted by Green and Alston (1990), the expenditure elasticity is estimated as:

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

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

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

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

2.4 *Measuring Nutrient Elasticity*

Nutrient elasticity with respect to the prices of food commodities and income of households are calculated by applying the technique used by Huang and Lin (2000) and Huang (1996). In simple terms, nutrient elasticity matrix (*l* nutrients and *n* foods) can be obtained as a product of multiplying matrix S by matrix D as follows:

N = S x D ....(7)

where N is the *l*x (*n*+1*)* matrix with entries of each row indicating a food's share of a particular nutrient, and D is the *n* x (*n*+1) matrix of demand elasticity.

III

RESULTS AND DISCUSSION

3.1 *Income Elasticity*

Income elasticity refers to the percentage change in the demand for a particular commodity in response to a given percentage change in the income of the households. Through the income elasticity, we can determine whether the food commodity under review is normal or inferior or necessity or a luxury. Estimates of income elasticities for food commodities in rural and urban areas of Karnataka are presented in Table 2. Except fish, egg and nuts in rural regions, all the food commodities are normal goods as the income elasticities of these food commodities are positive and significant in both rural and urban regions. In rural regions, income elasticity is found to be more than one for rice (1.203), meat (1.956), fruits (1.338) and spices (1.002), while it is less than one for millets (0.484), wheat (0.573), pulses (0.687), milk (0.979), edible oils (0.535) and vegetables (0.990). In urban regions, higher degree of elasticity of income is observed for fish (1.523), edible oils (1.128), egg (1.283), meat (1.612), vegetables (1.160), fruits (1.298), nuts (1.805) and spices (1.001) whereas income elasticity has been less than unit price for rice (0.496), millets (0.234), wheat (0.787), pulses (0.850) and milk (0.977). Besides, the results reveal that urban households are more income responsive than the rural households in the consumption of most of the food commodities. For instance, 10 per cent increase in the per capita income of the households leads to increase in demand for wheat by

TABLE 2. INCOME AND UNCOMPENSATED OWN PRICE ELASTICITIES IN RURAL AND URBAN KARNATAKA

	Rural		Urban	
	Income elasticity	Own price elasticity	Income elasticity	Own price elasticity
(1)	(2)	(3)	(4)	(5)
Rice	1.203**	-0.381**	0.496**	-0.428**
	(0.071)	(0.027)	(0.071)	(0.039)
Millets	0.484*	-0.134**	0.234*	-0.157**
	(0.161)	(0.021)	(0.092)	(0.023)
Wheat	0.573**	0.186**	0.787**	-0.144**
	(0.269)	(0.069)	(0.09)	(0.038)
Pulses	0.687**	-0.793**	0.850**	-0.622**
	(0.088)	(0.064)	(0.042)	(0.072)
Milk	0.979**	-1.098**	0.977**	-0.861**
	(0.092)	(0.044)	(0.05)	(0.063)
Fish and prawn	-1.375ns	-1.747 *	1.523**	-4.117**
	(1.32)	(0.913)	(0.412)	(0.889)
Edible oils	0.535**	-0.669**	1.128**	-0.491**
	(0.094)	(0.089)	(0.052)	(0.067)
Egg	0.737 ns	0.485 ns	1.283**	0.837 ns
	(0.461)	(0.776)	(0.211)	(0.528)
Meat	1.956**	-0.831**	1.612**	-0.196 ns
	(0.353)	(0.272)	(0.167)	(0.131)
Vegetables	0.990**	-0.456**	1.160**	-0.370**
	(0.079)	(0.06)	(0.047)	(0.057)
Fruits	1.338**	-1.077**	1.298**	-1.130**
	(0.094)	(0.033)	(0.034)	(0.026)
Nuts	-0.309 ns	-0.760**	1.805**	0.050 ns
	(0.272)	(0.112)	(0.153)	(0.156)
Spices	1.002**	-1.000**	1.001**	-1.000**
	(0.000)	(0.000)	(0.000)	(0.000)

Note: Figures in parentheses are standard errors; ** and * Significant at 1 and 5 per cent level; ns- non-significant.

7.87 per cent and pulses by 8.50 per cent in urban regions while the corresponding estimates for these food items are only 5.73 and 6.87 per cent in rural regions. Similarly, income elasticities of demand for fish and prawn, egg, vegetables, edible oils and nuts are relatively high in urban regions as compared to the rural regions. Furthermore, it is interesting to note that the income elasticity of demand for rice in rural regions is quite high, but it is inelastic in urban regions, demonstrating that the rice is still considered a superior item of consumption in rural regions of Karnataka.

3.2 *Own Price Elasticity*

Own price elasticity refers to percentage changes in the quantity consumed in response to a given percentage change in the own price of the commodity specified. According to economic theory, the sign of the own price elasticity is expected to be negative. Table 2 shows the un-compensated own price elasticity of demand for major food items in rural and urban Karnataka. As expected, own price elasticity estimates for all food items are negative and significant except for wheat and egg in the rural region, and egg and nuts in the urban region. In both the regions, own price elasticity estimates for milk, fish and fruits show high elasticity with a negative sign indicating that these commodities are highly perishable nature and demand for these food commodities are more responsive to small changes in the prices of their own. Consumption of all other foods are inelastic with respect to changes in their own prices.

3.3 *Cross Price Elasticity*

Cross price elasticity of demand for a commodity under review measures the percentage changes in the quantity of its consumption with respect to given percentage changes in the prices of the other commodities. Estimates of cross price elasticties facilitate determination of the nature of relationship among the food commodities, i.e., whether the commodities are substitutes or complements or independent of each other. Cross price elasticity estimates for food commodities in rural and urban Karnataka are given in Tables 3 and 4. The interpretation of cross price elasticity is ambiguous as most of the cross price elasticities are inelastic, i.e., of consumption of the food commodities to do not respond to changes in the prices of the other food commodities and most of them are not symmetric. However, strong substitutability is observed between fish and vegetables, and between fish and nuts in urban regions. Besides, it may also be noted that an increase in the price of rice reduced the demand for other food items such as pulses, vegetables, edible oils, fish and prawn, egg, meats and nuts in both rural and urban regions. Since rice is usually eaten with curry prepared with pulses, vegetables, edible oils and nuts in Karnataka, a hike in the price of rice would significantly adversely affect the consumption of these complementary food items.

TABLE 3. CROSS PRICE ELASTICITY OF FOOD COMMODITIES IN RURAL KARNATAKA

Food commodity groups (1)	Rice (2)	Millets (3)	Wheat (4)	Pulses (5)	Milk (6)	Fish (7)	Edible Oil (8)	Egg (9)	Meats (10)	Vegetables (11)	Fruits (12)	Nuts (13)	Spices (14)
Rice	-0.381**	-0.165**	-0.083**	-0.034**	0.017ns	-0.026**	-0.013**	-0.113**	-0.019**	-0.076**	-0.059**	-0.016**	0.000**
	(0.027)	(0.02)	(0.011)	(0.005)	(0.019)	(0.007)	(0.004)	(0.035)	(0.004)	(0.017)	(0.011)	(0.004)	(0.000)
Millets	-0.037ns	-0.134**	0.036**	-0.016 *	0.041 *	0.000ns	0.014**	-0.217**	-0.015**	-0.11 **	-0.057**	0.006 ns	0.000ns
	(0.034)	(0.021)	(0.012)	0.007)	(0.023)	(0.01)	(0.005)	(0.061)	(0.004)	(0.023)	(0.013)	(0.004)	(0.000)
Wheat	-0.304**	0.171**	0.186 **	-0.005 ns	0.077 *	0.010ns	-0.029 *	-0.291 ns	0.004ns	-0.223**	-0.154**	0.02 ns	0. 000 ns
	(0.096)	(0.034)	(0.069)	(0.018)	(0.041)	(0.021)	(0.014)	(0.223)	(0.007)	(0.066)	(0.032)	(0.013)	(0.000)
Pulses	-0.378**	-0.334 **	-0.008ns	-0.793 **	0.072ns	0.291 **	-0.015 ns	0.844ns	0.047 **	-0.119ns	-0.106*	-0.099**	-0.001**
	(0.105)	(0.067)	(0.067)	(0.064)	(0.079)	(0.034)	(0.032)	(0.628)	(0.017)	(0.171)	(0.052)	(0.031)	(0. 000)
Milk	0.118 *	-0.02 ns	0.013 ns	-0.009ns	-1.098 **	0.014ns	-0.023 **	-0.042 ns	0.02 *	-0.033 ns	0.021ns	-0.010 ns	0. 000 ns
	(0.05)	(0.041)	(0.021)	(0.01)	(0.044)	(0.019)	(0.008)	(0.081)	(0.01)	(0.031)	(0.023)	(0.007)	(0. 000)
Fish and Prawn	-2.047 ns	-0.736 ns	0.422ns	3.128 **	2.965 *	-1.747 *	0.705ns	-25.95 **	-0.139 ns	0.800 ns	1.23 ns	0.622 ns	-0.001 ns
	(1.388)	(0.783)	(1.049)	(0.458)	(1.632)	(0.913)	(0.428)	(7.133)	(0.276)	(1.699)	(0.79)	(0.475)	(0.004)
Edible oils	0.144ns	1.011 **	-0.228 *	-0.014 ns	-0.140ns	0.207**	-0.669**	2.851*	0.117**	-1.025**	-0.406**	-0.022ns	-0.002**
	(0.183)	(0.111)	(0.12)	(0.081)	(0.171)	(0.074)	(0.089)	(1.219)	(0.026)	(0.303)	(0.117)	(0.051)	(0. 000)
Egg	-0.077**	-0.105 **	-0.028 ns	0.03 ns	-0.003ns	-0.064*	0.039 *	0.485 ns	-0.006 ns	-0.004ns	0.0490*	-0.015ns	0. 000*
	(0.029)	(0.024)	(0.027)	(0.019)	(0.023)	(0.019)	(0.016)	(0.776)	(0.004)	(0.072)	(0.023)	(0.012)	(0. 000)
Meat	-5.452**	-6.643 **	-0.546 ns	0.021 ns	0.468ns	-0.618 *	0.092 ns	-1.502ns	-0.831 **	1.061ns	0.486 ns	-0.103ns	0.001 ns
	(1.236)	(1.179)	(0.393)	(0.28)	(1.247)	(0.293)	(0.184)	(1.572)	(0.272)	(0.817)	(0.543)	(0.169)	(0.001)
Vegetables	-0.149**	-0.098**	-0.05 *	0.001 ns	-0.017 ns	0.013ns	-0.018 *	0.005 ns	0.000ns	-0.456**	-0.0580**	-0.010ns	0. 000**
	(0.026)	(0.018)	(0.021)	(0.012)	(0.018)	(0.01)	(0.009)	(0.174)	(0.004)	(0.06)	(0.016)	(0.007)	(0. 000)
Fruits	-0.431**	-0.246**	-0.131 **	-0.02 ns	-0.027 ns	0.018ns	-0.027*	0.408 *	-0.011*	-0.110*	-1.077**	0.110**	0.001**
	(0.046)	(0.029)	(0.033)	(0.013)	(0.037)	(0.018)	(0.011)	(0.19)	(0.006)	(0.052)	(0.033)	(0.012)	(0. 000)
Nuts	-0.164ns	1.064**	0.385 *	-0.165 *	0.238ns	0.262 *	0.042 ns	-1.686 ns	0.033ns	-0.790*	1.224**	-0.760 **	-0.001 ns
	(0.23)	(0.149)	(0.165)	(0.098)	(0.166)	(0.108)	(0.07)	(1.064)	(0.035)	(0.348)	(0.154)	(0.112)	(0.001)
Spices	-0.086*	-0.163**	-0.057**	-0.072**	-0.119**	-0.039**	-0.045 **	-0.153 ns	-0.008 ns	0.005ns	0.245 **	-0.019**	-1. 000**
	(0.038)	(0.035)	(0.017)	(0.011)	(0.025)	(0.012)	(0.009)	(0.135)	(0.005)	(0.046)	(0.024)	(0.007)	(0. 000)

Note: Figures in the parentheses are standard errors; ** and * Significant at 1 and 5 per cent level respectively; ns- non-significant.The entry in rows i, column j of above elasticity matrix represents the percentage change in the quantity of good i consumed for a 1 per cent change in the price of good j.

TABLE 4. CROSS PRICE ELASTICITY OF FOOD COMMODITIES IN URBAN KARNATAKA

Food commodity groups (1)	Rice (2)	Millets (3)	Wheat (4)	Pulses (4)	Milk (6)	Fish (7)	Edible Oil (8)	Egg (9)	Meats (10)	Vegetables (11)	Fruits (12)	Nuts (13)	Spices (14)
Rice	-0.428**	-0.204**	-0.004 ns	0.002 ns	0.213**	0.004 ns	0.007*	-0.214 ns	-0.004 ns	-0.067**	-0.075**	0.005*	-0.020**
	(0.039)	(0.024)	(0.013)	(0.006)	(0.021)	(0.005)	(0.004)	(0.079)	(0.004)	(0.02)	(0.009)	(0.002)	(0.006)
Millets	-0.199**	-0.157**	0.051**	0.014**	-0.019 ns	0.019**	0.040**	-0.033 ns	-0.010*	0.074**	0.036**	0.017**	-0.050**
	(0.02)	(0.023)	(0.009)	(0.005)	(0.022)	(0.005)	(0.004)	(0.071)	(0.004)	(0.02)	(0.009)	(0.002)	(0.009)
Wheat	-0.123*	0.146**	-0.144**	-0.039*	0.113*	0.009 ns	-0.042**	0.253 ns	0.007 ns	-0.248**	-0.083**	0.0110 ns	-0.049**
	(0.049)	(0.032)	(0.038)	(0.017)	(0.057)	(0.015)	(0.01)	(0.242)	(0.008)	(0.068)	(0.025)	(0.008)	(0.015)
Pulses	-0.306**	-0.032ns	-0.154**	-0.622**	-0.333**	0.157**	-0.094**	1.323 ns	0.011 ns	-0.278 ns	-0.044 ns	-0.013 ns	0.011 ns
	(0.074)	(0.05)	(0.058)	(0.072)	(0.077)	(0.027)	(0.027)	(0.834)	(0.012)	(0.162)	(0.051)	(0.011)	(0.023)
Milk	0.193**	-0.127**	0.032 ns	-0.038**	-0.861**	-0.006 ns	-0.009 ns	-0.144 ns	0.012 ns	0.011 ns	-0.046**	-0.004 ns	-0.025*
	(0.038)	(0.03)	(0.022)	(0.009)	(0.063)	(0.012)	(0.006)	(0.111)	(0.007)	(0.05)	(0.016)	(0.003)	(0.012)
Fish and Prawn	-3.060**	1.923*	0.084 ns	2.301**	-1.564 ns	-4.117**	0.205 ns	-5.935 ns	-0.760**	4.845**	0.928 ns	1.155**	0.662 ns
	(1.045)	(0.968)	(0.936)	(0.461)	(2.071)	(0.889)	(0.287)	(6.08)	(0.231)	(1.694)	(0.687)	(0.291)	(0.455)
Edible oils	-0.562**	0.801**	-0.441**	-0.271**	-0.309 ns	0.0230 ns	-0.491**	0.087 ns	0.064**	-0.662**	-0.383**	-0.166**	0.047 ns
	(0.13)	(0.081)	(0.088)	(0.066)	(0.133)	(0.041)	(0.067)	(1.121)	(0.02)	(0.236)	(0.078)	(0.021)	(0.043)
Egg	-0.093**	-0.031 ns	0.016 ns	0.025 ns	-0.039 ns	-0.009 ns	0.000**	0.837 ns	-0.007 ns	-0.124*	0.000 ns	-0.001 ns	-0.010 ns
	(0.022)	(0.017)	(0.019)	(0.018)	(0.025)	(0.008)	(0.01)	(0.528)	(0.004)	(0.05)	(0.015)	(0.003)	(0.008)
Meat	-3.247**	-3.504**	-0.272 ns	-0.252*	0.073**	-0.420**	0.105 ns	-2.302 ns	-0.196 ns	-0.781 ns	-0.517**	-0.054 ns	-0.145 ns
	(0.576)	(0.431)	(0.242)	(0.107)	(0.592)	(0.107)	(0.076)	(1.369)	(0.131)	(0.459)	(0.194)	(0.047)	(0.125)
Vegetables	-0.179**	-0.006 ns	-0.079**	-0.030**	-0.016**	0.0180**	-0.023**	-0.388*	-0.005 ns	-0.370**	-0.028*	-0.013**	-0.005 ns
	(0.023)	(0.014)	(0.017)	(0.011)	(0.034)	(0.007)	(0.007)	(0.154)	(0.004)	(0.057)	(0.013)	(0.003)	(0.007)
Fruits	-0.561**	-0.029 ns	-0.128**	-0.041**	-0.203 ns	0.008 ns	-0.059**	0.007 ns	-0.021**	-0.139**	-1.130**	-0.018**	0.270**
	(0.038)	(0.029)	(0.025)	(0.014)	(0.044)	(0.012)	(0.009)	(0.193)	(0.007)	(0.052)	(0.026)	(0.005)	(0.014)
Nuts	-1.249**	1.918**	0.171 ns	-0.481**	-1.260**	0.873**	-1.169**	-0.503 ns	-0.142 ns	-2.961**	-0.963**	0.050 ns	-0.150 ns
	(0.374)	(0.319)	(0.396)	(0.156)	(0.472)	(0.239)	(0.126)	(1.93)	(0.081)	(0.594)	(0.26)	(0.156)	(0.158)
Spices	0.004*	-0.002*	-0.001*	0.000 ns	-0.003 ns	0.000 ns	0.000 ns	-0.006 ns	-0.001**	-0.003**	0.007**	0.000**	-1.000**
	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.004)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)

Note: Figures in the parentheses are standard errors; ** and * Significant at 1 and 5 per cent level respectively, ns non-significant.The entry in rows i, column j of above elasticity matrix represents the percentage change in the quantity of good i consumed for a 1 per cent change in the price of good j.

3.4 *Nutrient Elasticities with Respect to Income and Food Prices*

To examine nutrient intake response to changes in price and income, nutrient elasticities are calculated as per the estimator given in the Equation (4). A set of nutrient elasticities showing the effects on the intake of fourteen nutrients in response to changes in thirteen food prices and per capita income are computed and reported in Tables 5 and 6 for rural and urban regions respectively. For instance, one per cent increase in the price of rice (holding other prices and income constant) would affect the amount of all food consumption through the interdependent demand relationships. Accordingly, in both rural and urban regions, most of the price elasticities are less than one per cent (closer to zero). Since the rice is the predominant food commodity and a huge portion of the total expenditure is spent on rice only, changes in the prices of rice affected considerably the quantity intake of all the nutrients in both rural and urban regions. A one per cent increase in the price of rice would reduce the intake of all the nutrients, irrespective of the amount of a particular nutrient content in the rice. For instance, although rice contains no vitamin ‘A’ and ‘C’, a one per cent increase in the price of rice would reduce the quantity intake of these vitamins in the rural regions. Similarly, an increase in the millet price affected the intake of vitamin ‘C’ and B6, fat, carbohydrate and protein. If the price of pulses increased by one per cent, the intake of vitamin ‘C’ decreased by 0.64 per cent. Calcium consumption decreased by 0.693 per cent when the price of milk went up by one per cent. A one per cent increase in the price of fish would reduce intake of fat and vitamin ‘A’ by 0.941 per cent and 0.528 per cent respectively. A one per cent increase in the price of eggs caused fat, energy and vitamin ‘A’ to decrease by 14.382, 2.88 and 8.25 per cent, respectively. The same price change for vegetables caused all nutrients except fat to decrease.

In urban regions, increases in the prices of rice, wheat, pulses, milk, edible oils, vegetables and fruits would decrease considerably the quantity intake of all the nutrients. An increase in the rice price is considered as one of the major factors leading to decrease in the quantity intake of all nutrients. A one per cent increase in the price of milk would reduce the intake of fat, calcium, vitamin ‘A’, vitamin ‘B12’ and vitamin ‘C’. The increase in the price of edible oils reduced the intake of fat and vitamin ‘A’ by 0.339 and 0.184 per cent, respectively. The prices of vegetables are the major determinants of intake of all the vitamins. In both rural and urban regions intake of all nutrients (except fat in rural areas) respond well to an increase in per capita income. Urban households increased their intake of fat, calcium, vitamin ‘A’ and vitamin ‘B12’ more than proportionately in response to changes in per capita income.

TABLE 5. NUTRIENT ELASTICITY BASED ON FOOD DEMAND ELASTICITY IN RURAL REGION

Commodities/ Nutrients (1)	Income Elasticity of nutrients (2)	Rice (3)	Millets (4)	Wheat (5)	Pulses (6)	Milk (7)	Fish and Prawn (8)	Edible oil (9)	Egg (10)	Meat (11)	Vegetables (12)	Fruits (13)	Nuts (14)	Spices (15)
Protein	0.864	-0.307	-0.109	-0.061	-0.168	-0.159	0.072	-0.117	0.500	0.004	-0.226	-0.074	-0.045	-0.004
Fat	-0.480	-1.145	-0.249	0.229	1.746	1.448	-0.941	0.306	-14.382	-0.058	0.266	0.705	0.307	-0.002
Crude fibre	0.706	-0.302	-0.075	0.040	-0.357	0.055	0.137	-0.014	0.133	0.019	-0.189	0.023	-0.101	-0.082
Carbohydrates	0.994	-0.305	-0.139	-0.036	-0.097	-0.010	0.012	-0.010	-0.067	-0.009	-0.100	-0.052	-0.026	-0.003
Energy K.cal.	0.578	-0.429	0.005	-0.005	0.332	0.281	-0.173	-0.042	-2.880	-0.001	-0.160	0.070	0.050	-0.003
Calcium	0.864	-0.011	0.026	0.007	-0.098	-0.693	0.057	-0.062	0.202	0.024	-0.143	-0.012	-0.034	-0.005
Phosphorus	0.881	-0.218	-0.037	-0.042	-0.124	-0.236	0.057	-0.094	0.346	0.009	-0.204	-0.062	-0.038	-0.006
Iron	0.772	-0.230	0.065	-0.023	-0.230	-0.034	0.112	-0.108	0.487	0.026	-0.282	-0.056	-0.071	-0.029
Vitamin A (Carotene)	0.078	-0.728	-0.120	0.094	0.997	0.814	-0.528	0.109	-8.250	-0.020	-0.025	0.304	0.197	-0.006
VitaminB1 (Thiamine)	0.803	-0.267	0.060	0.011	-0.168	-0.048	0.081	-0.045	0.005	0.011	-0.236	0.076	-0.119	-0.006
Vitamin B2 (Riboflavin)	0.794	-0.044	0.250	-0.075	-0.087	-0.400	0.096	-0.233	0.951	0.043	-0.392	-0.138	-0.029	-0.006
Vitamin B6 (Niacin)	1.017	-0.342	-0.138	-0.043	-0.104	0.013	0.015	-0.013	-0.067	-0.011	-0.113	-0.023	-0.044	-0.006
Vitamin B12 (Folic acid)	0.890	-0.250	-0.149	-0.021	-0.282	-0.163	0.099	-0.028	0.262	0.015	-0.133	-0.064	-0.044	-0.001
Vitamin C	0.748	-0.345	-0.319	-0.014	-0.640	-0.028	0.233	-0.015	0.666	0.034	-0.133	-0.088	-0.084	-0.011

TABLE 6. NUTRIENT ELASTICITY BASED ON FOOD DEMAND ELASTICITY IN URBAN REGION

Commodities/ Nutrients (1)	Income Elasticity of nutrients (2)	Rice (3)	Millets (4)	Wheat (5)	Pulses (6)	Milk (7)	Fish and Prawn (8)	Edible oil (9)	Egg (10)	Meat (11)	Vegetables (12)	Fruits (13)	Nuts (14)	Spices (15)
Protein	0.860	-0.355	-0.108	-0.034	-0.094	-0.187	-0.041	-0.034	0.135	-0.020	-0.095	-0.058	0.021	-0.013
Fat	1.131	-0.377	0.513	-0.235	-0.187	-0.422	0.050	-0.339	0.107	0.029	-0.538	-0.276	-0.090	0.012
Crude fibre	0.790	-0.345	0.083	-0.052	-0.298	-0.208	0.140	-0.126	0.463	-0.009	-0.375	-0.112	0.002	-0.101
Carbohydrates	0.591	-0.346	-0.108	-0.032	-0.064	0.082	0.027	-0.020	-0.003	-0.002	-0.131	-0.076	0.005	-0.027
Energy K.cal.	0.843	-0.312	0.045	-0.071	-0.082	-0.085	0.020	-0.092	0.154	0.003	-0.219	-0.109	-0.016	-0.014
Calcium	0.944	-0.050	-0.030	0.010	-0.050	-0.642	-0.060	-0.032	-0.053	-0.013	0.009	-0.036	0.024	-0.014
Phosphorus	0.818	-0.261	-0.086	-0.021	-0.080	-0.205	-0.006	-0.033	0.100	-0.010	-0.111	-0.062	0.012	-0.022
Iron	0.835	-0.353	0.044	-0.031	-0.145	-0.167	0.014	-0.077	0.267	-0.020	-0.187	-0.073	0.022	-0.036
Vitamin A (Carotene)	1.110	-0.258	0.245	-0.172	-0.150	-0.284	0.024	-0.184	0.182	0.021	-0.351	-0.176	-0.061	0.010
VitaminB1 (Thiamine)	0.804	-0.411	0.119	-0.003	-0.162	-0.192	0.136	-0.157	0.088	-0.018	-0.456	-0.166	0.008	-0.039
Vitamin B2 (Riboflavin)	0.988	-0.104	-0.077	-0.002	-0.062	-0.321	0.006	-0.022	0.289	-0.003	-0.104	-0.043	0.002	-0.022
Vitamin B6 (Niacin)	0.619	-0.432	-0.075	-0.021	-0.049	0.058	-0.001	-0.040	-0.102	-0.015	-0.134	-0.086	0.018	-0.023
Vitamin B12 (Folic acid)	0.760	-0.237	-0.089	-0.055	-0.221	-0.204	0.060	-0.039	0.357	0.003	-0.160	-0.056	-0.003	-0.014
Vitamin C	0.903	-0.293	-0.040	-0.130	-0.496	-0.351	0.104	-0.081	0.970	0.003	-0.242	-0.052	-0.005	0.001

IV

SUMMARY AND CONCLUSIONS

It is concluded that food consumption patterns and nutrient intake in rural and urban areas are quite different. The per capita income of households positively influence the food consumption and nutrient intake in both rural and urban regions. It is found that households in urban areas are more sensitive to changes in per capita income as the estimated income elasticity for most of the food commodities are found to be more than one per cent. Further, our results clearly show that rice is income inelastic in urban regions, indicating that change in income has no impact on rice consumption. Rice is income elastic for rural households indicating that as income increases expenditure on rice increases more than proportionately. The results of the cross price elasticity matrix show that rice in Karnataka is a mild complement with pulses, vegetables, meat, fish and prawn etc. Consequently, increased price of rice significantly reduces the consumption of these complementary foods. These results clearly indicate that the increased price of rice and lower per capita income of households would severely affect the food and nutritional security of rural households. Therefore, efforts are required to enhance per capita income of rural households through income diversification activities and constant employment generation programmes. In addition, the price of the rice should be stabilised to prevent the reduced consumption of their complements.

Finally, the preceding analysis shows that increase in the per capita income of the households increase the intake of all nutrients. Price of rice, in general, determines the intake of most of the nutrients in both rural and urban regions, as rice has been the staple food crop and occupied larger share of total food expenditure of rural and urban households. It is suggested that the results of the study would provide insights and help the policy makers and nutritional experts to frame appropriate policies regarding food and nutritional security in Karnataka. The results of the study may encourage the researchers to undertake region wise analysis of food and nutrient consumption pattern.

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