
Asymptotic Limit of Consumption and Threshold Level of Income with reference to Indore City

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Abstract

The concept of asymptotic level of consumption is defined as increase in consumption of a commodity with income but only up to a level and then after reaching a maximum level it becomes stable irrespective of income. Especially, food consumption stops increasing with an increase in income because of the limitation associated with digestive system. It is observed that empirical study on maximum food consumption as well as threshold income have not been done on Indian situation. Growing need was felt to conduct an academic study for Indore city with respect to their food consumption pattern to derive the maximum potential level of consumption termed as asymptotic limit of consumption as well as threshold level of income. Data from Indore city are collected on the basis of a sample of size of 714 household units. Then, the asymptotic limit of consumption and threshold level of income have been estimated using reciprocal transformation method. In all the cases, there exists significant positive relationship between income and food consumption. Hence, the first hypothesis, $\beta_1 > 0$, was accepted at 5% level of significance for food commodities rice, wheat, other cereals, pulses, dairy products, edible oil, eggs and other food items. This indicates that increase in income results in increase in food consumption derived from the above mentioned food categories. Consumption of these food categories seems to have reasonable prospect for expansion although at a lower rate, especially in the case of animal products. The analysis suggests that consumption is still well below saturation level (asymptotic level) and that appreciable increases are still possible.

Key Words: *Asymptotic Limit; Threshold Level; Indore city; Food Consumption*

Introduction

The concept of asymptotic level of consumption is defined as an increase in consumption of a commodity with an increase in income only up to maximum level after which it becomes stable irrespective of income. This maximum level of consumption is defined as the limit of consumption and termed as asymptotic limit (Gujarati, 2007). For example, saturation level of consumption of any food item can be explained as the physical consumption of food which is limited by the capacity of the human digestive system. Yet,

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expenditure on food is not so strictly limited as it is possible for well-fed countries with sufficient purchasing power to go on spending more and more in order to obtain a more desirable quality and variety of food. Additionally, consumption expenditure might be increasing due to wastage by the rich countries.

The paper also assumes that families below threshold level of income do not purchase food from the market due to lack of purchasing power. Thus, the threshold level of income is the critical level at which the relationship between consumption and income is established. To estimate the asymptotic limit of consumption as well as the threshold level of income for a particular city like Indore at micro level for regional marketing strategies are of much interest. Any attempts to estimate these asymptotic or saturation levels of consumption and the threshold level of income must involve an element of subjective judgment but in exercising such judgment it is useful to have some objectively determined data as a check.

Review of Literature

The econometric estimation of asymptotic limit of consumption and the threshold level of income are gaining interest in recent econometric contributions. Moreover, there have also been significant advances in the methodology of estimation of maximum potential level of consumption. The reciprocal transformation model in the estimation of relevant parameters on the basis of cross-sectional data is a methodological refinements of traditional estimation methods. Its significant in policy formulations is mainly determined by how a reciprocal transformation model is specified and estimated.

The changing demographic profiles, increasing income levels, urbanization, technology, globalization and a free flow of ideas from within and outside the country, have brought about a dramatic shift in consumer tastes and preferences ultimately effecting the food consumption pattern (Kumar and Sarkar, 2008). Although recently, the study of food consumption is approached with the integrated perspective (Petrovici et al., 2005), initially it comprised of fragmented studies (Ritson et al., 1986). In the past, there have been evidences in the evolution of food consumption in European countries analyzed by several authors (Besch, 1993; Blandford, 1984; Frank and Wheelock,

1988; Gracia and Albisu, 2001) Meulenberg and Vianne, (1993) Ritson and Hutchins, (1991) Wheelock and Frank (1989), outline some of the important findings as follows: trend of decreased the proportion of expenditure allocated to food, food consumption reached the maximum level in total food category, an increase in proportion of take away food and there was a shift in the food consumption pattern. These trends indicated that economic growth was common to all the European countries. The reason for consumption reaching the maximum level in the total food category was that people wanted to eat better as their daily intake requirements diminished and in wealthy countries generally quantity surpassed by quality concerns. The proportion of shift in food consumption structure was not homogenous for all the European Countries, it varied depending on their cultural and historical evolutions. The last trend of increase in proportion of food take away was almost common for all countries but it varied in its intensity among countries and with labor circumstances.

The economic theory and the consumer behaviour suggest three important factors responsible for annual variation in per capita food expenditure which is explained by neoclassical methods of estimating household demand for food. The three important factors are household real income, product price, and the prices of substitute products including nonfood products (Deaton and Muellbauer, 1980 and Gracia et al., 1998) and two more added by Elsner and Hartmann (1997) as preferences and socio-demographic factors. The models that are based only on these three factors are quite powerful and impressive in predicting (Connor, 1994).

In the earlier studies, Adrian and Daniel (1976) studied the impact of socioeconomic characteristics of household and its constituents on consumption of protein, carbohydrate, fat, vitamin A, calcium, iron, thiamine and vitamin C. Socioeconomic factors considered included income, degree of urbanization, race educational attainment of the homemaker, stage of the household in the family life cycle, family size, meal adjustment and the employment status of the homemaker. The study showed a positive impact on the consumption of all nutrients except carbohydrate. It was also revealed that the nutrient consumption responsiveness to income was relatively small.

Several studies have focused on specifying the influence of household income and other socioeconomic characteristics on nutrient consumption but most of these have been limited to localized areas or particular groups of people (Babcock, Einstein and Horstein, Kel-say, Madden and Yoder). Generally, these studies noted significant variations in nutrient consumption with respect to income, education, and race. Saxon (1975) has used the model which explores the effects of prices and substitutes on the consumption of certain products. The results using these models incorporated prices of substitutes as explanatory variables. It has showed that a rise in the price of beef appeared to be a factor contributing to increase consumption of pork. The results revealed that prices of pork and chicken did not affect the elasticities for beef during the period 1963-1972 while the price of beef had significant effect on the consumption of both pork and chicken.

Saxon (1975) has further studied the saturation level of food particularly in Japan. During the period considered, there were evidences of people approaching or reaching a level of saturation in food consumption taken as a whole measured in calories. It revealed that this saturation level of food is being approached or has reached in most of the economically advanced countries. The estimation of maximum potential level or asymptotic level of consumption is meaningful in conjunction with other evidence in making some assessment of the likely growth or contraction in the region of Asia. It is generally acknowledged that income and the price are by no way the exclusive determinants of food consumption, although they are thought to be normally the easiest to measure. Other than income, the price and some additional factors influencing food consumption may be grouped, according to Saxon, under five headings. The headings go as (i) physical need (ii) availability (iii) changes in services (iv) tastes and (v) changes in geographical distribution of population.

All the research mentioned above, suffered from the limitation that they were confined to meet the marketing requirement(s) of the countries other than India. As such, growing need was felt to conduct an academic study of Indore city with respect to their food consumption pattern and to provide a maximum potential level of consumption and threshold level of income of the city. To fill in the gap, it is therefore,

useful at this juncture to examine trends in consumption patterns in Indore city at micro level and deliberate on the potential of the food and agriculture sector to meet demands and challenges posed by the dynamic environment. The objective of the study is to estimate asymptotic limit of food consumption and to estimate the threshold level of income at micro level in Indore city.

Research Methodology

One of the methods to estimate the asymptotic limit of consumption and threshold level of income is named reciprocal transformation method. The model is of the form given in equation (1).

$$Y_i = \beta_1 + \beta_2 \left(\frac{1}{X_i} \right) + u_i$$

where ... (1)

Y_i = Food Consumption in kcal per capita per day for i^{th} country

X_i = GDP at factor cost in \$ for i^{th} country

This model is non-linear in the variable X because it enters inversely or reciprocally, the model is linear in β_1 and β_2 and is therefore a linear regression model. The model has built in itself an asymptote or limit value that the dependent variable will take when the value of X variable increases indefinitely. As X increases indefinitely, the term

$$\beta_2 \left(\frac{1}{X_i} \right)$$

approaches zero and Y approaches the limiting or asymptotic value of β_1 . It is clear that as income becomes very large, consumption of any product will tend to level out. The relationship is unlikely to be as simple as suggested by this formula. In the first place, it assumes that income is the sole explanatory variable, and in the second place, saturation only approaches as income approaches infinity.

Empirical Analysis

Data from Indore city are collected with a sample of size of 714 household units. 94 percent of the respondents are headed by males while only 6 percent are headed by females. Families on an average are headed by a middle aged person with a mean age of 48 years. The occupation of head of the family is 57 percent service, 36 percent business, 5 percent retired and only 2 percent are headed with no males. Families considered for analysis reported that wives of head of the family are 69 percent housewives, 14 percent in service, 1 percent retired while rest are families with no male head. The qualification of head of family is 45 percent graduates, 40 percent post graduates, one percent post doctorate, 12 percent high school and rest 2 percent below high school. Most of families are with a household size of 4 members while an average household size of 5 members. The average annual income of families is Rs. 4,06,071 while there are maximum numbers of families earning a total annual income of Rs. 3, 00, 000. On an average the considered families spend Rs. 83,350 per year on food with an average 32 percentage share of their income on food.

The relation between income and food consumption is tested initially by plotting the scatter plot (**Appendix**). There is an indication of increase in consumption of total food expenditure, rice, wheat, other cereals, pulses, milk, vegetables, fruits, dairy products, oil, sugar, tea, coffee, meat / chicken, fish, eggs and other food with an increase in income. From the scatter plot it can be said that the rise in consumption is not directly proportional to the rise in income. The consumption increases initially and slows down later with increase in income. Estimation of asymptotic limit of household food consumption and threshold level of income at micro level in Indore city is done using reciprocal transformation model given by equation (1) where, Y_i denotes consumption of commodity of food in Rupees of a family (household), X_i represents annual income of a family (household) in Rupees to estimate parameters involved. The Ramsey's RESET test is applied to specify the model. The table 1 reflects the F -statistics used to identify specification error using Ramsey's RESET test and the parameters.

From the table 1, the RESET test indicates that F -values are lower than the critical value at 1 percent

level of significance for the food commodities such as rice, wheat, other cereals, pulses, dairy products, edible oil, eggs and other food items and hence do not contain any specification error.

Except for the food categories, milk, vegetables, fruits, sugar, tea, coffee, meat/chicken and fish, there does not exist any specification error in the model. Hence reciprocal transformation regression model is run and parameters are estimated for food categories which do not report specification error. The estimated maximum potential level (asymptotic limit) of food consumption and the threshold level of income for food categories with no specification error are reported in the table 1. In all cases where there existed significant relationship between income and food consumption, there existed a positive relationship. Hence the first hypothesis, $\beta_1 > 0$, was accepted at 5% level of significance for food commodities rice, wheat, other cereals, pulses, dairy products, edible oil, eggs and other food items. This indicates that increase in income results in increase in food consumption derived from the above mentioned food categories.

The food category of *other food items* is showing the highest asymptotic limit of Rs. 22, 134 amongst the reported food items and consumed by 90 percent of families. With increase in income in Indore, people are increasingly spending on the food items other than the items considered for the analysis. These other items may include ready to eat food items, packaged food items, meals taken away from home (not prepared at home) etc. As the percentage of working females has increased since last decade, the habit of eating out, using ready to eat food items (ready food items) and packaged food items have increased and hence reported highest asymptotic limit of consumption at micro level. The threshold level of income for this food category is Rs. 78, 860 which is again highest amongst the reported food items. This indicates that spending on other food items is mostly affordable by higher-middle-income class families.

Of the reported food items in the table 1, the next food commodity that has achieved a maximum potential level of consumption is *dairy products* with an asymptotic limit of Rs. 8, 733 and threshold level of income Rs. 64, 581. Dairy products include yogurt, cheese, butter, cottage cheese (paneer), chakka

(water-less yogurt used in the preparation of Shreekhand, one of the popular sweets in the city) and other milk products. Dairy products are consumed by 93 percent of families of the considered sample

size. Dairy products are high valued products which are consumed increasingly with an increase in income, High threshold level of income is an indication of consumption again by a higher-middle-income class of families.

Table 1:
Specification Error Test, Asymptotic Limit of Consumption and Threshold Level of Income:
Micro Data Analysis

Food Commodity	RESET test F-statistic	Asymptotic limit of consumption β_1	t statistic	β_2	Threshold level of Income β_2 / β_1
Rice	2.59	3698.87	21.51	-121930192.19	32964.18
Wheat	1.97	5258.95	30.44	-96699671.33	18387.64
Other Cereals	3.62	1073.68	13.91	-46340203.07	43160.09
Pulses	3.35	4013.02	21.61	-130003683.30	32395.50
Milk	18.06 *	-	-	-	-
Vegetables	6.04 *	-	-	-	-
Fruits	36.97 *	-	-	-	-
Dairy Products	3.25	8732.61	6.79	-563961873.13	64581.15
Edible Oil	2.06	8000.35	7.78	-347651692.73	43454.58
Sugar	4.93 *	-	-	-	-
Tea	7.16 *	-	-	-	-
Coffee	7.33 *	-	-	-	-
Meat/Chicken	5.00 *	-	-	-	-
Fish	5.42 *	-	-	-	-
Eggs	4.08	1423.79	8.73	-72419866.01	50864.23
Other Food	1.14	22134.10	2.96	-1745507587.57	78860.44
Total Food	48.24 *	-	-	-	-

Source : Authors calculation using Ramsey's RESET test and reciprocal transformation model (1)

Note : * significant at 1 % level of significance with critical value of F-statistic $F_{0.01(2,*)} = 4.61$.

Edible oil is the category of food which has attained an asymptotic limit of Rs. 8, 000 and threshold level Rs. 43, 455. With increase in income, consumption of edible oil is also increasing and has attained a third position in achieving maximum potential limit of consumption (amongst the reported food items) in Indore city. The threshold is not at the third place and hence oil is consumed by most of the families irrespective of any class of income.

The food item, wheat has attained a maximum potential level of Rs. 5, 259 and threshold level of Rs. 18, 388. The low threshold of the commodity is the indication of consumption of wheat by even low income-class people. The consumption of wheat is stabilized at the asymptotic level which is moderate, not much low and not high. Irrespective of the income class, families in Indore city are consuming wheat which is one of the staple food commodities. Traditionally, people in the city purchase wheat once in a year somewhere during March to June and store it for making use over a year. Wheat is the basic food item which is consumed mainly in the main course by every class of family. With increase in income, the consumption of wheat increases to a moderate size and stabilizes.

The category of staple food, *pulses, rice, and other cereals* stabilize respectively with an asymptotic limit of Rs. 4013, Rs. 3699 and Rs. 1074. It is considered that pulses (dal) is a high source of protein and traditionally it is consumed commonly with rice not only in the city Indore but also in the country irrespective of any season, religion, culture or income-class. While consumption of other cereals like corn (makka), jwar, bajara etc. stabilize at a low asymptotic limit. This category of food is mostly consumed by the people in rural area and hence its consumption does not increase much with increase in income in the Indore city. The category of other cereals is a special type of food category which is not so common in urban areas and is consumed very less frequently only by some of the categories of the people. Other cereals food category is consumed by 89 percent of families while rice and pulses are consumed by all families in the sample.

Eggs are consumed by 43 percent of families and attain a maximum potential level of Rs. 1, 424 and

threshold level of Rs. 50, 864. Less than half of the considered sample size consume this food commodity and attains a low asymptotic level of consumption. The reason may be that this is consumed by a particular group of people. Unlike the staple food, consumed uncommonly in the city and its consumption depends on the season (especially in winter and rainy), religion, culture. The threshold is not much low and indicates the consumption of the commodity by moderate income-class people.

Conclusion

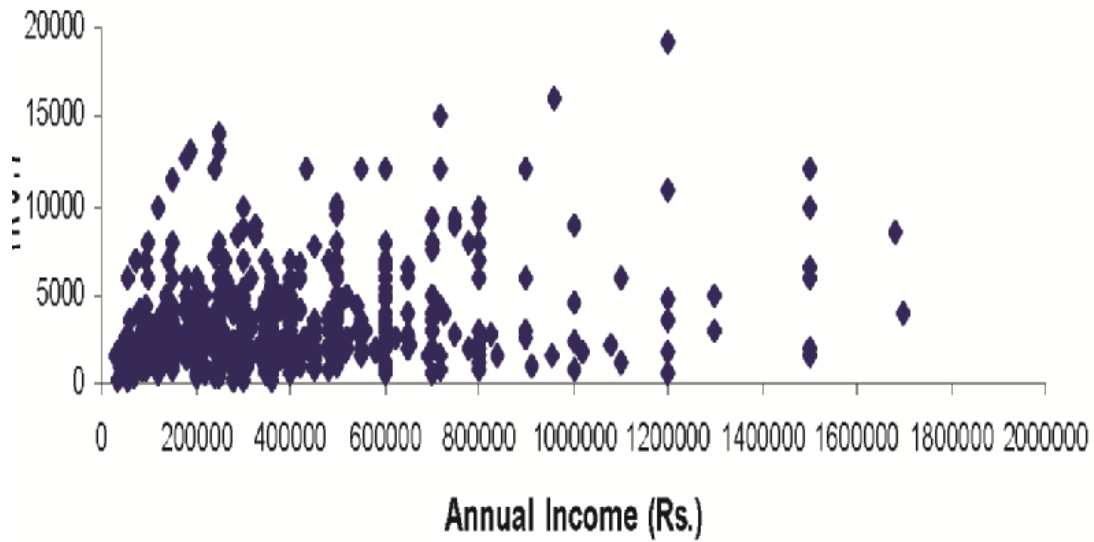
Micro data collected from Indore city is characterized on an aggregate by households which are middle aged, graduates male heading with majority of service class families. On an average families are headed by graduate males with a modal family size of four members and average family size of five members. This indicates the families in general are male headed and there still exists a culture of joint family in the city. Most of the families are middle income-class and spend on an average Rs. 83, 350 on food annually with an average 32 percent share of their income on food.

In general, consumption of food has not yet reached a plateau at micro level while there are some differences in different food categories. There is a general tendency of people in Indore to spend on other type of food items which may include ready to eat food items, packaged food items, meals take away (not prepared at home) etc. As the percentage of working females has increased since last decade, the habit of eating out, using ready to eat food items (ready food items), and packaged food items has increased and hence reported highest asymptotic limit of consumption at micro level. A High threshold level for this food category is the indication of consumption of other food items by the higher-middle-income class families. Consumption of dairy products and edible oil (fats) are also increasing with an increase in income and are appearing below the saturation level. Consumption of these food categories seems to have reasonable prospect for expansion although at a lower rate. Especially in the case of animal products the analysis suggests that consumption is still well below saturation level and that appreciable increases are still possible.

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Scatter Plot: Annual Income vs Pulses Consumption



Scatter Plot: Annual Income vs Milk Consumption

