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Evolving Food Consumption Patterns in Assam: A Comparative Demand Analysis Using LES Framework

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Abstract: *The formulation of economic policy primarily depends on the role of consumer behaviour. Any change involving the demand pattern of individuals have major consequences on the growth, trade and development of a country. Demand models play an important role in evaluating the indirect tax policy reform. The study provides a comparative analysis of demand for selected food items for Assam, using secondary data from National Sample Survey (NSSO) 66th and 68th rounds. Through a comprehensive analysis of consumer expenditure data, the paper demonstrates the theory behind demand estimation and highlight the importance of selecting appropriate demand system models based on the specific characteristics of the data and the policy questions at hand. The findings reveal significant transitions in consumption preferences over time, with "committed consumption" increasing for cereals, sugar, salt, and oil, while declining for pulses. The expenditure elasticity of cereals decreased, reflecting reduced demand sensitivity to income changes, while the elasticities of other commodities increased. The study also highlights differences in gross substitute and gross complement relationships between the two rounds. These results underscore the importance of developing nuanced fiscal policies for rural and urban sectors, tailored to address evolving dietary behaviors and socio-economic factors.*

Keywords: Demand System, Demand estimation, Consumption Demand, Demand Analysis, CoEsumption Expenditure

INTRODUCTION

Understanding consumer behaviour through the estimation of demand systems is a cornerstone of economic analysis. Demand systems allow economists to examine how consumers allocate their spending across different goods and services, providing insights into price elasticity, income effects, and the substitution patterns among goods. Consumption expenditure is a significant driver of economic growth which also contributes to government revenue through taxes on goods and services.

Demand models play an important role in evaluating the indirect tax policy reform. The first prominent demand system was Linear Expenditure System (LES) by Stone (1954) after which many other systems have been developed. The study provides a comparative analysis of demand for selected food items for Assam, using secondary data from National Sample Survey (NSSO) 66th and 68th rounds. The motivation of the study is to analyse official data as exhaustively as possible. This study seeks to inform both academic researchers and policymakers, providing them with the necessary knowledge to make informed decisions in areas such as taxation and welfare analysis.

The results highlight shifts in dietary preferences over time, reflecting broader socio-economic changes. For instance, the declining expenditure elasticity of cereals suggests a move toward diversified consumption, while the growing elasticity values of other commodities indicate increased sensitivity to income growth and price changes. Additionally, the changing relationships of gross complementarity and substitutability between commodities underscore the evolving interdependencies in household food baskets. By providing a detailed comparative analysis of demand, this study aims to inform policymakers on designing targeted fiscal interventions that accommodate regional and sectoral diversity in Assam. Addressing these consumption dynamics is critical for ensuring food security, economic equity, and sustainable development in the region.

REVIEW OF LITERATURE

In the context of developing economies, Taljaard et. al (2003) estimated demand for four categories of meat (beef, chicken, pork and mutton) for South Africa using the data for 1970-2000. Abdulai and Aubert (2004) have used QU-AIDS on Tanzanian food expenditure data, Wu et. al. (1995)

examined urban consumption of six broad food categories (rice, pork, vegetables, fish, eggs and fruits) using Chinese household survey data. For India, Mazumder (1986) compared the outcomes of LES and AIDS demand systems using NSSO 7-28th rounds and for nine food groups. She concludes that AIDS performs better than LES in explaining the data.

Since Stone's (1954) seminar article, many studies (Deaton and Muelbauer 1980) have adopted a linear expenditure system (LES) as a convenient starting point. The main problems with LES are (a) for certain values of prices and income, predicted expenditure is negative. Although it is not satisfactory from the theoretical aspect, this system may be still being used for other price-income points. (b) LES seems to be limited due to a lack of long time series data or continuous cross-section data. They are unduly restrictive as a result of arbitrary assumptions used in the derivation of parameters (Chang and Fawson1994). (c) LES is price relative and requires few independent parameters (2k-1; k = number of commodities). Although this makes its applicability an easy task, it is sometimes not free from limitations such as goods are Hicksian substitutes and cross-price derivatives are proportional to expenditure derivatives, expenditure elasticities are always positive, etc. Murty and Ray (1989) argued that estimation of optimal commodity taxes that are based solely on LES (e.g. Harris and Mackinnon 1979) distort the price and expenditure responses.

Despite these criticisms, LES (among all other demand models) exhibits a very close consistency with consumer choice theory (having well-defined expenditure and indirect utility functions). More recent examples include Clements et. al (2020, Australian data), Lahiri (ibid), Berges and Casellas (2002, Argentina), Raper (ibid). Arar and Verme (2016) have used LES (among other systems), to compute consumption and welfare changes implied by price changes. Chang and Fawson (1994) discussed certain systematic estimation trends in consumer behaviour during 1951-1990. A higher R^2 value along with significant t statistics of the relevant estimates revealed that the LES system was a useful tool in characterising the wide tendencies in the allocation of expenditure behaviour of individuals. Although somewhat dated, Howe (1977) demonstrated how to incorporate demographic variables in a LES framework.

METHODOLOGY

The Linear Expenditure System (LES) begins with the algebraic form of the consumer's utility function and then derives the corresponding demand functions. The utility function is given by

$$U=\prod(x_i-a_i)^{b_i}$$

Where a_i is minimum (subsistence) consumption for commodity i. Maximising utility subject to the budget constraint $\sum p_i x_i = M$ yields the following set of equations,

$$p_i x_i = p_i a_i + b_i\left(M - \sum_{j=1}^{n} p_j a_j\right)$$

$$M - \sum_{j=1}^{n} p_j a_j$$

Where = supernumerary expenditure (over and above subsistence expenditure).

The equation has a very straightforward interpretation. Total expenditure on any good consists of committed expenditure on the good, $p_i a_i$, and a fraction (b_i) of the income over and above the committed expenditure on all commodities ($M - \sum p_i a_i$). In this interpretation, b_i is the 'marginal budget share' of commodity i $\left(b_i = \frac{\partial E_i}{\partial M}\right)$. Of primary importance are the "subsistence consumption" parameters as thy directly reveal the state of poverty. This becomes important when one does a group comparison.

The model must obey $q_i > a_i$ (regularity condition), $b_i > 0$ (for normal goods) and marginal budget shares must add up to 1 $\left(\sum\left(\frac{\partial E_i}{\partial M}\right) = 1 \rightarrow \sum b_i = 1\right)$

This restriction also implies that the utility fictions are homogeneous of degree zero. On the other hand, some of the a_i can be negative (implying elastic demand).

Substituting the estimated values in the formula for Marshallian own price elasticity, Marshallian cross-price elasticity and expenditure elasticity:

Own price elasticity $\eta_{ii} = -1 + \frac{a_i(1-b_i)}{q_i} = -1 + \frac{a_i(1-b_i)}{\bar{q}_i}$.

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Cross price elasticity[1] $\eta_{ij} = -b_i \frac{p_j a_j}{q_i p_i} = -b_i \frac{p_j a_j}{\bar{E}_i}$

$\eta_{ij} = -b_i \frac{p_j a_j}{q_i p_i} = -b_i \frac{p_j a_j}{\bar{E}_i}$

Expenditure elasticity $\eta_m = \frac{b_i M}{q_i p_i} = \frac{b_i M}{\bar{E}_i} \eta_m = \frac{b_i M}{q_i p_i} = \frac{b_i M}{\bar{E}_i}$

Corresponding Hicksian elasticities are

$$\left.\begin{aligned} \eta_{ii}{}^h &= (b_i - 1) * \left(1 - \frac{a_i}{x_i}\right) = (b_i - 1) * \left(1 - \frac{a_i}{\bar{x}_i}\right) \\ \eta_{ij}{}^h &= -\left(\frac{b_i p_j}{p_i x_i}\right)(x_j - a_j) = -\left(\frac{b_i \bar{p}_j}{\bar{E}_i}\right)(\bar{x}_j - a_j) \end{aligned}\right\}$$

The norm is to calculate the elasticities at the mean value of price, quantity, expenditure, etc.

The model predicts that the Engel curve

$$E_i = p_i q_i = p_i a_i - b_i \sum p_j a_j + b_i * M$$

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is linear. This is an added restriction, and is likely to be satisfied only over small ranges of income.

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1 Note that $\eta_{ij} \neq \eta_{ji}$. Also, cross-price elasticities are always negative for a normal good (as long as $a_j > 0$). The model predicts that commodities are gross complements in a Marshallian sense if $a_j > 0$.

One added complication comes from the fact if the estimated value of a_i is negative. While this does not pose any theoretical problem, the interpretation of $a_i<0$ as the "subsistence purchase" becomes difficult to sustain (Pollack 1971). A negative value of a_i implies elastic demand. However, corresponding cross-price elasticities will be positive as already observed.

RESULTS

The 66th round (July 2009-June 2010) of the National Sample Survey (NSS) Organization and the 68th round (July 2011-June 2012) have been used. 'Household Consumer Expenditure' and 'Employment are regarded as the chief and vital source of statistical indicators on social consumption and well-being, level of living and inequality. For certain commodities, the questionnaire does not measure quantities as it is not possible to do so. So, such commodities have been dropped from our analysis. Data by NSS is collected separately for commodities purchased in the market, for commodities grown or produced at home, and for commodities obtained as loans or gifts.

A brief guide to the two rounds of NSSO, an overview of the commodities selected, as well as the summary statistics has been presented. The summary statistics of total consumption expenditure are shown in table 1

Table 1: Total consumption expenditure in deciles (in rupees)

DECILE CLASS	D1	D2	D3	D4	D5	D6	D7	D8	D9
Assam Rural 66 Round	576	656	741	815	904	1012	1121	1283	1550
India Rural 66 Round	537	631	718	804	895	1001	1133	1322	1653
Assam Urban 66 Round	674	835	1048	1205	1426	1747	1918	2311	3330
India Urban 66 Round	733	926	1101	1293	1502	1773	2097	2063	3665
Assam Rural 68 Round	584	742	806	880	1043	1263	1420	1710	2583
India Rural 68 Round	521	905	1018	1136	1266	1427	1645	2007	4481
Assam Urban 68 Round	821	976	1245	1432	1645	1855	2197	2664	5580
India Urban 68 Round	701	1363	1625	1888	2181	2548	3063	5350	7282

Source: 66 & 68 NSSO data

Although there are various categories of food and non-food items under consumption expenditure, our study focuses on food expenditure only. The rationale behind such an analysis is because there were many missing values in the NSSO Rounds data. The five items viz., cereals, pulses, sugar, salt and oil only had consistent quantity and value of consumption data. Also, rural-urban segregation which is the basic division followed by NSSO, India has been followed in our study. We speculate that both the magnitude and the signs of elasticities may vary across the food items as well as between the urban and rural sub-samples. Thus, as far as a targeted food policy is concerned, they ought to vary between the urban and rural centres in addition to the food items.

The commodity disaggregation will be as follows:

1. **Cereal:** It includes rice, chira, khoi, muri, wheat, maida, maize, bajra, ragi, etc. Household consumption does not include consumption of cereals by livestock belonging to the household. Such expenditure, being part of farm expenditure, is excluded from household consumer expenditure altogether.
2. **Pulse:** It includes urd, khesari, gram, moong arhar, masur, peas, besan, etc.
3. **Sugar:** This will include sugar, khandsari, gur, misri, honey, candy, etc.
4. **Salt:** This will include all edible salt, whether iodised or not.
5. **Edible oil:** When vanaspati, groundnut oil, mustard oil, coconut oil, etc. is used for cooking they are termed as "edible oil". But the same is not included here when used for toilet purposes.

The Linear Expenditure System (LES) and the Linearly-Approximate Almost Ideal Demand Systems (AIDS) which had been proposed by Deaton and Muelbauer (1980) shall be used for estimating a five-commodity disaggregation of consumer expenditure from NSSO data in India (66th NSS Round).

Table 2: Summary Statistics of Selected Items (both rounds) (in rupees)

Value	(66th round)		(68th round)	
	Mean	S.D.	Mean	S.D.
Cereals (Assam)	1061.45	475.637	1025.39	566.12
Cereals (Urban)	938.70	436.012	1021.34	555.30
Cereals (Rural)	1096.72	480.74	1026.64	556.47
Pulses (Assam)	134.38	25.44	194.09	116.07
Pulses (Urban)	180.77	112.08	203.6	134.39
Pulses (Rural)	168.97	108.4	191.17	109.68
Sugar (Assam)	71.81	46.02	84.64	47.32
Sugar (Urban)	76.953	52.427	88.37	59.597
Sugar (Rural)	70.33	43.91	83.50	42.79
Salt (Assam)	13.93	6.79	27.84	17.29
Salt (Urban)	13.28	6.90	31.94	21.95
Salt (Rural)	14.123	6.74	26.58	15.373
Oil (Assam)	167.91	80.81	596.86	406.24
Oil (Urban)	178.76	89.48	609.13	455.86
Oil (Rural)	164.79	77.88	593.08	389.71
Sample size (Pooled)	3393		3368	
Sample size (Urban)	752		793	
Sample size (Rural)	2641		2575	

Source: 66 & 68 NSSO data

Table 3: Mean prices of various commodities (in rupees)

Commodities	Mean Price (Assam) 66th Round	Mean Price (Assam) 68th Round
Cereals	16.86965	16.98403
Pulses	62.12575	56.00154
Sugar	28.90609	21.43286
Salt	9.586937	10.42264
Oil	68.22255	68.8975

The LES procedure estimates the following equation

$$w_i = \frac{p_i a_i}{M} + b_i \left(1 - \frac{\sum_j p_j a_j}{M} \right)$$

Here, M is the group budget, a_i is the minimum (subsistence) consumption, b_i is the marginal budget share and p_i is the (unit) price of commodity i. The system aims to estimate a_i and b_i. Since we have consistent data only for five categories, we will assume separability. In what follows, the commodities are identified as such

Commodity id	Commodity
1	Cereal
2	Pulse
3	Sugar
4	Salt
5	Oil

The procedure is as follows. We will first tackle pooled data for both the rounds. We will present the regression estimates, compute the elasticities (Marshallian, Hicksian and Expenditure. Then, we present the analysis of data as per linear expenditure system (LES) estimation with a comparison over time: pooled 68/ pooled 66, urban 66/urban 68, rural 66/ rural 68.

The reason behind such a comparison exercise is the following. Regression coefficients and elasticities reflect behavioural patterns, and hence different values indicate a possible transformation of preferences. Such transformations may happen not only over cross-section of data (e.g. urban/ rural preferences might be different within a single round of NSSO) but over time (e.g. urban/urban preferences are different over two different rounds of NSSO). An exhaustive study is required to investigate these aspects. This will throw light on whether preferences etc are changing over time.

In this section, we provide a brief comparative discussion on the evolution of coefficients, estimates, elasticities and their implication for tax rules over time. As already noted earlier, elasticities are dictated by behaviour. Hence, this exercise will show light on how behaviour has changed over time. We will begin with the pooled regression, followed by the sub-samples.

In the next table, we compare the coefficients across the NSSO rounds

Table 4: Over Time Comparison of Regression Coefficients: Pooled Sample

Coefficient	66th	68th
a1	-3.7665	25.6630
	(-1.23)	(39.46)***
a2	1.543778	1.5162
	(23.09)***	(45.70)***
a3	1.7584	2.09632
	(37.20)**	(63.39)***
a4	.90717	1.2573
	(34.84)***	(53.99)***
a5	1.48564	2.7282
	(27.90)***	(30.02)***
b1	.86676	.508796
	(185.21)***	(126.46)***
b2	.059755	.0955
	(18.25)***	(67.13)***
b3	.01656	.03597
	(12.75)***	(65.62)***
b4	.004190	.01331
	(19.21)***	(56.71)***
b5	.0527334	.34640
	(19.21)***	(91.97)***
N	3368	3368

It can be observed that "committed consumption" of cereals, sugar, salt and oil in the total food budget (of five items) has increased from the 66th to the 68th round, while that of pulses has reduced. The marginal budget share of cereals has fallen, but that of every other commodity has increased. A negative z in a1 indicates that the subsistence value of cereals is below the mean average but is insignificant.

	Cereal		Pulse		Sugar		Salt		Oil	
	66th	68th	66th	68th	66th	68th	66th	68th	66th	68th
Cereal	-1.00047	-.98770***	-.07831	-.04213	-.041498	-.02229	-.0070967	-.006502	-.082763	-.093270
P>(|z|)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pulse	.022125	-.214417	-.99154	-.99293	-.01769	-.022107	-.003026	-.006448	-.035292	-.092492
P>(|z|)	0.21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar	.01465	-.18520	-.022117	-.03608	-.97591	-.976126	-.002004	-.00556	-.023373	-.079889
P>(|z|)	0.207	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Salt	.019114	-.20827	-.02885	-.040584	-.015287	-.021473	-.9351492	-.955452	-.030488	-.08984
P>(|z|)	0.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oil	.0199548	-.25290	-.03011	-.04928	-.01595	-.026075	-.002729	-.00760	-.99161	-.99701
P>(|z|)	-1.00047	0.000	-.07831	0.000	-.041498	0.000	-.0070967	0.000	-.082763	0.000

DISCUSSION

The magnitude of own-price elasticity of cereal has decreased. It is seen that cereals with all other food items are gross substitutes in the 68th round but it is not the same case in the 66th round where they are gross complements. However, the 66th round values are not significant.

The value of Own-price elasticity of pulse has increased. For pulses, sugar and salt with all other items are negative and significant indicating gross substitutes. The value of own-price elasticity of sugar has increased marginally. Sugar is also a gross complement with other commodities. The value of own-price elasticity of salt has increased over time. The property of gross complement to other items is also maintained, i.e., there are changes in value, but no change in properties. The value of own-price elasticity has gone up for oil. Here too, there is no 'jump' in properties of gross complement, although the values have increased.

Now we turn to an analysis of change in expenditure elasticities.

Table 6: Over Time Comparison of Expenditure Elasticities: Pooled Sample

	Cereal	Pulse	Sugar	Salt	Oil
68th round	.957087	.94910	.8197796	.9219052	1.11947
66th Round	1.214028	.5176909	.3428567	.4472285	.4669015

Thus, we see that with time, the expenditure elasticities of cereal have decreased, while those of other commodities have increased. This probably reflects a change in preference over time.

Next, we turn to a comparison of Hicksian (own-price) elasticities.

Table 7: Over Time: Comparison of Hicksian Own-price Elasticities

	68th	66th
Cereal	-.282009	-.1411891
Pulse	-.510171	-.4208671
Sugar	-.44955	-.3021698
Salt	-.522171	-.3810814
Oil	-.44974	-.375079

Thus, the own (compensated) price elasticity of each commodity has increased over time.

CONCLUSION

Economists utilize consumption data in multiple ways. At one end, macroeconomists pay their attention to the aggregate consumption behaviour of a country as it constitutes a large part of national income. On the other hand, microeconomists focus on patterns of household consumption. The reason behind such a focus is the implicit fact that individual levels of material well-being depend crucially on the consumption of goods and services. Hence, the consumption vector of goods and services (both in levels as well as composition) translates into an indicator of the standard of living of an individual or a society.

This chapter presents a comparative demand analysis of selected food items in Assam using 66th and 68th round secondary data of NSSO. Data has been analysed using LES Own and Cross-price elasticities along with expenditure elasticities have been calculated. It was found that depending on the value judgement of the social planner, for urban and rural sectors, the tax policies are expected to be very different.

The comparative analysis of food demand in Assam, based on NSSO 66th and 68th round data, highlights evolving consumption patterns and elasticities for key food commodities. The findings underscore a shift in household preferences and budgetary allocation over time.

The increase in the "committed consumption" share of cereals, sugar, salt, and oil within the total food budget, alongside a decline for pulses, reflects changing dietary priorities. The marginal budget share trends reveal that while cereals have experienced a decrease, all other commodities have seen growth, indicating a diversification in consumption behavior.

Own-price elasticity values reveal significant insights. For cereals, the magnitude has decreased, indicating reduced sensitivity to price changes. The transition of cereals from being gross complements with other food items in the 66th round to gross substitutes in the 68th round signifies a notable change in inter-item relationships. Pulses, sugar, and salt maintain gross substitute properties with other items, although the own-price elasticity of pulses has increased, signifying heightened price sensitivity. Sugar and oil, though showing increased elasticity values, retain their gross complement properties with other commodities, indicating consistency in their consumption patterns relative to other items.

Expenditure elasticity analysis further strengthens the evidence of shifting preferences. The decline in expenditure elasticity for cereals, juxtaposed with an increase for other commodities, suggests a gradual move away from staple-heavy consumption to a more varied dietary pattern. This transition may reflect broader socio-economic changes such as urbanization, rising incomes, and shifts in lifestyle. The study also underscores the importance of tailoring fiscal policies for rural and urban sectors in Assam. Given the observed differences in elasticity values and consumption preferences, a nuanced approach is crucial for taxation and subsidy policies to achieve equity and efficiency in food consumption. In conclusion, this study provides a detailed understanding of changing food demand dynamics in Assam. The results underline the necessity for informed policy interventions that account for evolving consumption patterns, aiming to balance affordability, nutritional outcomes, and economic sustainability.

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