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State-Level Food Demand in India: Some Evidence on Rank-Three Demand Systems

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Working Paper No. 60

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ABSTRACT

This paper examines the relevance of estimating rank-three demand systems in the context of India. The analysis is based on state-level estimation of higher-order generalisations of two popular demand systems: the Linear Expenditure System and the Almost Ideal Demand System. Our results suggest that while incorporating higher-order income terms in consumer demand estimation is important, it is not always necessary to undertake the additional computational burden imposed by rank-three demand systems. Also highlighted in this paper is the state specificity of demand parameters; regional variations in consumer (food) behaviour should not be ignored.

1. INTRODUCTION

The analysis of consumer demand has considerable policy significance, since estimated demand parameters are used in a variety of welfare applications, for example, in optimal commodity taxes and tax reforms, in demand forecasting, in calculating true cost of living indices, and in evaluating inequality and poverty. In recent years, the demand literature has seen greater attention being paid to the way income effects are modelled. This interest stems from the evidence from a large number of countries that suggests that consumer allocation responses to changes in income are certainly non-linear and perhaps even non-monotonic. Making simplistic assumptions about the relationship between budget shares and income can result in seriously-biased parameter estimates. With the availability of powerful software at the desk-top, it is relatively easy to estimate higher-order approximations to flexible functional forms and other complex functions. Indeed, the choices are seemingly endless. However, there are limits to the amount of independent information that can be obtained from incorporating more complex income terms. In a landmark paper, Gorman (1981) established that the matrix of coefficients of demand systems that are polynomial functions of expenditure can have at most rank 3. In practical terms, his theorem implies that the quadratic case is as general as one needs to get.

There is a long and policy-oriented literature on demand analysis in the Indian context--see Ray (1991) for a review. However, the empirical evidence on rank-3 demand systems is relatively limited, especially for India, [see, however, Ray (1996) and Chakrabarty (1996)]. Studies for developed countries such as the UK suggest that rank-3 generalizations matter, while those for less developed countries (see for instance Burgess and Ping (1995) on China) indicate that they do not. This is because food accounts for a major portion of consumer expenditures in poorer countries, and food items are unlikely to exhibit rank-3 behaviour. This paper investigates whether a similar statement may be made for India, where food consumption patterns since the early 1970's are indicative of non-linear and non-monotonic income effects.

In another paper, it was demonstrated that the evidence for a rank-3 demand system was weak, at least at the all-India level (Meenakshi and Ray, forthcoming). This conclusion was based on a quadratic generalization of the Almost Ideal demand system. In this paper we extend the analysis to a quadratic rank-3 generalization of the popular Linear Expenditure System to examine whether this conclusion is sensitive to the choice of the functional form. We investigate whether the extra computational burden imposed by rank-3 systems is worthwhile in terms of greater explanatory power and significantly different estimates of crucial policy parameters. Also, we compare the two rank-3 systems to assess which seem one is to be better at capturing income responses in India.

Given the wide diversity in culture and preferences within the country, the analysis is undertaken for 16 major states, and for rural and urban areas separately. Earlier work suggests that aggregating over states is inappropriate in the Indian context (Meenakshi and Ray, forthcoming; Meenakshi, 1996a). Estimating state-level demand systems allows for the possibility that the choice of the "best" functional form varies from state to state. Given that levels of living vary widely within the country, it is conceivable that (food) demand in the richer states is more effectively captured by rank-3 demand systems, while rank-2 systems suffice for the less-developed states.

To simplify the analysis, we ignore demographic influences on consumer demand.

The next section sets out very briefly the five models that are estimated, the third describes the data set used, in the fourth section a discussion of the results is presented, and the conclusions and implications are drawn out in the final section.

The Models

1. Linear Expenditure System (LES):

We begin with the popular Linear Expenditure System. In budget share form, it is given by:

$$w_i = \frac{p_i \gamma_i}{Y} + \beta_i [1 - \sum_j \frac{p_j \gamma_j}{Y}] \tag{1}$$

where w is the budget share, p refers to prices, Y refers to total expenditure; γ and β are parameters; and the subscript i refers to the ith commodity. By the Klein-Rubin theorem, any demand system in which expenditure on a commodity is linearly related to prices and income can be expressed as the LES.

The LES is, of course, very restrictive. Marginal budget shares β_i are constant, implying that elasticities are a decreasing function of the average budget share--which is counter-intuitive for many commodities, especially food. Put another way, linear Engel curves imply that rich and poor people spend their incomes in a similar way at the margin. This is clearly unlikely to be true in most contexts.

Despite being somewhat discredited, the LES--with modifications--continues to be popular, and is the reason we use it as our benchmark. For instance, the Piece-wise Linear Expenditure System is used to capture nonlinearity over the entire range of the sample; it forms the basis of the Planning Commission's consumption submodel used to make demand projections for the country. However, this still implies linear income effects within the piece.

2. Quadratic Expenditure Systems (QES):

One generalization of the LES which circumvents this limitation is the Quadratic Expenditure System [see Ray (1985) for other LES generalizations and their evidence on rural India]. Pollak and Wales (1992), extending the results of Howe, Pollak and Wales (1979), provide a complete characterization of all preference-consistent demand systems that are quadratic in expenditure. They demonstrate that such demand systems are generated by indirect utility functions of the form (see Pollak and Wales, 1992 for details):

$$V(\mathbf{P}, Y) = -\frac{g(\mathbf{P})}{Y - f(\mathbf{P})} - \frac{\alpha(\mathbf{P})}{g(\mathbf{P})} \tag{2}$$

where V(.) is the indirect utility function; **P** refers to a vector of prices, Y is total expenditure, g(.), f(.) and α(.) are homogenous of degree 1 in prices P.

For appropriate choices of g(.), f(.) and α (.) it is possible to derive rank-3 demand systems which nest the LES, thus making it simple to test whether ignoring non-linear income terms matter. Thus the choice of::

$$g(\mathbf{P}) = \prod_k p_k^{\beta_k} \text{ where } \sum \beta_k = 1; f(\mathbf{P}) = \sum p_k \gamma_k; \quad \alpha(\mathbf{P}) = \sum p_k \delta_k \tag{3}$$

yields what Pollak and Wales term the Σ-QES, which in budget share form is given by:

$$w_i = \frac{p_i \gamma_i}{Y} + \beta_i [1 - \sum_j \frac{p_j \gamma_j}{Y}] + [\frac{p_i \delta_i}{Y} - \beta_i \sum_j \frac{p_j \delta_j}{Y}] \prod p_i^{-2\beta_i} [1 - \sum_j \frac{p_j \gamma_j}{Y}]^2 \tag{4}$$

The first two terms in the above expression constitute the LES component; the δ's distinguish the QES from the LES. Unlike the LES, marginal budget shares in the QES are functions of all prices and income.

3. The Almost Ideal (AI) Demand System:

Since the introduction of the LES, a wide range of alternative functional forms have been proposed. Among the latter is the Almost Ideal Demand System, proposed in by Deaton and Muellbauer (1980). Consider a cost function which exhibits price-independent generalized linearity in logarithms (PIGlog):

$$\log C(u, \mathrm{P}) = \log a(\mathrm{P}) + u\, b(\mathrm{P}) \tag{5}$$

where u is utility, $\boldsymbol{P}$ is a vector of commodity prices, and $a(.)$ and $b(.)$ are homogenous of degree one and zero, respectively in prices. For

$$\log a(\mathbf{P}) = \alpha_0 + \sum \alpha_i \log p_i + \frac{1}{2}\sum_i \sum_j r_{ij} \log p_i \log p_j \,; \sum \alpha_i = 1, \sum_i r_{ij} = 0,\; r_{ij} = r_{ji}$$
$$b(P) = \beta_0 \prod p_k^{\beta_k} \; where \sum_k \beta_k = 0 \tag{6}$$

the Almost Ideal Demand system takes the form:

$$w_i \;=\; \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log Y^*; \quad where\, Y^* = \frac{Y}{a(\mathbf{P})}; \tag{7}$$

where the superscript star refers to real income deflated using an appropriate price index. A member of the class of flexible functional forms, the AI demand system has found favour in many empirical applications, as it allows for non-linear income responses, while retaining the attractive aggregation properties (because of the PIGlog cost function), and also because of the ease of its estimation. Notice that here the marginal budget shares vary with income, but do so monotonically.

4. The Quadratic Almost Ideal (QAI) demand system:

A quadratic extension of the AI demand system which allows marginal budget shares to vary with income is the Quadratic Almost Ideal (QAI) Demand System (see Blundell, Pashardes and Weber, 1993). Consider now a quadratic logarithmic family of cost functions given by :

$$\log C(u,\mathrm{P}) \;=\; \log a(\mathrm{P}) + \frac{ub(\mathrm{P})}{1\; - \; uc(\mathrm{P})} \tag{8}$$

with $a(\mathrm{P})$ and $b(\mathrm{P})$ as before, and setting $c(\mathrm{P}) = \lambda b(\mathrm{P})$, the QAI Demand System can be written as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log Y^* + \beta_i \lambda [\log Y^*]^2; \quad where\, Y^* = \frac{Y}{a(\mathbf{P})} \tag{9}$$

This specializes to the AI system when λ is zero and allows for a non-monotonic relationship between the marginal budget share and income, depending on the sign of λ. Specifically, it allows for the possibility of an inferior good becoming normal, or vice-versa, with increases in income. This demand system however has rank two because the parameters of the quadratic (in logarithms) income term are functionally related to the linear (in logarithm) income term.

5. The Generalized Quadratic Almost (GQAI) Demand System:

A rank-three generalization of the QAI is made by choosing:

$$c(P) = \prod p_k^{\lambda_k} \; where \sum_k \lambda_k = 0 \qquad (10)$$

Substituting this in (8) where log *a(.)* and *b(.)* are as given as in (6), this demand system takes the form:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log Y^* + \lambda_i \prod p_k^{\lambda_k - \beta_k} [\log Y^*]^2; \; where \; Y^* = \frac{Y}{a(P)} \qquad (11)$$

Clearly, this rank-3 demand system specializes to the AI demand system with the imposition of the restrictions $\lambda_i = O\forall_i$.

Data

The data for this analysis are taken from the consumer expenditure surveys conducted by the National Sample Survey Organization. Information on allocation of total expenditures for sixteen major states in the country are taken from various issues of the NSSO publication *Sarvekshana.* Excluded from consideration are most of the north-eastern states for lack of comparable data; however, these states account for a fairly small percentage of the total population of the country. The data pertain to four survey rounds corresponding to the years 1972/73, 1977/78, 1983 and 1987/88. The price data are taken from Jain and Minhas (1991) and Tendulkar and Jain (1993).

The study considers allocations of food expenditures across four major commodity groups: *cereals and cereal substitutes; milk and milk products; meat, eggs and fish; and other foods*. Excluded from the analysis are non-food expenditures: as in most developing countries, food accounts for a major portion of the consumer's budget. At the all-India level, in 1972/73 the share of food in total expenditures was 73 percent in rural and 65 percent in urban areas, respectively. Fifteen years later, these had dropped to 64 percent and 56 percent, respectively. Not surprisingly, given the low levels of per capita income, cereals dominate the food budget, accounting for 56 percent of rural and 36 percent of urban food expenditures in 1972/73. Fifteen years later, these had dropped to 41 percent and 26 percent, respectively. Over time, consumers in both rural and urban areas have spent relatively more on milk and meat products, substituting away from cereals, despite a relative cheapening of cereals. Thus over this period, in rural areas the milk share in food expenditures increased from ten to fourteen percent, and that of meat products increased from a little over three percent to five percent; in urban India the combined share of milk and meat products increased from 19 to 23 percent. A more detailed description of the data set used, and of the trends in food consumption, is contained in Meenakshi, 1996 b and Meenakshi and Ray, forthcoming.

A Full Information Maximum Likelihood procedure is used for estimation. We were unable to achieve convergence for urban areas of three states--Karnataka, Tamil Nadu and Uttar Pradesh; the results therefore pertain to 16 rural and 13 urban states.

Results

The estimates of δ_i that distinguish the Quadratic Expenditure System from the Linear Expenditure System are set out in Table 1. A vast majority of the coefficients have reasonably low standard errors, suggesting that the QES marks a distinct improvement over the LES:

marginal budget shares clearly vary with income and prices in both rural and urban India. Similarly, the estimated λ's of the rank-2 Quadratic Almost Ideal Demand System, and all three $\lambda_{i's}$ of the rank-3 Generalized Quadratic Almost Ideal Demand System (at least in the rural areas) are, by and large, significant (Table 2). This suggests that including higher-order (log) income terms matters. In the urban areas, the evidence is less compelling: the estimated λ's (of the rank-2 QAI) and the $\lambda_{i's}$ (of the rank-3 GQAI) have fairly low asymptotic t-ratios.

The log likelihood values of all five models are presented in Table 3. As might be expected given the estimates in Table 1, for all sixteen states considered in this study the likelihood ratio test rejects LES in favour of the QES in both rural and urban areas. Similarly, the rank-two QAI demand system is preferred over the AI demand system in 15 of 16 states in rural areas, but only in six of 13 states in urban India. The rank-3 GQAI is preferred over the AI demand system in all 16 rural states, and in eight of 13 states in urban India.

Of greater interest is the comparison between the two quadratic extensions of the Almost Ideal Demand System. To compare these non-nested models, the Likelihood Dominance Criterion (LDC) proposed by Pollak and Wales (1991) may be used. The LDC establishes an unambiguous ranking of any two competing models by comparing the difference in their log likelihood values with Chi-square values associated with a wide range of possible parametric sizes of a notional composite model. The application of this criterion suggests that the rank-3 extension is preferred over the rank-2 QAI in 10 of 16 states in rural India and in 7 of 13 states in urban India. The rank-2 QAI model is preferred in five rural states, and in three urban states; the criterion is indifferent between the two models in one rural and three urban states.

A similar comparison of the two rank-3 systems--the GQAI demand system and the QES--once again underlines the state-specificity of food demand behaviour in India. The LDC ranks the GQAI higher than the QES in 11 rural states and in 5 of 13 urban states. In urban Punjab, the test statistic is inconclusive. Indeed, by this criterion even the rank-two QAI outperforms the QES in 10 rural and four urban states.

Thus it appears that while the case for incorporating higher-order income terms is very strong, that for estimating the rank-three generalizations is not, especially when one considers extensions to the Almost Ideal Demand System. For many states in India (especially in urban areas), the rank-two QAI system adequately captures consumer preferences. However, no systematic pattern can be discerned for those states for which the rank-three GQAI is preferred--neither are these richer, nor do they form a distinct geographical cluster, compared to those states where the rank -two QAI is preferred.

How different are the resulting elasticities for the various models estimated? Consider the evidence for two of the commodity groups: cereals and cereal substitutes, and milk and milk products. Table 4 reports expenditure elasticities for the commodity group: cereals and cereal substitutes. These are evaluated at base year (1972/73) all-India prices and incomes. It is clear that the elasticity magnitudes in rural and urban areas vary considerably (with urban estimates predictably lower than the rural). They also vary substantially between the states. This is to be expected, and only serves to reiterate the need for considering state-specific demand systems.

Also substantial, however, are differences among the various functional forms. The QES cereal elasticities are quite different from their LES counterparts. The QES elasticities are lower than the LES in some of the richer Northern states, and are higher in some of the poorer Eastern states in rural India; and are lower in nearly all states in urban India. The direction of the impact of including a quadratic expenditure term thus seems to depend on the particular state.

On the other hand, the elasticities associated with the rank-three GQAI demand system seem to be lower than those associated with Almost Ideal demand system in rural areas, with the few exception of three central & western states. In urban areas, the GQAI cereal elasticities are lower than the AIDS elasticities in 9 of 13 states. The estimates implied by the rank-three GQAI and the rank-2 QAI vary quite substantially across states, but it is hard to discern any systematic pattern in these differences. Comparing the two rank-three systems, the GQAI estimates are lower than the QES in three eastern, two western states, and one southern state, and higher in the rest of rural India; in urban India, the GQAI estimates are lower than the QES in six of the 13 states.

It is difficult to assess how these estimates compare with those found in other studies, simply because there are virtually no state-specific studies based on complete demand systems. An exception is a study by K.N.Murty (Where is the reference?), who uses Engel functions to estimate income parameters and assumes want independence to derive price elasticities for various cereals. His results are therefore not comparable with ours; furthermore, the elasticities we report are conditioned on *food* expenditures, while Murty's are conditioned on *total* expenditures.

The importance of incorporating higher-order income terms is further highlighted in Figure 1, which plots how estimated cereal elasticities in rural Andhra Pradesh, for example, change with income. It becomes apparent that the magnitude of decline in the elasticity is much better captured by the QAI demand system than the AI demand system; the latter understates the extent of decrease and is not as plausible.

Widely varying elasticities, both among states and among functional forms, also obtain for milk and milk products (Table 5). The QES estimates are typically higher than the LES estimates in urban areas, as also in over half of the rural states; no systematic patterns can be discerned among the milk elasticities implied by the AI, QAI and GQAI functional forms; the numbers are extremely sensitive to the choice of functional form.

To further assess model performance, we compare in-sample forecasts for the five demand systems with the observed budget shares, a criteria that has been referred to as "interpolative robustness". We restrict the comparison to the budget share of cereals and cereal-substitutes, and to a subset of the sample. The graphs for four representative states for the year 1987/88 are presented in Figure 2. It becomes immediately apparent that the use of the LES is inappropriate for characterizing consumer preferences for food in India. Indeed even the AI demand system (which embeds a non-linear but monotonic relationship between budget shares and income) performs poorly in many states.

In rural India, visual inspection suggests that the GQAI is indeed best able to track the observed budget shares in all four states. The rank-2 QAI comes a close second in tracking observed cereal shares--performing better than the rank-3 QES. In urban India, the two quadratic extensions to the AI demand system perform well as compared to the QES in Punjab, West Bengal and Maharashtra, while the QES is preferred in Punjab. Thus even a limited visual inspection of in-sample forecasts serves to reinforce the rankings indicated by the LDC: the preferred functional form varies from state to state. Further, the rank-three generalizations are favoured in many, but not all, states.

Conclusions

The evidence presented in this paper demonstrates unequivocally that mis-specification bias is likely to occur if consumer demand in India is modelled incorporating only linear or monotonic income effects, as is the case with the popular LES and the AI demand systems. However, while incorporating higher-order income terms is clearly warranted, it is not *always* necessary to undertake the additional computational burden imposed by rank-three demand systems.

Also highlighted in this paper is the need to premise all comparisons of functional forms on the region for which these are estimated. There is no single "best" functional form for all states, although the rank-3 quadratic extensions to the AI demand systems do surprisingly well in a large number of them. This is evident both from the non-nested (LDC) test, as well as a visual inspection of in-sample predictions with the observed for a subset of the sample. The appropriate choice of functional form for a given state is important not only in a statistical sense, but also has consequences for policy: estimates of policy parameters--illustrated in this paper using income elasticities of demand--are not invariant to choice of functional form; rather, they vary substantially.

Thus any government intervention that uses demand parameters as an input--be it in the area of targeting of food subsidies, or the design of optimal commodity taxes--must take into account non-linear responses of food allocations to increases in income, and recognize state-specificity in food preferences. Otherwise, these measures will be ineffective at best, and counter-productive at the worst.

TABLE 1

ESTIMATED δ_i COEFFICIENTS OF THE QUADRATIC EXPENDITURE SYSTEM

	RURAL				URBAN			
	δ1	δ2	δ3	δ4	δ1	δ2	δ3	δ4
Haryana	-0.16 (0.34)	0.60 (2.48)	0.02 (3.19)	0.24 (1.12)	0.08 (2.36)	0.37 (4.52)	0.01 (5.02)	0.37 (6.06)
Himachal Pradesh	-1.26 (2.75)	-0.55 (1.84)	0.01 (0.54)	-0.17 (0.80)	-0.22 (1.46)	-0.35 (0.85)	-0.004 (0.07)	-0.08 (0.21)
Jammu & Kashmir	1.33 (9.14)	0.54 (8.84)	-0.06 (1.06)	0.45 (4.70)	-0.40 (3.04)	-0.01 (0.22)	0.06 (3.70)	0.28 (5.18)
Punjab	1.09 (10.5)	0.09 (5.52)	-0.02 (8.93)	1.29 (11.56)	-0.17 (1.37)	-0.59 (2.59)	0.01 (2.12)	-0.09 (0.74)
Madhya Pradesh	0.13 (0.27)	0.56 (6.34)	0.07 (5.99)	0.61 (4.69)	-10.3 (0.41)	-0.03 (0.59)	0.01 (3.41)	0.07 (1.76)
Rajasthan	-0.06 (1.04)	0.40 (9.10)	0.02 (8.28)	0.28 (9.62)	-0.43 (5.17)	0.01 (1.60)	-0.01 (2.14)	0.09 (3.73)
Gujarat	0.10 (5.26)	0.04 (4.22)	-0.01 (0.86)	0.10 (4.82)	-0.21 (2.62)	0.11 (2.81)	0.002 (0.04)	0.38 (7.20)
Karnataka	0.17 (16.13)	0.04(42.07)	0.01 (8.43)	0.11 (56.79)	-0.30 (1.39)	0.19 (4.27)	0.03 (1.78)	0.41 (5.03)
Maharashtra	0.62 (2.04)	0.21 (8.15)	0.08 (7.04)	0.53 (6.51)	-0.09 (2.11)	0.25 (16.43)	0.04 (9.51)	0.39 (18.39)
Bihar	0.28 (13.10)	0.21(12.30)	0.08 (11.08)	0.31 (14.03)	-0.03 (3.20)	0.21 (3.29)	0.10 (11.18)	0.40 (12.06)
Orissa	-0.42(17.28)	0.14(23.06)	0.08 (13.09)	0.51 (28.06)	-0.22 (0.34)	0.16 (2.29)	0.09 (1.90)	0.46 (1.75)
West Bengal	0.58 (36.92)	0.08 (9.76)	-0.002(0.49)	0.07 (6.70)	-0.23 (0.96)	0.18 (4.16)	0.15 (3.14)	0.43 (3.43)
Andhra Pradesh	0.28 (0.93)	0.24 (9.22)	0.12 (6.55)	0.40 (4.96)	-0.19 (0.81)	0.30 (7.12)	0.07 (3.38)	0.48 (5.94)
Kerala	0.95 (6.36)	0.21(13.51)	0.20 (10.44)	0.80 (9.29)	-0.13 (0.19)	0.16 (9.23)	0.09 (4.31)	0.47 (5.81)
Tamil Nadu	-0.37 (1.32)	0.24(16.17)	0.09 (5.30)	0.42 (4.52)	-1.08 (4.06)	0.08 (1.39)	-0.06 (1.79)	0.16 (1.26)
Uttar Pradesh	2.19 (5.68)	0.77 (6.08)	0.10 (6.94)	1.08 (6.43)	0.38 (9.77)	0.24 (17.51)	0.04 (15.09)	0.33 (13.43)

Note: Figures in parentheses refer to asymptotic t-ratios.

Note: Figures in parentheses refer to asymptotic t-ratios.

TABLE 2
ESTIMATED λ OF THE QUADRATIC ALMOST IDEAL DEMAND SYSTEM AND
ESTIMATED λ_I OF THE GENERALIZED QUADRATIC ALMOST IDEAL DEMAND SYSTEM

	RURAL				URBAN			
	λ	λ1	λ2	λ3	λ	λ1	λ2	λ3
Haryana	0.01 (0.36)	-0.06 (8.99)	0.02 (5.26)	0.001 (2.53)	-0.47 (1.71)	0.04 (5.12)	-0.01 (0.58)	-0.001(0.58)
Himachal Pradesh	0.26 (1.21)	-0.03 (3.16)	-0.01 (1.77)	0.002 (2.09)	-0.02 (0.63)	0.03 (1.45)	-0.02 (0.98)	0.01 (3.13)
Jammu&Kashmir	0.34 (3.45)	-0.03 (4.87)	-0.01 (0.75)	0.01 (0.89)	-0.15 (4.00)	-0.02 (2.33)	-0.01 (3.67)	0.002 (0.58)
Punjab	-0.60 (7.41)	-0.04 (9.34)	0.02 (8.25)	0.002 (6.37)	0.07 (1.10)	-0.004(0.58)	-0.02 (1.73)	0.002 (0.65)
Madhya Pradesh	0.30 (5.89)	-0.07 (10.64)	0.03 (8.46)	0.01 (7.81)	0.13 (2.85)	-0.03 (3.49)	0.003 (0.73)	0.003 (2.71)
Rajasthan	0.15 (5.68)	-0.06 (10.04)	0.02 (6.75)	0.002 (5.54)	-0.05 (0.82)	-0.01 (0.63)	-0.002(0.31)	0.003 (1.22)
Gujarat	0.14 (9.46)	-0.05 (8.64)	0.08 (7.47)	-0.002 (2.33)	0.01 (0.34)	-0.02 (2.81)	-0.01 (1.18)	-0.004(0.3)
Karnataka	0.07 (9.00)	-0.03 (8.06)	0.001 (0.57)	0.002 (3.16)	*	*	*	*
Maharashtra	0.10 (20.47)	-0.06 (12.99)	0.02 (12.92)	0.01 (10.24)	0.09 (1.57)	-0.03 (8.23)	0.02 (9.11)	0.002 (0.96)
Bihar	0.09 (9.11)	-0.05 (8.64)	0.02 (7.94)	0.01 (6.30)	0.14 (1.93)	-0.03 (2.57)	0.01 (1.64)	0.003 (1.80)
Orissa	1.52 (1.32)	-0.08 (6.04)	0.12 (3.87)	0.01 (5.20)	0.19 (2.15)	-0.03 (1.86)	0.01 (1.57)	0.01 (3.18)
West Bengal	0.47 (3.93)	-0.04 (4.51)	0.01 (4.02)	0.01 (4.86)	0.03 (0.75)	-0.02 (1.20)	-0.001(0.33)	-0.001(0.29)
Andhra Pradesh	0.54 (17.17)	-0.05 (12.48)	0.02 (11.43)	0.01 (6.06)	0.004 (0.12)	-0.03 (2.75)	0.01 (2.64)	-0.004(2.44)
Kerala	0.07 (13.20)	-0.03 (7.00)	0.01 (6.30)	0.01 (4.51)	-0.40 (22.65)	-0.02 (4.62)	0.01 (3.69)	-0.004(3.50)
Tamil Nadu	0.44 (10.36)	-0.04 (8.98)	0.01 (4.08)	0.002 (3.44)	*	*	*	*
Uttar Pradesh	0.10 (14.78)	-0.06 (12.27)	0.02 (4.62)	0.002 (3.53)	*	*	*	*

Note: Figures in parentheses refer to asymptotic t-ratios. * No Convergence

TABLE 3
LOG LIKELIHOOD VALUES FOR THE VARIOUS STATIC MODELS

	RURAL					URBAN				
	LES	QES	AIDS	QAIDS Rank 2	GQAIDS Rank 3	LES	QES	AIDS	QAIDS Rank 2	GQAIDS Rank 3
Haryana	311.0	346.3	327.4	327.4	354.9	301.0	320.8	298.7	311.1	312.7
Himachal Pradesh	327.7	348.5	349.4	352.3	367.0	232.4	257.7	236.5	236.7	247.8
Jammu & Kashmir	250.1	279.4	265.2	271.7	280.3	289.4	306.1	288.1	312.2	344.0
Punjab	273.7	319.6	298.8	305.2	328.4	303.5	320.2	319.9	320.5	323.5
Madhya Pradesh	342.3	403.5	367.2	379.4	395.1	335.6	375.8	375.3	379.4	384.0
Rajasthan	332.5	368.4	367.6	373.6	398.5	328.7	364.1	354.4	354.7	356.4
Gujarat	304.2	319.7	332.1	349.1	345.9	309.2	331.0	345.3	345.3	349.5
Karnataka	406.7	418.1	453.0	458.7	471.3	323.0	371.6	*	*	*
Maharashtra	382.4	417.9	420.7	465.2	458.3	314.3	366.6	364.4	387.7	388.4
Bihar	367.5	406.1	391.7	413.9	408.3	303.8	362.0	340.4	343.1	343.7
Orissa	373.0	458.3	386.9	394.9	401.3	261.0	312.4	288.2	291.8	292.3
West Bengal	353.2	371.9	378.4	387.5	389.1	281.0	325.3	334.3	334.5	336.0
Andhra Pradesh	358.7	382.6	412.4	432.2	450.0	307.1	370.1	343.0	343.0	348.1
Kerala	388.3	440.3	442.6	468.4	457.7	300.9	393.5	382.5	374.1	395.4
Tamil Nadu	389.5	455.4	404.3	413.6	443.8	348.2	407.9	*	*	*
Uttar Pradesh	346.8	409.9	364.3	429.4	429.1	332.4	394.8	*	*	*

TABLE 4

EXPENDITURE ELASTICITIES OF DEMAND FOR CEREALS

	RURAL					URBAN				
	LES	QES	AIDS	QAIDS Rank 2	GQAIDS Rank 3	LES	QES	AIDS	QAIDS Rank 2	GQAIDS Rank 3
Haryana	0.68	0.55	1.09	0.83	0.84	0.23	0.24	0.04	0.62	0.49
Himachal Pradesh	0.58	0.58	0.92	0.95	0.70	0.19	0.24	0.29	0.46	0.50
Jammu & Kashmir	0.70	0.69	1.08	0.98	0.82	0.78	0.60	0.96	0.63	0.77
Punjab	0.50	0.38	1.09	1.08	1.03	0.39	0.35	0.76	0.76	0.71
Madhya Pradesh	0.99	0.77	0.77	0.93	0.87	0.72	0.64	0.67	0.66	0.41
Rajasthan	0.85	0.75	0.76	0.84	0.80	0.66	0.52	0.74	0.60	0.67
Gujarat	0.57	0.88	0.74	0.07	0.84	0.55	0.51	0.78	0.57	0.57
Karnataka	0.87	1.06	0.95	0.54	0.86	0.78	0.71	*	*	*
Maharashtra	0.82	0.79	0.91	0.09	0.87	0.88	0.58	0.07	0.39	0.65
Bihar	0.96	0.99	0.96	1.05	0.80	1.41	0.89	0.77	0.77	0.48
Orissa	0.97	0.90	1.46	1.08	0.82	0.81	0.72	0.60	0.74	0.46
West Bengal	0.89	1.05	1.04	1.02	0.78	0.77	0.70	0.30	0.50	0.44
Andhra Pradesh	0.94	1.11	1.04	1.03	0.82	1.18	0.79	0.95	0.69	0.69
Kerala	0.68	0.72	0.92	0.35	0.86	0.94	0.80	0.97	1.22	0.70
Tamil Nadu	0.94	0.67	1.03	1.01	0.88	0.89	0.54	*	*	*
Uttar Pradesh	0.90	0.78	0.87	0.17	0.81	0.69	0.74	*	*	*

TABLE 5

EXPENDITURE ELASTICITIES OF DEMAND FOR MILK AND MILK PRODUCTS

	RURAL					URBAN				
	LES	QES	AIDS	QAIDS Rank 2	GQAIDS Rank 3	LES	QES	AIDS	QAIDS Rank 2	GQAIDS Rank 3
Haryana	2.98	3.56	2.31	2.33	1.79	2.84	2.77	1.80	1.56	2.05
Himachal Pradesh	2.89	2.94	2.00	1.17	2.53	2.00	2.28	1.12	1.13	1.49
Jammu & Kashmir	1.87	1.73	1.28	1.03	1.54	1.64	1.68	1.42	1.65	1.65
Punjab	2.69	2.73	1.31	0.35	1.06	2.26	2.42	1.38	1.31	1.79
Madhya Pradesh	1.21	1.80	1.81	1.22	1.83	1.53	1.66	1.69	1.39	1.63
Rajasthan	2.15	2.44	2.06	1.73	2.14	1.98	2.17	1.33	1.40	1.37
Gujarat	2.38	1.35	1.64	5.30	2.21	2.07	2.21	1.73	1.73	1.85
Karnataka	0.88	0.66	1.30	1.83	1.28	1.07	1.19	*	*	*
Maharashtra	0.95	1.04	1.38	3.04	1.30	0.95	1.35	1.45	1.79	2.17
Bihar	1.15	0.99	1.63	3.24	1.26	0.85	1.11	1.48	1.21	1.19
Orissa	0.48	0.50	1.28	0.87	0.69	0.81	0.85	1.37	1.17	1.25
West Bengal	0.69	0.14	1.41	0.97	1.08	0.89	0.91	1.47	1.42	1.44
Andhra Pradesh	0.72	0.71	1.50	0.92	1.08	0.76	1.26	1.46	1.46	1.28
Kerala	0.76	0.74	1.40	2.79	1.29	0.54	0.65	1.34	0.75	1.05
Tamil Nadu	0.48	1.06	1.29	0.99	1.12	0.88	1.13	*	*	*
Uttar Pradesh	1.49	1.80	1.85	3.65	1.69	1.68	1.57	*	*	*

Figure 1

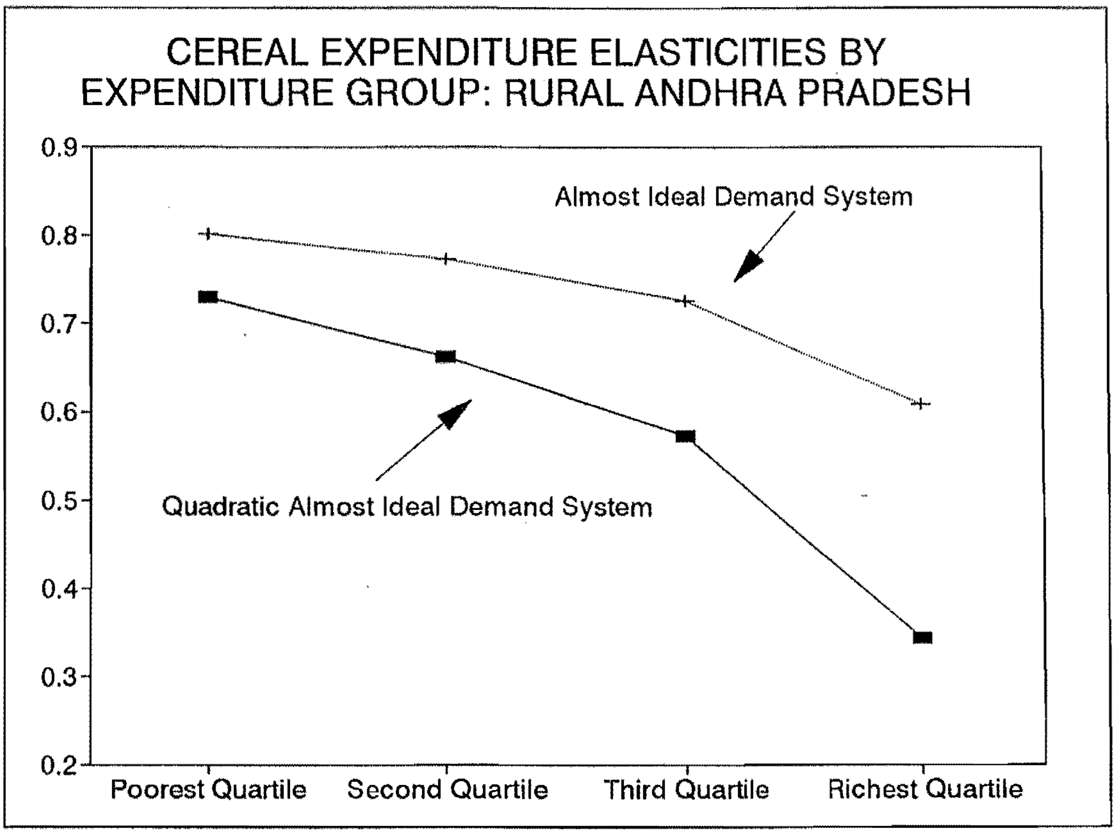

CEREAL EXPENDITURE ELASTICITIES BY EXPENDITURE GROUP: RURAL ANDHRA PRADESH
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
Almost Ideal Demand System
Quadratic Almost Ideal Demand System
Poorest Quartile
Second Quartile
Third Quartile
Richest Quartile

FIGURE 2: COMPARISON OF FUNCTIONAL FORMS: RURAL INDIA

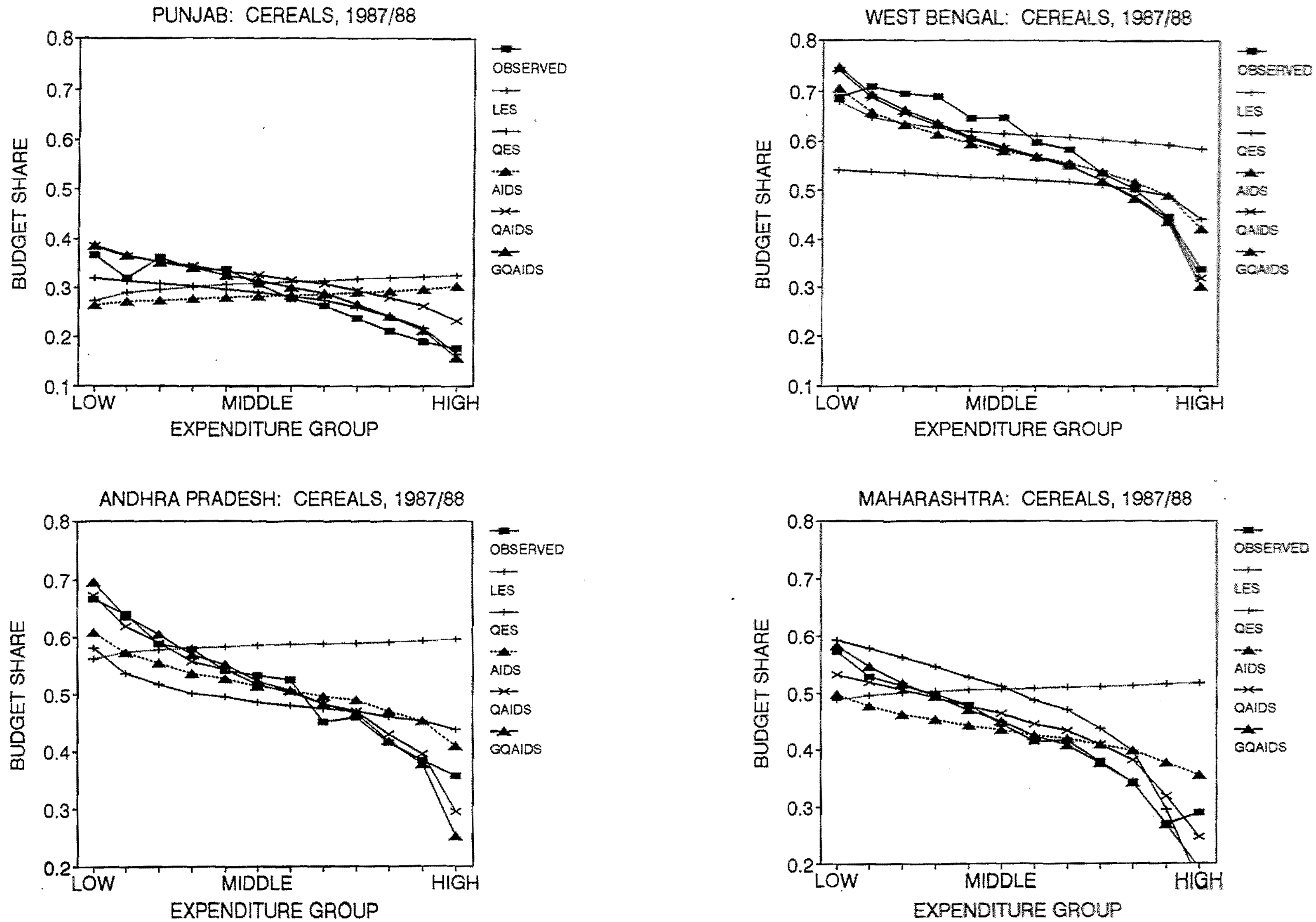
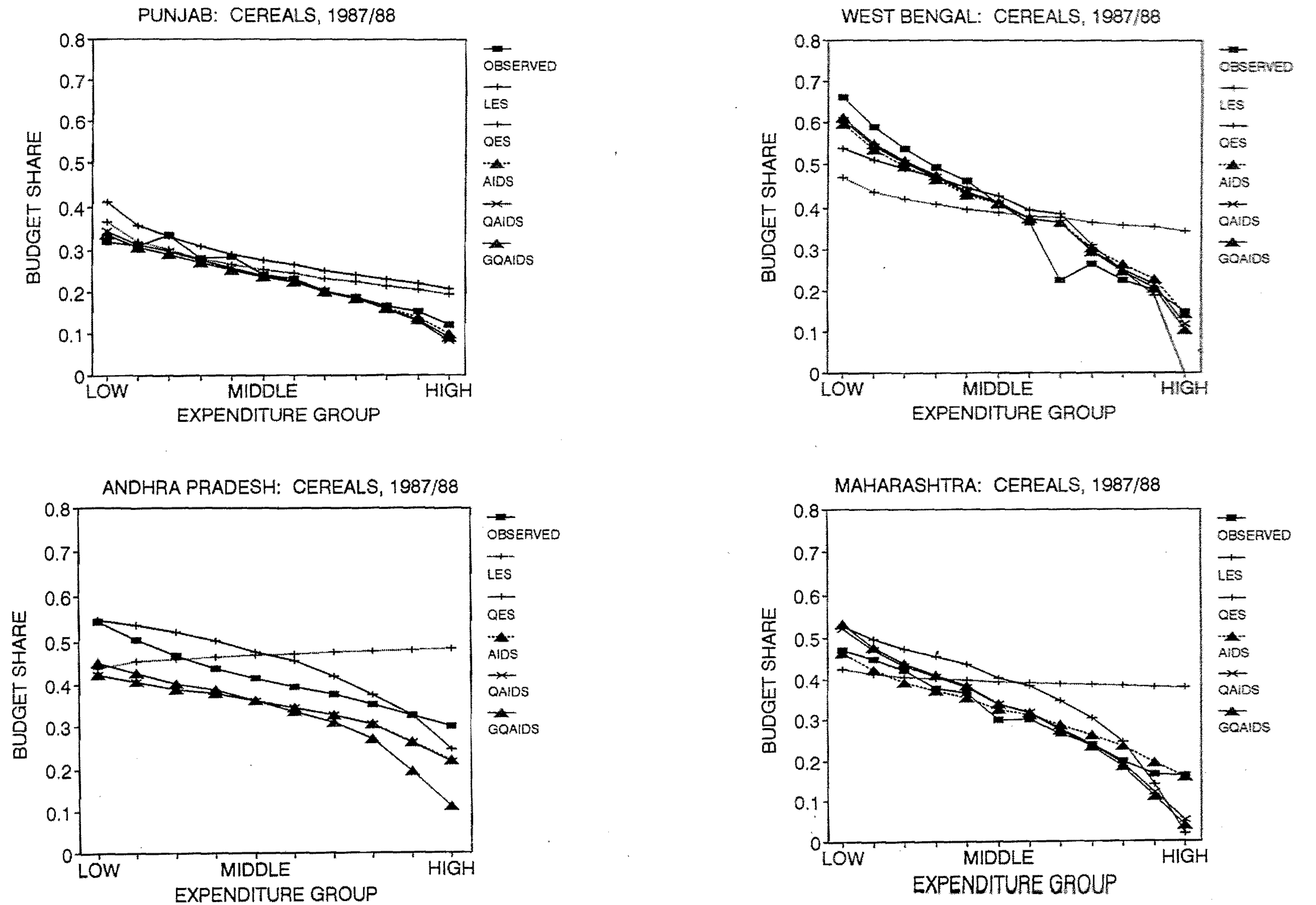


FIGURE 2 continued: COMPARISON OF FUNCTIONAL FORMS: URBAN INDIA



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