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Measures, Spatial Profile and Determinants of Dietary Diversity:Evidence from India

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Abstract

Food security policies in developing countries generally focus on calorie intake, which is not sufficient to tackle the triple burden of malnutrition: undernourishment, micronutrient deficiencies and over-nutrition. Consumption of a diverse diet is important to lessen the burden and is constrained by different factors. This paper using nationally representative dataset from India, analyzes the determinants of dietary diversity, which is measured using the Entropy Index. Heterogeneous dietary diversity profile across adjoining regions highlights the persistence of uneven development in terms of consumption and health indicators. Quantile regression analysis is used to identify the impact of determinants at different parts of the intake distribution. We find that level of consumption expenditure, quality adjusted prices of food items, educational attainment and information dissemination are important factors that affect the household's consumption of a diverse diet. As one moves away from towns dietary diversity improves. Large size landholders need not necessarily consume a diverse diet as expected. Suitable policy interventions are identified.

Keywords: Dietary Diversity, Quality-adjusted prices, Quantile regression, Food Policy, India

JEL Code: C21, D12, O10, Q18

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Food security is a complex process and is the final outcome of production, distribution, optimal consumer choice and consumption, adequate intake of macro and micro nutrients and their effective assimilation (World Food Summit, 1996; Pinstrup-Andersen, 2009; FAO, 2013). However food security policies in developing countries generally focus on the consumption of adequate calories only (Suryanarayana, 2013). The other dimensions of food security are either ignored or not given attention in an integrated framework (Maxwell and Smith, 1992; Pinstrup-Andersen, 2009; Barrett, 2010). This is a very important reason as to why the developing countries are home to a large proportion of malnourished population (Pinstrup-Andersen, 2009). Nutrition transition and its consequent impact on health has not been paid attention to (Popkin et al., 2001; Drewnowski and Popkin, 1997; Popkin, 1994, 1998). Developing countries are now burdened with the "triple burden of malnutrition." It is the simultaneous presence of malnutrition encompassing the three dimensions of undernourishment (reduction of which is a Millennium Development Goal), micronutrient deficiencies and over-nutrition (Gómez et al., 2013). The focus of food security policies should not only be on calorie intake but consumption of a diversified diet (Ruel, 2002). Consumption of a diversified diet ensures the intake of different nutrients and thus prevention of a plethora of diseases (Johns and Sthapit, 2004; FAO, 2012, 2013). [1] A fall in dietary diversity leads to an increase in the proportion of malnourished population (Torlesse, Kiess and Bloem, 2003 and Block et al., 2004). Ruel (2002) rightly identifies dietary diversity as "a promising measurement tool." Dietary diversity indicators are "nutrition-relevant" (Headey and Ecker, 2012). This paper seeks to examine the measures, spatial profile and impact of determinants across different quantiles of the distribution of dietary diversity for India.

The motivation to understand dietary diversity in the context of India rises from the fact that the actual average calorie intake of the population has been declining by choice and not due to any real economic constraint. This is corroborated by the fact that households belonging to the richer decile groups of consumption expenditure distribution in both rural and urban India have reduced their calorie intake and the poorest have improved calorie intake levels with marginal dietary

[1] Different policy initiatives are adopted in many developing countries to improve the nutritional outcome of its population, to not only increase the intake of calories but also other micronutrients. In the entire discussion on the agriculture nutrition disconnect key pathways have been identified between agriculture and nutrition, and policies to improve the nutrition sensitivity of agriculture in India and subsequent nutritional status of the population (Gillespie at al., 2012).

diversification (Suryanarayana, 1995, 2009; Deaton and Dreze, 2009). What is striking about India's diet is that it has limited diversification involving deficiency of micro and even macronutrients like protein and fat. [2] This is a major hindrance to achieving nutritional adequacy as established in Ruel (2002) in the context of developing countries. Thus in India though there has been a fall in calorie intake it has not been compensated by a rise in the intake of other nutrients and a reduction in the proportion of population suffering from nutrient deficiency diseases. For example in 2005-06, 56 percent of women in India suffered from anemia.[3] Existing evidence shows that there has been a rise in micronutrient deficiencies in India over time (Ramakrishnan, 2002; Vijayaraghavan, 2002).

In the Indian context the National Food Security Act, 2013 aims to provide food and nutrition security based on the life cycle approach. [4] The Bill identifies the importance of the quality of food and the role of sanitation and hygiene in improving food absorption and nutritional outcomes, but the focus remains mostly on cereal consumption. However the focus should be on dietary diversity, which is hardly appreciated in any of the contemporary policy debates on the Food Security Act. This paper fills the gap in the existing literature in the context of India by: (i) estimating an improved Entropy measure of dietary diversity; [5](ii) providing a spatial profile of dietary diversity and child nutritional status across regions of India; (ii) analyzing the impact of quality adjusted unit prices, district level amenities and market infrastructure[6], household and socio-economic characteristics on different parts of the dietary diversity distribution using OLS and quantile regression methodology;[7]

[2] See Dyson and Hanchate(2000), Pingali and Khwaja (2004) ,Chand(2008), Deaton and Dreze(2009), Kumar et al. (2009), Khera (2011),Gaiha(2013), Oldiges(2012) and Suryanarayana (2013) for a discussion on dietary patterns in the context of India.

[3] http://www.rchiips.org/nfhs/NFHS-3%20Data/VOL-1/Summary%20of%20Findings%20(6868K).pdf

[4] http://indiacode.nic.in/acts-in-pdf/202013.pdf

[5] Entropy measure of dietary diversity provides unequal weight to different food items in the food basket.

[6] Information on district level amenities is available from Census for rural India only.

[7] We estimate quality adjusted unit values based on Majumdar et al (2012).Also we conduct separate analysis for the rural and urban sector instead of using a sector specific dummy in the regression analysis.

We find that level of consumption expenditure (proxy for income), quality adjusted prices of food items, agricultural land holding, access to markets, educational attainment and information dissemination leads to a significant improvement in the consumption of a diverse diet. A rise in quality adjusted prices of food items lead to a reduction in dietary diversity. Identification of policies to promote dietary diversity and subsequently improve health status is urgently required given the large proportion of malnourished population in the country. We proceed as follows: Section 1 provides a brief review of literature and identifies the issue; Section 2 discusses the measures of dietary diversity and its spatial profile across regions in India in conjunction with the child nutritional status; Section 3 gives an overview of the dataset to be used; Section 4 discusses empirical model, determinants of dietary diversity and quality-adjusted prices; and Section 5 provides the main findings of the paper. The final section concludes.

1. Related literature

Dietary diversity is a measure of the number of different food items/groups consumed during a given reference period (Patterson,Haines and Popkin, 1994; Ruel, 2002). Nutritional science supports the importance of diverse diets for protecting against chronic diseases (Randall, 1985; Drewnowski et al., 1997; Hatloy , 1998; Jacques and Tucker, 2001; Ogle, 2001). Benefits of a varied diet in improving nutritional quality and child growth in developing countries is found in a growing body of epidemiological studies (Ogle, 2001; Ruel, 2002; Arimond and Ruel, 2004).For example proper iron nutrition in the first three years of life is very crucial for brain development (Hunt,2002). Diversified diet improves longevity and reduces rates of chronic degenerative diseases (Jacques and Tucker, 2001). Dietary diversity not only leads to balanced diets and improved health outcomes, but also enhances nutrient intake and other functional components like fiber, and anti-oxidants, which is important for the prevention of diseases like HIV/AIDS, diabetes, cancer and vision impairment (Johns and Sthapit, 2004). Monotonous diets or consuming the same food items daily can have serious nutritional implications (Haralanova, 1991; Cornia, 1994). In short, a diverse diet provides a - safeguard against "one-sided unbalanced nutrition," [8] which people might not be aware of that they are lacking (Johns and Sthapit, 2004).

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[8] Monotonous diets for example diets rich in carbohydrates will be concentrated in a particular nutrient like calories only.

Extensive empirical work analyzing determinants of dietary diversity exists for developed countries (Theil and Finke, 1983; Lee, 1989; Moon et al., 2002; Thiele and Weiss, 2003; Stewart and Harris, 2005; Drescher, Thiele and Weiss, 2006; Drescher, Thiele and Mensink, 2007; Moursi et al., 2008; Martin-Prevel, 2010; Dewan, 2011; Drescher and Goddard, 2011;Karamba et al., 2011 and Nguyen and Winters, 2011).The studies examine how different socio-demographic characteristics like age, gender, religion, marital status, occupation affect the pattern of dietary diversity. Boukouvalas et al. (2009) examine the impact of determinants across different parts of fruit and vegetable intake distribution for England. The study finds that the impact is not significant at lower levels, which is a challenge for the policy makers to improve distribution for those at the lower end of the distribution.

Few studies have tried to explore the issue of dietary diversity for developing countries (Arimond and Ruel, 2004; Bhargava, 2014; Dewan, 2011; Jones et al, 2014). Leroy et al. (2008) find that children of the head of the household or a powerful member consume a more diverse diet than others in Ghana, which implies that the male child does not always consume a more nutritious diet. Studies have examined the association between dietary diversity and caloric availability (Hatloy, 1998; Hoddinott and Yohannes, 2002; Kennedy et al., 2010). Hoddinott and Yohannes (2002) in a study of ten countries including India tested for the association between dietary diversity and caloric availability across different seasons. [9] Mixed results were found between dietary diversity and caloric availability. Jones et al. (2014) find positive correlation between dietary diversity score and height-for-age z-score for Bangladesh, Ethiopia, India and Zambia.

2. Measurement of Dietary Diversity

Diversity measures were developed to estimate the extent of biodiversity of plant and animal species. In the context of food security similar measures are adopted to quantify diversity of the food consumption basket. A simple indicator of dietary diversity is the count measure. Count measure is a frequency of the number of food items/groups consumed during a given reference

[9] Villages covered by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) survey were examined for different months with periods of food surplus and poor food availability.

period. [10] One limitation of the count measure is that no weights are attached to food items belonging to different food groups since each food item has a different nutritional content, and nutrient content of the diet cannot be measured(Drescher et al., 2007). In this context measures, which are based on a differential weighing based on characteristics like the nutrient content or daily requirement of the different food items/groups are appropriate. The weighted aggregate measures are: (i) Herfindahl Index; (ii) Simpson Index; and (iii) Shannon/Entropy Index, which are composite indices. [11]

The Herfindahl Index is defined as:

$$Herfindahl\ Index(H) = \sum_{i=1}^{n} w_i^2 \qquad (1)$$

where i=1,2,…..,n, n is the total number of food items, and w denotes the share of expenditure on the i[th] food item. The range of H is ($\frac{1}{n}$, 1). The lower the value of the index, greater is the diversity in food consumption. One limitation of the measure is that it weighs the share of expenditure on each food item by its own share and gives more weight to those, which dominate the food basket. Another improved measure based on the concept of the Herfindahl Index is the Simpson Index which is defined as:

$$Simpson\ Index(S) = 1 - \sum_{i=1}^{n} w_i^2 \qquad (2)$$

The range of S is $(0, 1 - \frac{1}{n})$, and is a compliment of the Herfindahl Index. The third indicator is the Berry or Entropy or Shannon Index. The value of the Shannon Index is independent of n. Food items, which dominate the household budget, receive lesser weight in the computation of the Shannon Index as compared to that of the Herfindahl Index. It is defined as:

$$Entropy\ Index\ (E) = -\sum_{i=1}^{n} w_i ln(w)_i \qquad (3)$$

The range of E is (0, ln n).[12] The higher the value of the index, greater is the diversity in food consumption. In this paper we estimate the Entropy Index as a measure of dietary diversity. We

[10] Analysis of the count measure using Indian data is part of a separate work. We find an increase in the count of the healthy food items along with an increasing value of the Entropy Index. Also NSS collects information on 142 food items out of which only five percent correspond to unhealthy food items like soft drinks and beverages. Thus a higher value of the Entropy Index corresponds to a more healthy food basket.

[11] Patil and Taillie (1982), Gollop and Monahan (1991) and Kant (1996) provide an overview of the various measures of diversity.

compute the Entropy Index based on the share of expenditure on different food items/ groups. It can also be computed using the nutrient content in each food item.

Spatial profile of dietary diversity

A spatial analysis of dietary diversity profiles is important to examine the performance of regions on the basis of agricultural production and food security indicators, and design appropriate policy interventions for the same. A region may have adequate agricultural production but low levels of dietary diversity. This can be due to factors like selling of most of the home production to earn greater profits if production is more than consumption levels, local availability, lack of knowledge about healthy eating practices, etc. The National Sample Survey identifies regions, which consist of several districts within a state with similar agro-climatic conditions and socio-economic features.[13] The 63 regions are stratified into four different quartiles (low, medium, high and very high) based on the value of the Entropy measure for the year 2009-10 (Table 1).Overall we find mixed results for the correlation between the count and the Entropy measure of dietary diversity.

Rajasthan is the worst performing state and Karnataka, Tamil Nadu and Maharashtra perform the best. In a poor state like Bihar stark difference in consumption pattern are found between adjoining regions. Central Bihar has low levels of dietary diversity unlike northern Bihar. Differences in diversity pattern are also observed among regions of Assam: Cachar Plain ranks the lowest, Western and Central Brahmaputra Plains are in the medium category, and the Eastern Plains perform the best. Even in a better-off state like Andhra Pradesh stark disparity across regions is observed. Regions in this state have low to high to very high levels of dietary diversity. Assam, Chattisgarh and Gujarat have regions with dietary diversity ranging from low to medium to high levels. Maharashtra and Tamil Nadu are the only states with all regions consuming the most diversified diet in contrast to Rajasthan with all regions very poor levels of dietary diversity. In a high income state like Punjab all the regions have very low levels of dietary diversity.

[13] Further details of the data used are provided in Section 4.

It is beyond the scope of this paper to discuss the interlinkage between agricultural production, food consumption patterns and health status of the population in different regions.[14] The final health status depends on intake of a balanced diet, feeding practices, hygiene and sanitation, etc (CGIAR, 2013).[15] Table 2 provides a classification of states according to Entropy Index and health status. Maharashtra, a high income state has a rank high rank in terms of Entropy Index but the state also has a high proportion of children less than five years who are underweight. Nutritional status of children in Punjab, again a prosperous state, is very high but the state performs poorly in terms of diet diversity. Thus stark differences in consumption profile across adjoining regions or in the same state exist showing unbalanced growth and development.

3. Data

We use 61st and 66th round nationally representative household consumption expenditure survey (July 2004 - June 2005 and July 2009 - June 2010) data conducted by the National Sample Survey Organization (NSSO) for all states across rural and urban India. A stratified multi-stage design was used for the survey. The first stage units (FSUs) comprise the 2001 Census villages in the rural sector and Urban Frame Survey (UFS) blocks in the urban sector. The ultimate stage units (USU) were the households in both the sectors. Within each district of a State/UT two basic strata were formed: (i) rural stratum comprising all rural areas of the district, and (ii) urban stratum comprising all urban areas of the district. The total sample size was 79298(45346) and 59097(41697) households in rural India for the years 2004-05 and 2009-10 respectively.

The NSS collects information on various demographic and socio-economic characteristics. The survey also collects detailed information on expenditure (in rupees), quantity consumed and source of purchase for the main food groups: cereal, cereal substitutes, pulses & pulse products, milk & milk products, sugar, salt, edible oil, egg, fish & meat, vegetables, fruits(fresh and dry),spices, and beverages. The recall period for edible oil, egg, fish & meat, vegetables, fruits, spices, beverages and processed foods was seven days and for other food items was 30 days. Quantities for food items were collected in kilograms except for a few exceptions like milk

[14] Consumption expenditure and health and nutritional status data cannot be matched at the household level for India.

[15] See Ramalingaswami et al., 1996.

(liters), eggs, lemon, banana, pineapple, coconut and orange in units, ice-cream and other milk products in rupees and for spices in grams. Appropriate conversion of food items to kilograms was done wherever possible as in Majumdar et al (2012).[16] We supplement this with information from Census 2001 on indicators of infrastructure like connectivity with rail/bus service, distance from the nearest town, availability of education and medical facilities and newspaper/magazine at the district level for rural India. Village level data from Census is agglomerated at the district level and matched with NSS district level data. For measure of proximity of a village from the nearest town four categories are considered: (i) between 0-7 kms;(ii)7-15 kms;(iii)15-30 kms; and (iv)more than 30 kms.

4. The Empirical setting

The empirical specification using OLS methodology is as follows[17]:

$$D_{i=}\beta_0 + \beta_1 X_i + \beta_2 P_i + \varepsilon_i \, , i = 1, \ldots\ldots, n \qquad (4)$$

where D_i is the measure of dietary diversity for the i^{th} household, [18] X_i represents the vector of household characteristics and different determinants, P_i is the vector of quality adjusted unit values of food groups, and n is the total number of households. A modified version of the Entropy Index is used as the dependent variable as suggested in the literature to obtain a normal distribution (Dewan et al., 2011). The transformed Entropy Index (TD_i) is defined as:$TD_i = \ln\left(\frac{D_i}{\max(D_i) - D_i}\right)$, which is unbounded unlike D_i whose range is (0, 4). For the computation of the index 142 food items are considered. The explanatory variables included in the model are: dummy variable for classifying households into different categories based on consumption expenditure (proportion of households divided into five quantiles based on logarithm of monthly per capita consumption expenditure(MPCE)), social group (scheduled caste, scheduled tribe, other backward class, and others), religion (Hindu, Muslim, Christian, Others), household type (for rural areas: self-employed in non-agriculture, agricultural labour, other labour, self-

[16] The following conversions are used: 1 litre milk=1 kg; 1 egg =58 gms; 10 bananas=1 kg; 1 orange=150 gms; 1 pineapple=1.5 kgs; 1 coconut=1 kg.

[17] Both pooled and separate regression analysis is done for the 61st and the 66th round data.

[18] The Entropy Index can be computed using both expenditure and quantity consumed data. We find a positive significant correlation between the expenditure and the quantity based Entropy measures for both the rounds and sectors.

employed in agriculture and others; for urban areas: self-employed, regular wage/salary earning, casual labour and others), marital status(never married, currently married, widowed and divorces/separated), education(not literate, primary, middle, higher secondary, diploma, graduate and post-graduate), and number of household members in the age group 15-24, 25-34,35-44,45-59 and 60 and above. We also control for the size of land possessed by households, gender and region level dummies as explanatory variables. Land possessed is a dummy variable and is categorized as follows: less than 0.001, 0.001 - 0.004, more than 0.004 - 0.40, more than 0.40 - 1, more than 1 - 2.0, more than 2.0 - 4.0, and greater than 4.0 hectares (for rural India only). All characteristics are at the household head level. Standard errors are clustered at the FSU level.

Quantile regression

Estimation using OLS helps to analyze the relationship between the dependent (y) and the explanatory variables (vector X) based on the conditional mean function E(y|X).However this is not based on the entire distribution of the dependent variable. Quantile regression helps to overcome this limitation by analyzing the relationship between the outcome variable y and the explanatory variables at different points in the conditional distribution of y. The diversity measure is sensitive to small changes in the composition of the household's food basket. Thus we examine the impact of the explanatory variables at different quantiles of the conditional distribution function of dietary diversity. Let the q^{th} conditional quantile function of y be written as $Q_q(y|X)$.Then the empirical specification can be written as (Koenker and Basset, 1978):

$$ln(TD_i) = X_i^{'}\beta_\theta + \varepsilon_{\theta_i} \; with \; Quant_\theta(ln(TD_i)|\, X_i) = X_i^{'}\beta_\theta \quad (5)$$

where θ is the respective quantile and X_i represents the vector of household head's characteristics and other determinants, and E $[\varepsilon_{\theta_i}|X_i] = 0$.The θ^{th} sample quantile,0< θ<1,is defined as the solution to the following minimization problem:

$$min_\beta \frac{1}{n}\left[\sum_{i:lnw_i \geq x_i^{'}\beta} \theta|\, ln(TD_i) - X_i^{'}\beta| + \sum_{i:lnw_i < x_i^{'}\beta}(1-\theta)|\, ln(TD_i) - X_i^{'}\beta|\right] \quad (6)$$

This can be further written as:

$$min_\beta \frac{1}{n}\left[\sum_{i=1}^{n} \rho_\theta(\varepsilon_{\theta_i})\right] \quad (7)$$

where $\rho_\theta(\varepsilon)$=(θ - $1_{\{\varepsilon<0\}}$)ε is known as the check function.

Thus in this case the weighted absolute value of the residuals is minimized unlike in the OLS where the sum of squared residuals is minimized. Given θ, minimizing the term in equation (7) gives the θ^{th} sample quantile of y. Also the sample quantile can be found out by an optimization program. The marginal effects after quantile regression are given by:

$$\frac{\partial Q_q(\ ln(TD_i)|X)}{\partial X_j}=\beta_{qj} \quad (8)$$

Estimation of quality-adjusted prices

NSS provides detailed information on the quantity and value of 142 food items. Unit values are computed for each food item by dividing total expenditure by quantity consumed and expressed in Rs/kilogram. These unadjusted unit values give biased estimates as they do not control for quality and demographic characteristics, and are not a true representation of market prices. Unit values suffer from measurement error, quality changes and the impact of household composition on MPCE (Majumdar et al., 2012). Prais and Houthakker (1955) discuss quality effects, which leads to a difference between raw unit value and prices. Quality-adjusted unit values need to be computed to reduce the bias. Certain food items bought in the urban areas are generally of superior quality than those consumed in the rural areas. Also households in rural areas have a higher proportion of consumption from home produce than in urban areas. We compute the same using the procedure followed in Majumdar et al. (2012) controlling for both quality, demographic and income related factors. The empirical specification is as follows:

$$v_i^{hsjd} - \left(v_i^{sjd}\right)_{median} =$$

$$\alpha_i D_s + \beta_i D_j + \gamma_i \sum_j \sum_d D_j D_d + \varphi_i x^{hsjd} + \omega_i f_i^{hsjd} + \sum_m b_i Z_{im}^{hsjd} + \varepsilon_i^{hsjd} \qquad (9)$$

where v_i^{hsjd} is the unit value paid by household h for food item i in state j, district d and sector s, $(v_i^{sjd})_{median}$ is the median unit value for the i^{th} food item in the district in which the household lives, x is monthly per capita food expenditure, f is the proportion of meals that is consumed outside by the members of the household, Z_{im} is household characteristics(household details of age, gender, household size, number of adult males and females in the household), and D_s, D_j and D_d are the dummies for the sector, state and district respectively. Inclusion of x, f and Z_{im} in the model controls for the income and demographic factors, which affects the household consumption expenditure. The district-wise quality-adjusted price for each food item p_i is obtained by adding the residual obtained after estimating the model as specified in equation (9) to the district's median value for that particular food item. The residual contains the unexplained factors not incorporated in the model, and thus a measure of the quality difference, which is unexplained by the explanatory variables. This residual when added to the raw unit value corrects for the differences in quality across different districts. This procedure is based on Hoang (2009) with a slight modification as in Majumdar et al. (2012) that median unit values are used in place of mean unit values. Those observations, which are more than 1.5 times the interquartile range are identified as outliers, are eliminated. Quality-adjusted unit values for the following food groups are considered-rice, wheat, and pulses & pulse products, by aggregating over food items belonging to the respective food groups.

5. Results

In this section we discuss the results obtained after estimating the model using OLS and quantile regression (0.10, 0.25, 0.50, 0.75, 0.90, and 0.99) techniques.[19] Figure 1 provides the box plots of the Entropy Index across time for all-India rural and urban sectors. There is an improvement in diet diversification in the rural sector only. Tables 3 and 4 and Figures 2-8 provide the detailed estimates/graphs of the main variables of interest for rural and urban India for 2009-10. Tests of significance are conducted to check the difference in values of the estimated coefficients across quantiles. The pseudo-R^2 obtained is usually low and quite typical with cross-sectional data as found in other studies. The value of the coefficients across different quantiles are mostly statistically different and this supports the fact that OLS coefficients, which are mean based do not represent the differential impact of the determinants across the conditional distribution of the dependent variable. F-tests are carried out for checking whether coefficients are statistically same across symmetrical quantiles.[20]

Quality-adjusted unit values

Expenditure on staple food items like cereals and pulses dominate the household budget and thus an increase in their price might change consumption patterns. However other than income and prices, taste and preferences also determine the household food consumption profile.OLS and

[19] We discuss the pooled regression results only for the main variables of concern.

[20] Detailed results of the F tests are not reported. Tables and figures with the main variables of interest for the year 2009-10 are reported.

quantile regression estimates (QRE) show that an increase in expenditure on rice, wheat and pulses, the consumption of which dominates the food basket of households, leads to a fall in diversity for both the rounds. We find that at higher quantiles of the distribution of dietary diversity a rise in the unit value of both rice and wheat has a greater impact in reducing diet diversification than at lower quantiles. The results mostly hold for pooled and separate QRE for both the rounds. For urban India negative relationship holds between the quality-adjusted unit value of rice and dietary diversity and a positive one for wheat and pulses. However, the QRE are not statistically different from the OLS estimates.[21] We need to understand the pattern of consumption from home produce in the rural sector and beverages in the urban sector.[22] This can give an idea as to what extent the consumption depends on prices of food items. It needs to be verified to what extent deficient home production is compensated by purchase from the public distribution system. Also to what extent availability of cheap or free subsidized grains induces diet diversification.

Household characteristics

Household size is expected to have a positive impact (Lee, 1989). OLS estimates show a positive significant relation between household size and dietary diversity. Due to economies of scale, a larger household is expected to consume a more varied diet. Similar result holds across different quantiles of the distribution of dietary diversity. For household size squared, as expected negative significant relationship is obtained for both OLS and QRE (except for some lower quantiles). Dependency ratio defined as the share of young children in the age group of zero to six years to the household size has a significant and positive impact. This implies that more the number of young children in the household more diversified are the diet. The same result holds for the case of urban India for both the rounds separately and the pooled data.

Per capita monthly household consumption expenditure (in rupees) is used as a proxy for income. It is expected that higher the income more is the consumption of a varied diet (Theil and

[21] For rural India percentage expenditure on cereal consumption out of total expenditure was 18 percent in 2004-05, which decreased to 15.6 percent in 2009-10. Percentage expenditure on pulses & products increased from 3.1 to 3.7 percent. For urban India the percentage expenditure on cereals decreased from 10.1 to 9.1 percent and that on pulses & products increased from 2.1 to 2.7.

[22] Consumption from home produce is more in rural areas. Urban areas consume more of beverages, which include cooked meals eaten outside.

Finke, 1983; Behrman and Deolalikar, 1989; Lee, 1989; Falkinger and Zweimiller, 1996; Thiele and Weiss, 2003; Stewart and Harris, 2005). Our results show that an increase in household income increases the variety in consumption according to both OLS and QRE for both the rounds. This holds for the pooled third income quartile and for both the rounds separately. Surprisingly for urban India the expected hypothesis does not hold true.

If there is an increase in the age group of household members there is an increase in the variety of food consumption (Moon et al., 2002; Drescher et al., 2006; Drescher et al., 2007; Moursi et al., 2008; Martin-Prevel et al., 2010; Drescher and Goddard, 2011).Age of the household head has no significant impact on consumption pattern. Higher levels of education has a significant impact on the consumption of a diversified diet (Moon et al., 2002; Variyam et al., 1998), since it is expected that educated people will be more concerned about nutritional balance in the household. There is no significant impact of education on dietary diversity except for middle and post-graduate category for certain quantiles across rounds and sectors. This may be possible due to the positive correlation between income and level of education. However, for the year 2004-05 we find a significant positive impact of education across different groups on dietary diversity. Across the different quantiles the value of the coefficient decreases. No significant differences are observed across religion, social groups and marital status. Women are expected pay greater attention to the consumption of a nutritious diet (Dewan et al., 2011).However we find no significant difference in consumption between male and female headed households for rural and urban India(except for certain quantiles).

Land holding and occupation

Size of landholdings plays an important role in influencing consumption pattern. Those households who have home production might choose to consume or sell the surplus produce depending on the market price of the crops grown. Singh et al. (2002) find that dietary diversity increases with an increase in farm size using NSS data for 1993-94. Land size holdings are classified into four groups: sub-marginal, small, medium and large. Sub-marginal farmers (land holding size between 0.001 and 0.004 ha) perform better as compared to marginal landholders according to OLS and QRE. This can be explained by the fact that households with small land holdings can easily diversify their cultivation pattern unlike the case of large size landholders.[23] Those with large landholdings in fact have lower dietary diversity as compared to the marginal landholders. Sub-marginal landholders with land holdings between 0.004-0.4 ha have the highest value of Entropy Index and those with landholding less than 0.001 ha consume the least diverse diet. While positive association is found between size of land possessed and MPCE (GoI, 2012), the same need not hold for dietary diversity. For example for the case of Haryana and Tamil Nadu positive association holds between size of land possessed and MPCE however as far as dietary diversity is concerned we find that marginal farmers perform better than even the large farmers. For West Bengal positive relationship holds between land size, MPCE and dietary diversity. Thus we find that the agricultural sector plays an important role in influencing dietary patterns which affects nutritional outcomes (Bhagowalia et al., 2012). The agriculture sector not only employs more than 58 percent of the work force but also acts as a source of food and income. Agricultural growth, food security and nutrition are interrelated and integral to the development process (Babu, 1993; Gillespie at al., 2012).

Occupation of the household head is an important factor determining both food and non-food consumption pattern. Households who have their own production might choose to consume or sell their produce depending on the crops they grow. Others might lack access to diverse food items due to lack of time to purchase, reduced availability or far away location from markets. Occupation also determines the income earned, though it might not always lead to improved food consumption. Significant, positive coefficient is found for those who are self-employed in non-agriculture and others.[24] Those who are self-employed in agriculture are found to consume a diet less diverse than what the agricultural labourers consume. [25] In this context we need to

[23] Pingali and Khwaja (2004) provide an overview of dietary diversity in India by examining the linkages between demand and supply side of the food system in India, and the impact of globalization on the same. He identifies two distinct phases of diversification in the context of India: (i) Income induced diet diversification, which is consumption of superior in favor of inferior food items, and (ii) Diet globalization, which is the increased consumption of proteins, sugars and fats. This has serious implications for the growing number of small and marginal farmers who might lose their market and buyers.

[24] For the Others category and Other labour there is a positive significant impact of on dietary diversity at certain higher quantiles for the case of pooled regression.

[25] Agricultural labourers are found to have the lowest levels of MPCE and MPCE (Food) but highest level of dietary diversity. Others category have the highest levels of MPCE and MPCE (Food) but rank second in terms dietary diversity for ranking across different occupational categories. The Indian agricultural system is dominated by small

examine the impact of household size. For example small-size landholders can easily increase diversity of cropping pattern given the availability of family labour (Singh et al, 2002). [26] For pooled data for urban India we find that as compared to the regular wage/salary earners those who are self-employed and the others category are worse off as compared to the casual labourers. The QRE are not significantly different from the OLS estimates.

District level amenities

Connectivity by rail/bus is important to understand the market structure of rural districts. It plays an important role in increasing market access and availability of food items and thus improving consumption pattern. Districts with higher connectivity will have a greater availability of a variety of food items. Overall we find a significant, positive impact of rail/bus services on dietary diversity. Closer a household is to farmlands the greater is the availability of food items and the more is dietary diversity. We find that rural localities, which are further away from the town have greater access to a variety of food products mainly locally grown fruits and vegetables, and poultry and thus consumes a more diversified diet. So regions, which are more than 15 kms away from the town, seem to consume a more varied diet.

Though we have examined the impact of the level of education of the household head on the consumption pattern, we also analyze the impact of the presence of educational, medical and newspapers and magazines in the districts. Presence of educational institutions or medical facilities does not seem to have any significant impact on consumption according to both OLS and QRE. Overall we can conclude that availability of newspapers and magazines has a significant, positive impact on dietary diversity. This implies that the print media can play a better role in disseminating information about the consumption of a more nutritious diet rich in minerals and vitamins. Gustavsen and Rickerstsen (2006) conduct a censored and ordinary quantile regression analysis on vegetable purchase data for Norway and find that polices like income support and removal of indirect taxes may not be effective in improving consumption

farmers, low yields and declining per capita availability of food grains. Thus, the small farmers play an important role in ensuring food security and dietary diversity (Birthal et al., 2011; Dev, 2012).

[26] This paradox can be explained by the fact that large-size land holders have the largest mean household size, and thus this might reduce the per capita availability of food. For example household heads who are self-employed in agriculture has the highest mean household size of 5.47 and lowest levels of dietary diversity, others have the lowest mean household size of 4.3.

pattern, especially for the low consuming households. The authors suggest exploring other policy options for information dissemination. Similar studies and experiments should be conducted in the context of India to understand, which policy will work best.

6. Concluding Remarks

In this paper we examined the dietary diversity index and its determinants in the Indian context. Heterogeneous dietary diversity profile across different regions highlights the persistence of uneven development in terms of consumption and health indicators. Income, education and infrastructural facilities have a significant, positive impact on dietary diversity. There is a negative association between quality-adjusted unit values and dietary diversity. The greater is the distance from a town, the higher is the consumption of a diverse diet. Non-agricultural labourers and households with medium size landholdings perform well in terms of dietary diversity. The above mentioned factors are discussed in the recent FAO (2013) report identifies the above mentioned factors as crucial for tackling undernourishment. The focus of food policy in India has always been on consumption of macronutrients like calories. This calls for the focus of food security programs to be not only on the consumption of cereals but a diverse food basket. Though the present National Food Security Act focuses mainly on the quantity aspect of food security. A possible extension of the work would be to identify what is the threshold level for a balanced and diverse diet. This can then serve as a cut-off for identifying households as food secure or insecure incorporating the consumption of both macro and micro nutrients.

Investments are required for improving market access, connectivity, spread of information and knowledge for diet diversification and tackling the problem of hidden hunger. We find that large size landholdings need not necessarily translate into the consumption of a diverse diet nor does it lead it to improved nutritional status. This calls for convergence in policy targeting across agriculture, health and nutrition sectors. Studies provide a comprehensive framework of a monitoring policy to be adopted by policy makers (Babu and Pinstrup-Andersen, 1994; Swaminathan, 2002; Babu, 2013; Bhargava, 2014; von Braun, 2013). For example biofortification of crops can be an effective strategy as adopted in many countries (Miller and Welch, 2013). Maintaining food diaries help to keep a check on the consumption of healthy and unhealthy and the variety of food items. Identification of policies to promote dietary diversity and subsequently improve health status is urgently required in India.

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Table 1:State region wise Dietary Diversity profile,2009-10

Low		Medium		High		Very high	
Region	**State**	**Region**	**State**	**Region**	**State**	**Region**	**State**
Northern	Rajasthan	Northern Upper Ganga Plains	Uttar Pradesh	Southern Plains	West Bengal	Coastal	Maharashtra
North-Eastern	Rajasthan	Southern Upper Ganga Plains	Uttar Pradesh	South Western	Madhya Pradesh	Inland Central	Maharashtra
Southern	Punjab	Northern	Orissa	Eastern Plains	West Bengal	Northern	Kerala
Cachar Plain	Assam	Plains Western	Assam	Plains Eastern	Assam	Southern	Kerala
Western	Rajasthan	Central	Uttar Pradesh	Southern Chhattisgarh	Chhattisgarh	Inland Southern	Andhra Pradesh
Northern Chhattisgarh	Chhattisgarh	Mahanadi Basin	Chhattisgarh	Southern	Orissa	Inland	Tamil Nadu
Dry areas	Gujarat	Malwa	Madhya Pradesh	Saurashtra	Gujarat	Coastal	Tamil Nadu
Northern	Madhya Pradesh	Central	Madhya Pradesh	Plains Northern	Gujarat	Inland Eastern	Maharashtra
Southern	Rajasthan	Kachchh	Gujarat	Inland North Western	Andhra Pradesh	Eastern	Maharashtra
Northern	Punjab	South	Madhya Pradesh	Inland Northern	Karnataka	Southern	Tamil Nadu
Central	Bihar	Northern	Bihar	Coastal Southern	Andhra Pradesh	Coastal Northern	Tamil Nadu
Inland North Eastern	Andhra Pradesh	Himalayan	West Bengal	Coastal Northern	Andhra Pradesh	Inland Eastern	Karnataka
South-Eastern	Rajasthan	Ranchi Plateau	Jharkhand	Coastal	Orissa	Inland Northern	Maharashtra
Southern	Uttar Pradesh	Western Plains	West Bengal	South Eastern	Gujarat	Inland Western	Maharashtra
Vindhya	Madhya Pradesh	Eastern	Uttar Pradesh	Coastal & Ghats	Karnataka	Inland Southern	Karnataka
Hazaribagh Plateau	Jharkhand	Central Brahmaputra Plains	Assam	Central Plains	West Bengal		

*Author's estimates based on NSS data

Table 2: Dietary Diversity and Child nutritional status

Dietary Diversity		
States with all regions ranking high	**States with all regions ranking low**	**States with regions having belonging to different quartiles**
Karnataka Kerala Maharashtra Tamil Nadu	Punjab Rajasthan	Andhra Pradesh Assam Madhya Pradesh

Child nutritional status* (% of children underweight under five years of age)		
<34%	**35-39%**	**40% or more**
Kerala Punjab Andhra Pradesh Tamil Nadu	Maharashtra Rajasthan West Bengal Karnataka	Gujarat Madhya Pradesh Uttar Pradesh Jharkhand Chattisgarh Orissa

*Nutritional status data is based on NFHS 2005-06 ;Dietary diversity estimates author’s computations based on NSS 2009-10 data

Table 3:Quantile Regression Results: Rural India NSS 2009-10

Variable	Quantiles						
	0.01	**0.25**	**0.5**	**0.75**	**0.9**	**0.99**	**OLS**
Reference group: MPCE: Quartile 1							
MPCE: Quartile 2	0.2480***	0.2630***	0.2963***	0.3655***	0.4374***	0.5766***	0.3588***
	-0.0266	-0.0135	-0.0178	-0.025	-0.041	-0.1462	-0.0194
MPCE: Quartile 3	0.2680***	0.3978***	0.4885***	0.6375***	0.8374***	1.3643***	0.6079***
	-0.0285	-0.0143	-0.0189	-0.0267	-0.0439	-0.1597	-0.0262
MPCE: Quartile 4	0.2603***	0.4729***	0.6325***	0.8986***	1.2089***	1.9339***	0.8045***
	-0.0323	-0.0156	-0.0205	-0.0289	-0.0482	-0.182	-0.0316
MPCE: Quartile 5	0.2312***	0.6092***	0.8770***	1.3183***	1.8921***	3.7212***	1.1730***
	-0.0366	-0.018	-0.0235	-0.0331	-0.055	-0.2043	-0.045
Quality-adj. unit value of rice	-0.0470**	-0.2193***	-0.3363***	-0.5126***	-0.7031***	-1.2323***	-0.3650***
	-0.0226	-0.0096	-0.0112	-0.0143	-0.0219	-0.0761	-0.0197
Quality-adj. unit value of wheat	0.0437	-0.0531***	-0.0945***	-0.1495***	-0.2361***	-0.2899**	-0.0678***
	-0.0268	-0.0123	-0.0155	-0.0211	-0.0343	-0.1274	-0.0262
Quality-adj. unit value of pulses	-0.0313	-0.0304	-0.0349	-0.0582*	-0.0106	0.2565	-0.0722*
	-0.0455	-0.0207	-0.0256	-0.0336	-0.0528	-0.1858	-0.0432
Reference group: 0.4 < Land owned < 1 ha							
Less than 0.001 ha	0.0552	0.0299	-0.0132	-0.0011	0.0533	0.1012	-0.0856
	-0.121	-0.0664	-0.0867	-0.1218	-0.1959	-0.6703	-0.0946
0.001 ha < Land owned < 0.04 ha	0.0188	0.0468**	0.0754***	0.0625*	0.1801***	0.5268**	0.0723*
	-0.0354	-0.0195	-0.0256	-0.0359	-0.0585	-0.2085	-0.0425
0.04 < Land owned < 0.4 ha	0.0076	0.0310**	0.0374**	0.0410*	0.0675*	0.1506	0.0398*
	-0.0241	-0.0121	-0.0158	-0.0222	-0.0363	-0.1253	-0.021
1 < Land owned < 2 ha	0.0097	0.0082	-0.0013	0.0272	0.0181	0.3603**	0.0288
	-0.0303	-0.0157	-0.0206	-0.0288	-0.0469	-0.1667	-0.0257
2 < Land owned < 4 ha	-0.0223	-0.0450**	-0.0604**	-0.0333	-0.0283	0.1748	-0.0482
	-0.0368	-0.0188	-0.0247	-0.0346	-0.0564	-0.2073	-0.0313
Land owned > 4 ha	0.0077	-0.0813***	-0.0903***	-0.1077***	-0.1226*	0.0759	-0.0953***
	-0.04	-0.0215	-0.0283	-0.0399	-0.0656	-0.238	-0.0361
Reference group: Agricultural labour							
Self-employed in non-agriculture	0.0616*	0.0807***	0.0599***	0.0793***	0.0643	-0.021	0.0471**
	-0.0314	-0.0154	-0.0201	-0.028	-0.0461	-0.1654	-0.0233
Other labour	0.0102	0.0275*	0.0148	0.0162	0.0415	0.1068	0.0126
	-0.0325	-0.0161	-0.0211	-0.0295	-0.0484	-0.1758	-0.0245
Self-employed in agriculture	0.0042	-0.0221	-0.0556**	-0.0928***	-0.0930*	-0.3799**	-0.1007***
	-0.035	-0.0172	-0.0226	-0.0317	-0.0518	-0.1804	-0.0269
Others	0.0666*	0.1078***	0.0846***	0.1122***	0.1700***	0.0636	0.0858***
	-0.0354	-0.0175	-0.0228	-0.0317	-0.0521	-0.1814	-0.0267

Table 3:Quantile Regression Results: Rural India NSS 2009-10							
Variable				**Quantiles**			
	0.01	**0.25**	**0.5**	**0.75**	**0.9**	**0.99**	**OLS**
Reference group: DIST_TOWN2001>=0 & <=7 kms							
DIST_TOWN2001>7 & <=15 kms	-0.0112	-0.3017***	-0.1343	-0.0712	-0.1967	0.7818	0.1197
	-0.204	-0.0966	-0.1251	-0.1759	-0.2957	-0.9999	-0.25
DIST_TOWN2001> 15 & <=30 kms	0.0484	-0.2956***	-0.3486***	-0.5361***	-0.7923***	-0.0943	-0.3194*
	-0.1437	-0.0703	-0.0922	-0.1282	-0.2078	-0.6256	-0.1691
DIST_TOWN2001>30 kms	0.0327	-0.0915	-0.0034	0.1388	0.1525	1.6079**	0.3613*
	-0.1292	-0.0669	-0.0877	-0.1246	-0.2087	-0.6823	-0.1933
Reference group: Rail Service: Within Village							
Rail Service: 0-5	-1.2133**	-0.2799	0.5334	0.7173	1.4455*	8.3255***	0.9858
	-0.5128	-0.2583	-0.3408	-0.4799	-0.8	-2.9261	-0.8974
Rail Service: 5+	-0.7718*	-0.0484	0.6447**	0.9352**	1.7081***	8.2288***	1.1077
	-0.4432	-0.2083	-0.2718	-0.379	-0.6278	-2.4049	-0.7422
Rail Service: No service/ no info	-0.5041	0.1297	0.9201***	1.0385***	1.1955*	7.0344***	1.1548
	-0.4555	-0.2159	-0.2801	-0.3881	-0.6375	-2.4154	-0.7556
Reference group: Bus Service: Within Village							
Bus Service: 0-5	0.1311	0.3685***	0.4089***	0.4402**	0.2404	0.3177	0.8319***
	-0.19	-0.0996	-0.1288	-0.178	-0.2902	-1.0393	-0.2275
Bus Service: 5+	0.0541	0.0767	0.1843**	0.2734**	0.2215	0.294	0.3235**
	-0.1433	-0.0711	-0.0916	-0.1282	-0.2111	-0.7457	-0.1598
Bus Service: No service/no info	0.0399	0.5727	1.4328**	1.6149*	3.5360**	12.7500**	3.0603**
	-0.9147	-0.4843	-0.6525	-0.9415	-1.5569	-6.4869	-1.1932
Reference group: No/NA							
Education facility: Yes	0.1942	-0.0416	-0.1349	-0.2009	-0.0233	0.724	-0.1723
	-0.2155	-0.1036	-0.1314	-0.1801	-0.2911	-1.1018	-0.2339
Reference group: Yes							
Medical facility: No/NA	-0.0568	0.1166**	0.1129*	0.1453*	0.2252	0.8668*	0.025
	-0.0937	-0.0472	-0.0612	-0.0856	-0.1389	-0.4813	-0.1193
Reference group: No/NA							
Newspaper/magazine: Yes	0.0235	0.1773***	0.2627***	0.3914***	0.3742***	1.3104***	0.3602***
	-0.0805	-0.0395	-0.0512	-0.0715	-0.1162	-0.3946	-0.0946
Constant	1.8159***	2.4405***	2.7103***	3.5975***	3.5213***	-3.9199	2.1419***
	-0.5662	-0.264	-0.3433	-0.4753	-0.7828	-3.0008	-0.7973
Observations	36,298	36,298	36,298	36,298	36,298	36,298	36,298
Standard errors in parentheses						R-square	0.337

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4: Quantile Regression Results: Urban India NSS 2009-10							
Variable				**Quantiles**			
	0.01	**0.25**	**0.5**	**0.75**	**0.9**	**0.99**	**OLS**
Reference group: MPCE: Quartile 1							
MPCE: Quartile 2	0.1746***	0.1293***	0.1221***	0.1133***	0.1155***	0.1339***	0.1400***
	-0.0388	-0.0053	-0.0057	-0.006	-0.0131	-0.0054	-0.0063
MPCE: Quartile 3	0.1954***	0.2036***	0.1933***	0.1817***	0.1571***	0.2000***	0.2104***
	-0.0437	-0.0059	-0.0063	-0.0067	-0.0147	-0.0064	-0.0071
MPCE: Quartile 4	0.2448***	0.2808***	0.2777***	0.2680***	0.2596***	0.2741***	0.2717***
	-0.0521	-0.0068	-0.0072	-0.0076	-0.0164	-0.0075	-0.0082
MPCE: Quartile 5	0.2406***	0.3479***	0.3529***	0.3606***	0.3684***	0.3372***	0.3260***
	-0.0659	-0.008	-0.0085	-0.0089	-0.0185	-0.0094	-0.0098
Quality- adj. unit value of rice	-0.0887**	-0.1176***	-0.1148***	-0.1038***	-0.0937***	-0.1073***	-0.1052***
	-0.0362	-0.0045	-0.0046	-0.0047	-0.0121	-0.0061	-0.0058
Quality- adj. unit value of wheat	0.0258	0.0105**	0.0138**	0.0047	0.0033	0.0067	0.0044
	-0.0354	-0.0052	-0.0057	-0.0061	-0.0126	-0.0062	-0.006
Quality- adj. unit value of pulses	0.0014	-0.0322***	-0.0261***	-0.0239***	-0.0325*	-0.0210*	-0.0331***
	-0.0639	-0.0084	-0.0086	-0.0087	-0.0173	-0.0115	-0.0103
	-0.193	-0.0254	-0.0274	-0.0291	-0.069	-0.0305	-0.0303
Reference group: Regular wage/salary earning							
Self-employed	-0.0216	-0.0091**	-0.0021	-0.0003	0.002	-0.0097**	-0.0152***
	-0.0288	-0.0039	-0.0042	-0.0044	-0.0095	-0.0039	-0.0047
Casual labour	0.0182	-0.0041	0.0027	-0.001	0.01	-0.0098*	-0.0151**
	-0.0445	-0.0057	-0.0061	-0.0064	-0.014	-0.0058	-0.0069
Others	-0.0203	-0.0290***	-0.0208***	-0.0178**	-0.0024	-0.0304***	-0.0422***
	-0.046	-0.0063	-0.0068	-0.0072	-0.0166	-0.0064	-0.0076
Constant	1.7543***	3.0045***	3.0820***	3.2482***	3.2529***	2.9017***	2.8130***
	-0.3597	-0.0465	-0.0494	-0.0513	-0.1135	-0.059	-0.0562
Observations	26,374	26,374	26,374	26,374	26374	26374	26374
Standard errors in parentheses						R-square	0.315
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1							

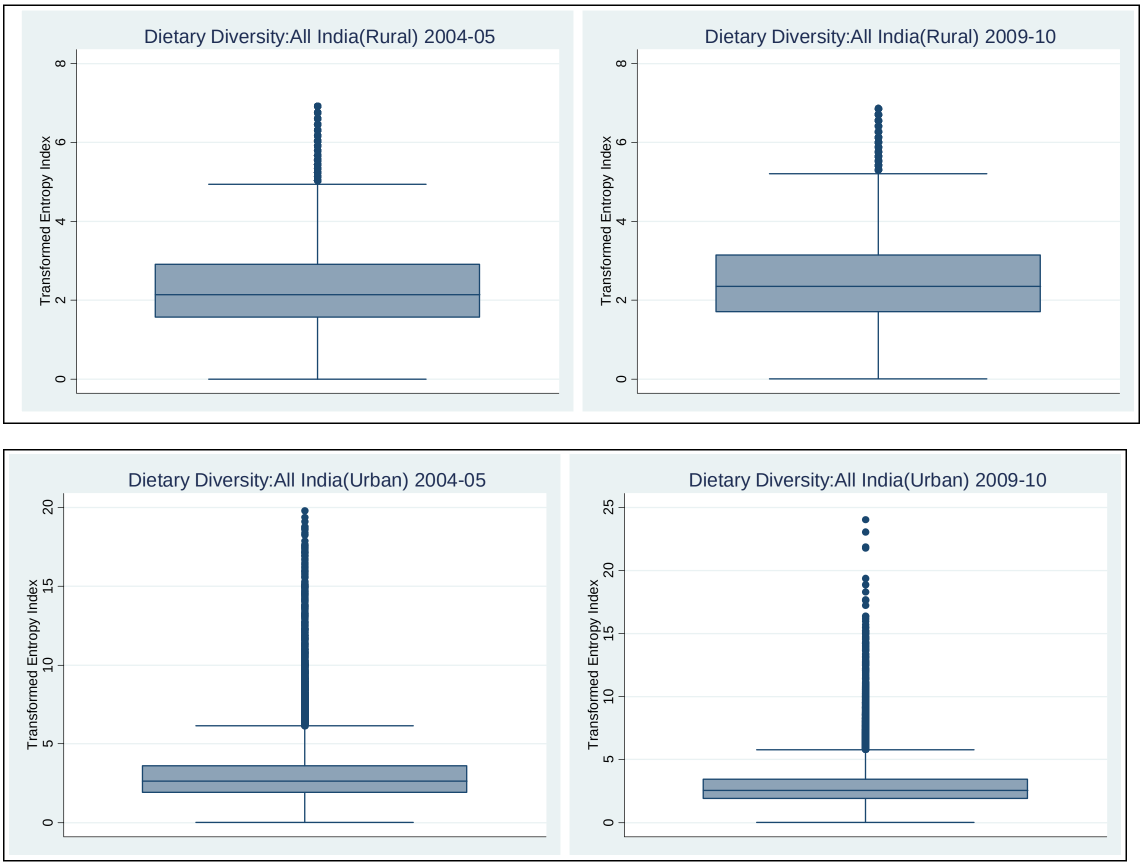

Figure 1: Box plots of the transformed Entropy Index

RURAL INDIA

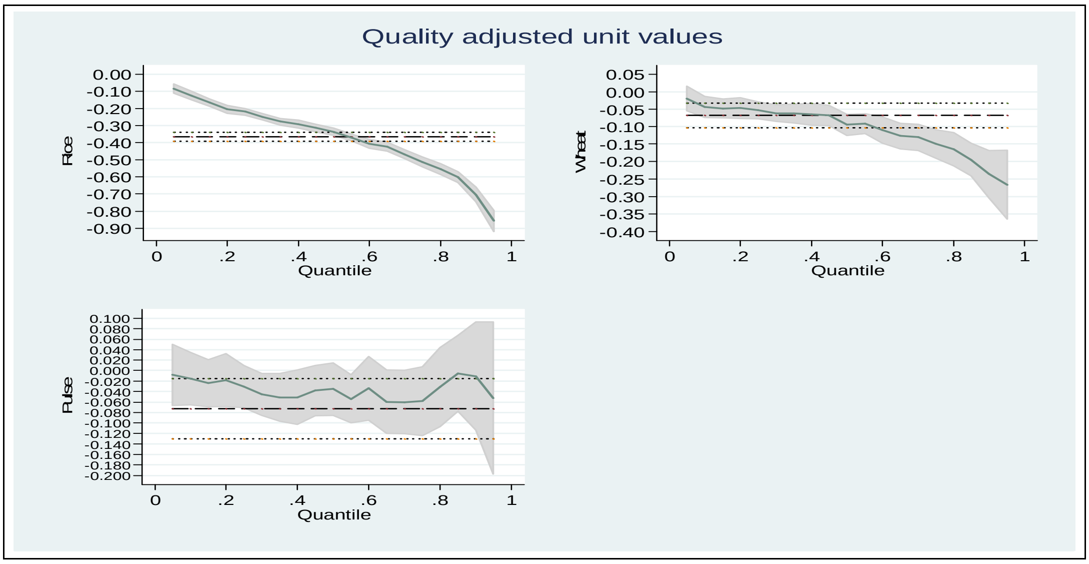

Figure 2: Quantile regression coefficients for quality adjusted unit values of rice, wheat and pulses, 2009-10

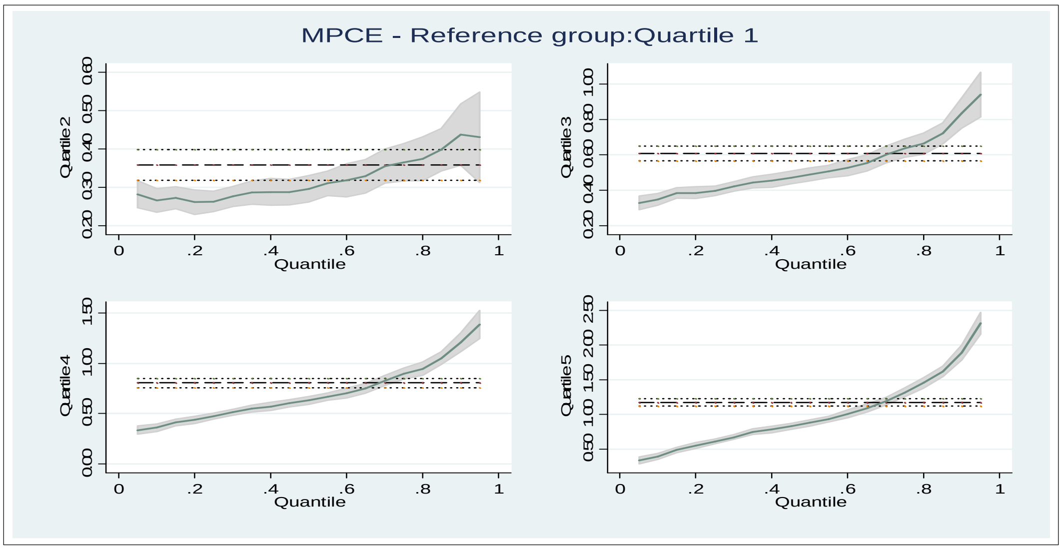

Figure 3: Quantile regression coefficients across different MPCE groups, 2009-10

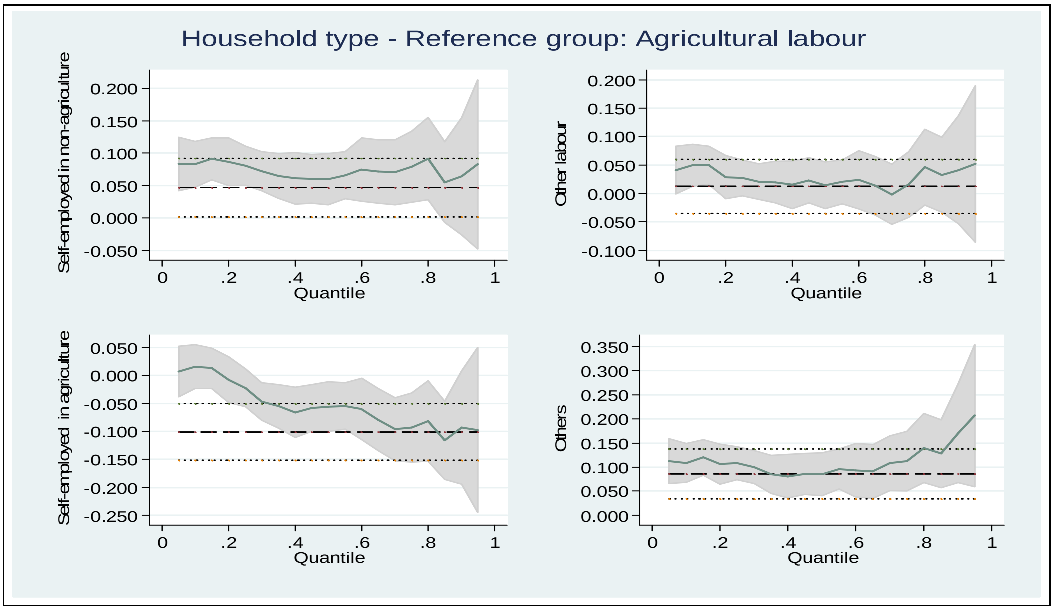

Figure 4: Quantile regression coefficients across different household types, 2009-10

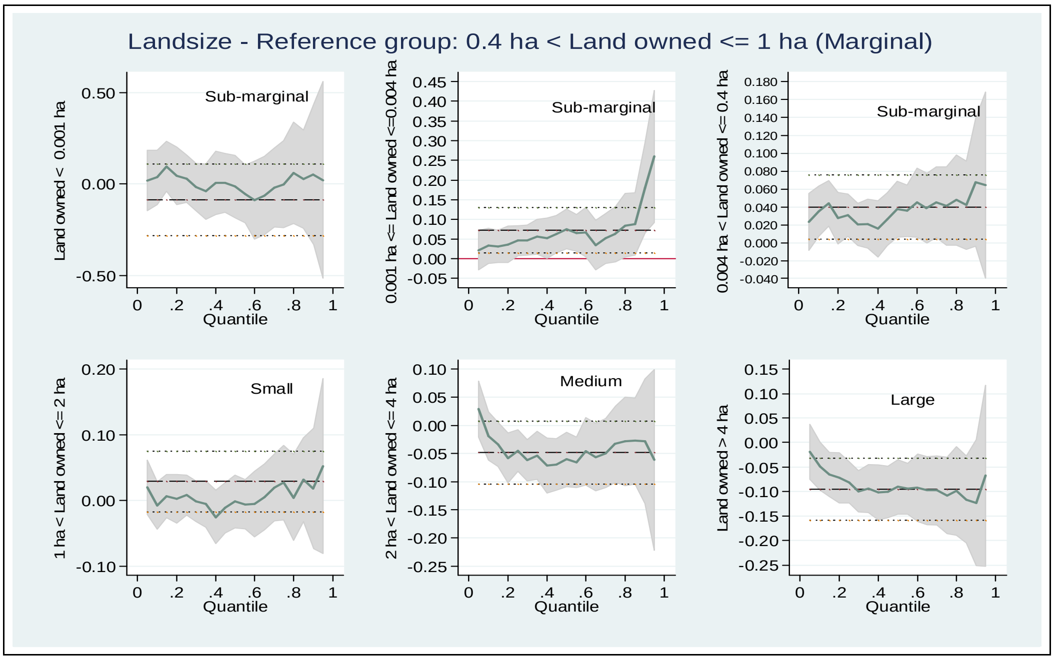

Figure 5: Quantile regression coefficients across different landholding size, 2009-10

URBAN INDIA

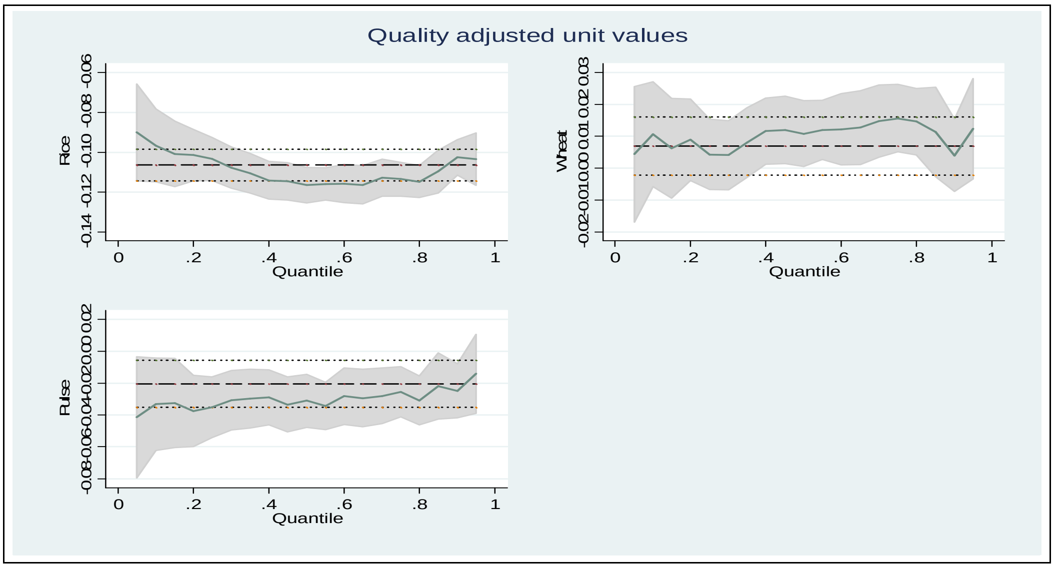

Figure 6: Quantile regression coefficients for quality adjusted unit values of rice, wheat and pulses, 2009-10

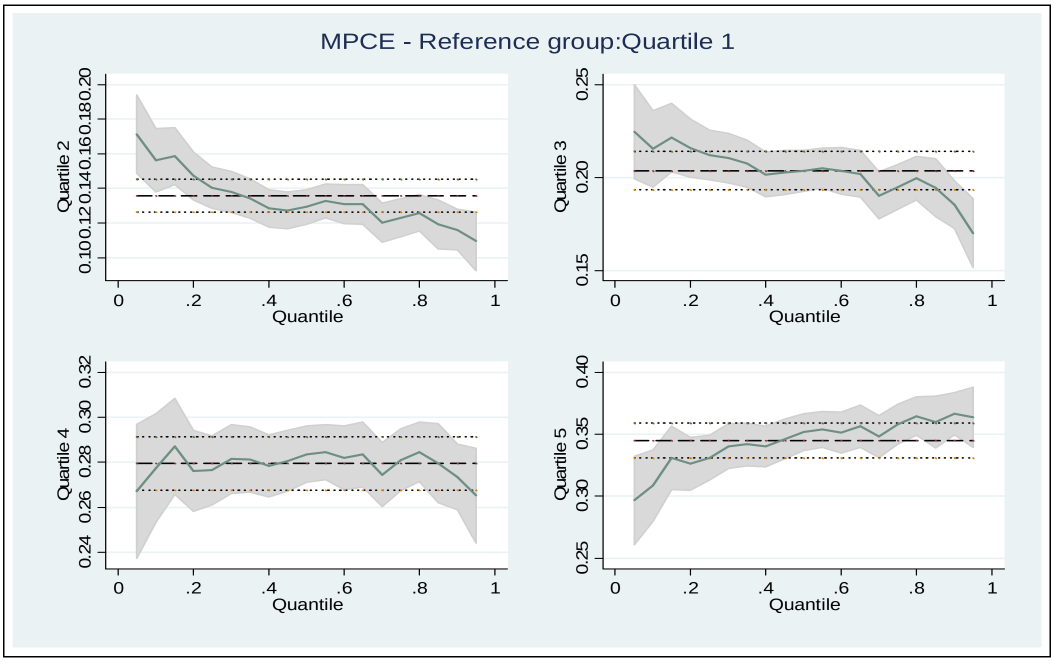

Figure 7: Quantile regression coefficients across different MPCE groups, 2009-10

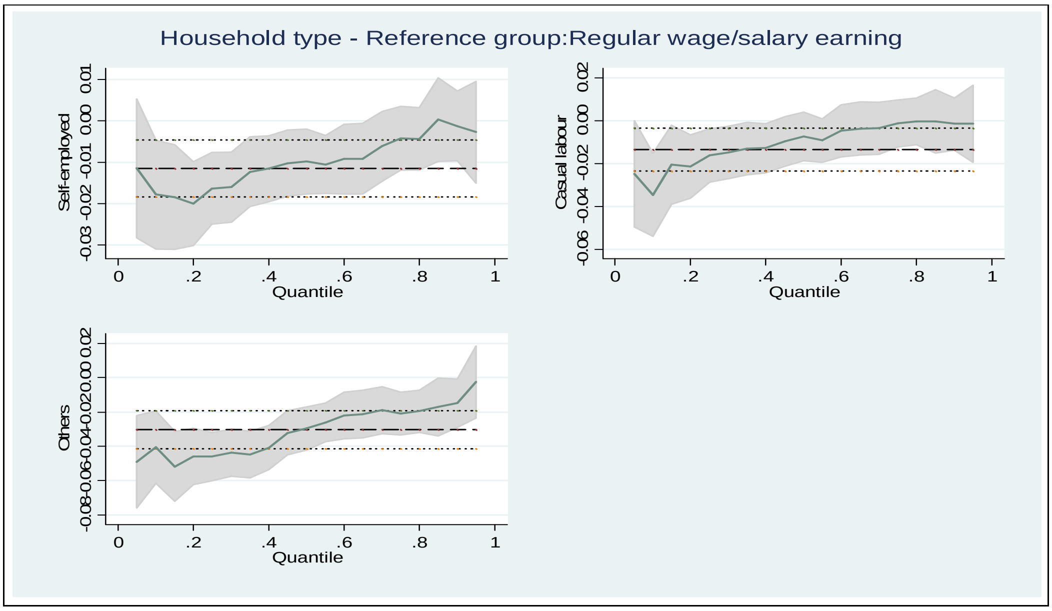

Figure 8: Quantile regression coefficients across different household types, 2009-10