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Nutrition transition and changing food preferences in India

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Abstract

We present empirical evidence on how changes in food preferences have contributed to nutrition transition, a phenomenon in which the dietary pattern of households shifts away from traditional staples. Using household level time series cross-section survey data, we estimate time varying demand elasticities, revealing evidence of declining importance of cereals in Indian household diets. The estimates show that Indian demand for cereals has become more income inelastic and price elastic. We also find that cereals are a substitute rather than a complement to animal products in household diets. Since changes in elasticities can only be attributed to variation in utility parameters, this indicates that cereals are losing favour with Indian households. These findings have implications for Indian government food policy design and implementation.

Keywords: nutrition transition, QUAIDS, India, demand elasticities

JEL: D12, O12, Q18

1. Introduction

Improving food security and nutrition intake remains a key policy concern in developing countries and India is no exception. The government has implemented, most recently via the 2013 National Food Security Act (NFSA), an extensive set of public policy measures to ensure that sufficient food is available to the poorest and most vulnerable in society (Narayanan and Gerber, 2017). For example, the Public Distribution System (PDS) is a food safety-net program that provides poor households quantities of rice or wheat at below market prices (Kishore and Chakrabarti, 2015). In addition, there are also the Integrated Child Development Scheme (ICDS) and the Mid-Day Meal Scheme (MDMS) that help ensure access to food at the household level (Pingali et al., 2017). However, while these policies have been in place, there has been a decline in cereal consumption in India. Between 1987-88 and 2011-12, the per capita daily calorie intake from cereals has fallen from 1,323kcal to 1,182kcal in urban India and from 1,684kcal to 1,336kcal in rural India.[1] At the same time the consumption of edible oils and animal products increased significantly. This structural shift of food consumption away from cereals and towards a more fat intense diet is known as the nutrition transition, a phenomenon observed in many developing countries (Drewnowski and Popkin, 1997). It is therefore important that policies implemented to ameliorate nutritional deficiencies take into account the changing nature of food preferences in a country.

Income and prices are the standard factors used to explain this dietary shift in food consumption and associated calorie intake. According to Bennet's Law, the share of calories from starchy staples declines with household income (Timmer et al., 1983; Fugile, 2004). But if income growth were the only cause, it would imply a negative relationship between income and cereal consumption in India. Given that cereals are a

[1] The decline in calorie intake in India is another widely discussed trend in Indian food consumption. See Deaton and Dreze (2009) and Smith (2015) for a detailed account of this puzzle.

traditional staple and major source of dietary nutrients, this negative relationship is hard to explain. In terms of prices, cereal consumption would be in decline if prices have risen, but according to Pingali et al. (2017) cereals have become cheaper relative to other nutritious food like pulses, fruits and vegetables. Thus, income growth and changing food prices do not fully explain the declining dietary importance of cereals in India.

One key determinant that we examine in this paper, which has been under-researched within the existing literature, are consumer preferences. Past studies on nutrition transition indicate that food preferences have been significantly influenced by the progress of economic development (Popkin, 1999; Thow, 2009; Kearney, 2010). In particular, urbanization and trade liberalization increase the variety and availability of food products and thus enable households to diversify their diets. Similar arguments have been made in the case of India. Shetty (2002) argues that economic development has altered Indian dietary habits towards a Western-type diet. Pingali and Khwaja (2004) also state that globalization, along with economic growth, has triggered Indian household adoption of a food culture that is different from the traditional ones. However, preferences are hard to observe and quantify. Existing studies account for changes in food preferences by adding time trends (Banks et al., 1997; Mittal, 2007), extrapolating data given parameter estimates (Dong and Fuller, 2010) or correlating time-varying demographic characteristics which are used as proxy variables for consumer preferences with consumption (Moro et al., 2000). These approaches have been criticized in the literature (Gao, et al., 1997), so we follow an alternative empirical strategy proposed by Chavas (1983) who observed that changing consumer preferences will alter demand elasticities over time. To date, several studies have assessed structural dietary shifts through comparing demand elasticities over time. For example, Guo et al. (2000) and Hovhannisyan and Gould (2011) show that food demand elasticities have changed over time in China. For India, Mittal (2007) reports that changes in food preferences have contributed to at most 0.1% decline in per capita cereal intake for different expenditure groups from 1983 to 1999. Gaiha et al. (2013) demonstrate that there are significant shifts in food price elasticities for fats, calories and protein, which are not determined by changes in price, income and household characteristics.

In this paper, we add to the literature investigating the nutrition transition in two significant ways.

First, we capture changes in food preferences in the rural and urban context by estimating time varying household level price and expenditure (income) elasticities of demand for four time periods between 1987-88 and 2011-12. We have taken this approach for two main reasons. First, there is evidence that the key elasticities of interest are not constant over this time period and understanding the evolution of these parameters is important. Second, in examining the evolution of the elasticity estimates over several data periods, we can assess if specific years of the data might be providing estimates that are less to do with a trend in the data and more as a result of an unobserved idiosyncratic feature that are unique to a specific year. The potential importance of this, especially for demand projections, will be revealed by the simulation results we generate.

Second, not only do we generate standard elasticity estimates but we also estimate "preference-based" elasticities. These elasticities are estimated by holding household characteristics, prices and income constant (at base year levels), such that any changes we observe in elasticities are going to be relatively independent of changes in income, prices and demographics and hence can only be attributed to the underlying utility parameters. We compare our preference-based estimates to standard elasticities in order to understand the extent to which demand responsiveness to price and income changes are influenced by changes in food preferences. In presenting these estimates, we are aware of both the limitations associated with them as well as alternative approaches previously employed within the demand estimation literature.[2] Therefore, given the limitations of the data set employed and the approach we can implement, we simply focus on whether consumer preferences have shifted away from cereals, with identification of the source of changes beyond the scope of the current study.

Our expectation is that there have been changes in demand elasticities for cereals in India over our sample period. Indeed, there is prior evidence to this effect in relation to calories reported by Gaiha et al. (2013) and Rahman (2017). Specifically, if cereals are becoming less favored by Indian households, the expenditure elasticity (YED) for cereals is expected to decline over time as households are likely to spend proportionally less on them as income increases. Weaker preferences for cereals will also make Indian households less resistant to changes in their relative prices. Thus, we anticipate that the price elasticity of demand (PED) for cereals has become relatively more price elastic over time. Also, it is expected that demand for cereals has become more sensitive to changes in the prices of substitutes but less so for complements (i.e. cross price elasticity of demand (XED)). If our priors are met, this implies that the preferences of Indian households have shifted away from cereals and hence contributed to the nutrition transition being observed in India.

To undertake our analysis we use India's National Sample Survey (NSS) covering the periods 1987-88, 1993-94, 2004-05, 2011-12. This household level survey data is then analysed following Ecker and Qaim (2011) who employ a two-stage estimation procedure. In the first stage, the Working-Leser model is used to analyze how households allocate total expenditure among food and non-food items. Then in the second stage, we examine the composition of the food bundle consumed by Indian households using the quadratic almost ideal demand system (QUAIDS) with demographic scaling (Banks et al., 1997; Capacci and Mazzocchi, 2011). We estimate our demand equations using a two-step procedure advocated by Shonkwiler and Yen (1999) to account for the sample selection bias from zero expenditure data. Also, as unit values are used as a proxy for the unobserved market prices, we mitigate the potential bias from measurement error and quality effects by implementing an adjustment following Majumder et al. (2012). Together with the results from the Working-Leser model, these QUAIDS estimates give the combined demand elasticities for cereals, which can be used to infer the changes in food preferences in recent decades.

[2] Alternative approaches have been used in the literature to capture preference change such as a time trend or a discrete intercept shift. Also, if suitable data is available it is possible to try and identify causal factors (e.g., demographic changes, advertising, and changes in information about the health consequences of diet) driving change and explicitly include them within the demand system. See Okrent and Alston (2011) for an overview of the literature.

Overall, our preference-based elasticity estimates for cereals are in line with our prior beliefs. We find that rural demand for cereals is becoming less sensitive to changes in income whereas urban demand for cereals has become more price elastic over time. We also observe a general declining trend of the complementary relationship between cereals and other food groups. These results highlight the impact of changing preferences on demand responsiveness to income and price changes. Furthermore, as demonstrated by our simulation exercises, these changes in demand elasticities play an important role in driving the nutrition transition in India. From these findings, it is clear that cereals are no longer the only food group that matters with regard to food security and nutritional objectives in India. Thus, with the declining dietary importance of cereals, a transition of the Indian food system from its current focus on staples to a much more diversified food system that enhances accessibility and availability of key non-cereal food is essential for achieving food security as well as nutritional objectives.

This paper is structured as follow. In Section 2 we describe our data as well as the adjustment of unit values. Then in Section 3 we detail our estimation methodology. Section 4 presents the various demand elasticity estimates. In Section 5, we perform two simulation exercises to understand how these changes in elasticities affect food consumption behaviour. We highlight the limitations in Section 6 and conclude in Section 7.

2. Data

2.1 The Indian National Sample Survey

This study uses household consumption expenditure data from four rounds of India's National Sample Survey (NSS) covering the periods 1987-88, 1993-94, 2004-05, 2011-12, yielding data on 265,770 rural and 174,067 urban households from over 70 Indian regions.[3] The NSS adopts a two-stage stratified sampling method. In the first stage the sampling units are villages and urban frame blocks for rural and urban sectors respectively. Households are then selected from the sampling units in the second stage. Importantly, the survey has a wide coverage of food items at a disaggregated level, from basic staples to various types of vegetables and fruits. Like previous studies on Indian food demand (e.g., Mittal, 2007 and Kumar et al., 2011), we divide the food items into six groups: cereals; eggs, fish and meat (EFM); edible oils; pulses; vegetables and fruits; and other food (other includes milk, milk products, cereal substitutes, dry fruits, nuts and sugar). As income data is not collected in the NSS, we proxy household income with monthly per capita expenditure (MPCE). Expenditure and income are used interchangeably thereafter.

Table 1 presents descriptive statistics of MPCE and food consumption for our sample.

{Approximate Position of Table 1}

From Table 1 we can see that compared to the rural sector, households in urban India are generally richer and have higher MPCE. Rural households tend to allocate a higher share of their budget to food than their urban counterparts. Despite the increase in monthly per capita food expenditure (MFE) over time, Indian households

[3] For more details see http://www.mospi.gov.in/national-sample-survey-office-nsso.

spent relatively less on food in 2011-12 than 1987-88, with the average share of food in total expenditure falling from 51% to 37% for urban households and from 58% to 43% for rural households.

In terms of food consumption, we see from Table 1 that rural households purchase relatively more cereals while urban households have a relatively more diverse diet. Even with the extensive set of government policies in place to distribute food grains to the poor, cereal consumption recorded the largest decrease among all the food groups. From 1987-88 to 2011-12, the average calorie intake from cereals of urban and rural households decreased by 141 kcal and 348 kcal respectively. Similar decline in the dietary importance of cereals has been observed in previous studies on Indian food consumption (Deaton and Drèze 2009; Smith 2015).

2.2. Quality adjusted unit values (prices)

The NSS does not collect market prices for food items faced by households like most food surveys. Therefore, the common practice is to proxy prices with unit values obtained by dividing expenditure with quantity bought. This approach can exaggerate actual price differences across markets as product quality is not captured in the data. Unit values may also exhibit measurement error due to the failure of household to accurately recall expenditure and quantity consumed. Thus, unit values need to be corrected before being used as a proxy for market prices.

Following Majumder et al. (2012), we adjust the initial unit values calculated from the NSS for each round, using the following Ordinary Least Squares (OLS) model:

$$v_i - (v_i^{ur})_{median} = d_{i1}D_r + d_{i2}D_u + d_{i3}D_s + \theta_i food + \eta_i Z + \varepsilon_i \tag{1}$$

where v_i is the unit value of food group i (i=1,…,n) in Indian rupee per kilogram faced by each household and $(v_i^{ur})_{median}$ is the median unit value of that item in sector u and region r in which a household resides. D_r and D_u denote regional and urban sector dummies respectively.[4] We extend the Majumder et al. (2012) approach by adding a set of dummy variables, D_s, to indicate the quarter of the year (i.e. sub-round of the survey) when the household is interviewed to account for variation in market prices resulting from seasonal changes in supply availability of food commodities. The variable $food$ represents MFE. A vector of household characteristics, Z, (i.e., age and gender of household head, household size, proportion of adult males and females in the households, and share of times that meals are consumed outside by that household) are added as control variables. In particular, the share of meal consumed outside of home is employed as a proxy for the degree of market access to food enjoyed by the household. ε_i is the residual in the regression. We then assume that households in the same sector of the same region face the same vector of food prices, p_i which is obtained by summing the median unit value with the median estimated residual of the sector in

[4] In Majumder et al (2012), prices are modified at the district level by using the median unit value in each district and adding district dummies. However, information on Indian districts is not available in earlier surveys. For estimation consistency, prices used in this study are adjusted to the regional level, following Cox and Wohlgenant (1986).

each region.[5] Table 2 presents the average quality and demographically adjusted unit values of food groups for selected years.

{Approximate Position of Table 2}

The values reported in Table 2 are similar to those in Majumder et al. (2012), with EFM being the most expensive food group and vegetables and fruits being the cheapest in the 2000s. Food prices are generally higher in the urban sector than the rural sector with the exception of edible oils for which the price differential is minimal. Other food and pulses recorded the fastest rise in adjusted unit values in urban and rural sectors respectively. In contrast, edible oils have become relatively cheaper in both sectors as the rate of growth in prices is the lowest among all food groups. Finally, there is also evidence of a general increase in the relative price of cereals. Cereal prices recorded a percentage increase higher than that of EFM. While this may reflect that price subsidies were not sufficient to counteract the upward pressure from market forces, it may also be driven by the likelihood that Indian households have been substituting low cost cereals (i.e. coarse grains) for high cost ones (i.e. rice and wheat) (Chand, 1999; Mittal, 2007).

3 Econometric methodology

3.1. Two-stage demand system

In the first stage, a household decides how total expenditure is allocated across food and non-food commodities. Then in the second stage, the household allocates total food expenditure across six food groups. Together with the assumption that the price indices of food groups do not vary significantly with the expenditure level, the allocation of total expenditure will be approximately correctly estimated (Edgerton, 1997). The two-stage demand system is estimated separately for the rural and urban sectors for each round of the NSS considered.

3.1.1 Stage 1: The Working-Leser Model

We follow Ecker and Qaim (2011) and employ a Working-Leser model to study the allocation of household food and non-food expenditure as follow[6]:

$$w_F = \alpha_F + \beta_F \ln P_F + \gamma_F \ln M + \varepsilon_F \tag{2}$$

where w_F is the share of food (F) in total expenditure. P_F is the median of average weighted food prices in each region, with the weights being equal to the proportion of total food expenditure that households spend on each food item. To avoid price endogeneity, households in each region are assumed to face the same general food price level. M denotes household income which is proxied by MPCE and ε_F is the error term. Finally, a vector of household characteristics (Z) are added as control variables through linear demographic translation (Ecker and Qaim, 2011). This vector of variables is same as the one employed in the price adjustment

[5] Since other food includes a variety of food items, the price faced by households is subject to their consumption pattern and differs greatly within sectors and regions. To eliminate the influence of extreme unit values and ensure positivity of the adjusted price, outliners are dropped using Cook's distance in the price adjustment regression for other food. Our results are generally robust to the case when regional median unit values are used in demand estimation.

[6] It is not feasible to account for non-food prices in stage 1 as the NSS does not collect quantity consumed of many non-food items and quality data of non-food prices is rare.

estimation with the exception of the age of household head and household size, which enter in equation (2) in logarithm form for better model fit.

3.1.2 Stage 2: QUAIDS

In the second stage, we assume that an individual decision to consume is as a result of utility maximization subject to a budget constraint. Banks et al. (1997) uses the following indirect utility function (V) to derive the QUAIDS:

$$\ln V = \left\{\left[\frac{\ln m - \ln a(p)}{b(p)}\right]^{-1} + \lambda(p)\right\}^{-1} \tag{3}$$

where m denotes the MFE and $\ln a(p)$ takes the translog form[7]:

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \tag{4}$$

and $b(p)$ is the Cobb-Douglas aggregator function of the price vector (p) defined by:

$$b(p) = \prod_{i=1}^{n} {p_i}^{\beta_i} \tag{5}$$

and $\lambda(p)$ is a price aggregator function which is homogenous of degree zero in prices such that:

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \tag{6}$$

Equations (3) to (6) together define the QUAIDS specification. It can be seen that, apart from income and prices, the utility that a consumer receives from consuming a good is determined by the parameters α_i, γ_{ij}, β_i and λ_i. By capturing changes in these parameters, demand elasticities provide the best way to interpret how consumer preferences have changed as well as providing valuable insights into how consumer behavior is affected by these changes in food preferences.

After applying Roy's identity to equation (3), the budget share of food group i (w_i) is derived as follow:

$$w_i = \alpha_i + \sum_{j}^{n} \gamma_{ij}\, ln\, p_j + \beta_i\, ln\left[\frac{m}{a(\mathbf{p})}\right] + \frac{\lambda_i}{b(\mathbf{p})}\left\{\ln\left[\frac{m}{a(\mathbf{p})}\right]\right\}^2 + \varepsilon_i \tag{7}$$

The higher order income term in equation (7) marks the key difference between QUAIDS and the almost ideal demand system (AIDS) introduced by Deaton and Muellbauer (1980). The inclusion of this term allows the budget share Engel curve to be non-linear, such that goods can be a luxury for the poor but a necessity for richer households.

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[7] Following Deaton and Muellbauer (1980) and Banks et al. (1997), α_0 is chosen to be just below the lowest value of the logarithm of MFE (i.e. minus by 0.1).

As in Moro and Sckokai (2000) and Capacci and Mazzocchi (2011), we incorporate demographic scaling into the QUAIDS by allowing letting constant term and income coefficients depend on the set of household characteristics (z_d). For conformity, these demographic variables are same as the ones used in the first budgeting stage. Equation (7) is thus modified as follow:

$$w_i = \left(\alpha_{i0} + \sum_{d}^{D} \alpha_{id}\, z_d\right) + \sum_{j}^{n} \gamma_{ij}\, ln\, p_j + \left(\beta_{i0} + \sum_{d}^{D} \beta_{id}\, z_d\right) ln\left[\frac{m}{a(\mathbf{p})}\right]$$
$$+ \left(\lambda_{i0} + \sum_{d}^{D} \lambda_{id}\, z_d\right) \frac{1}{b(\mathbf{p})} \left\{\ln\left[\frac{m}{a(\mathbf{p})}\right]\right\}^2 + \varepsilon_i \quad (8)$$

Demand theory implies that following restrictions are required in the estimation of QUIADS:
Adding up:

$$\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = 0, \sum_{j=1}^{n} \gamma_{ij} = 0, \sum_{i=1}^{n} \lambda_i = 0 \quad (9)$$

Homogeneity:

$$\sum_{i=1}^{n} \gamma_{ij} = 0, \quad (10)$$

Symmetry:

$$\gamma_{ij} = \gamma_{ji} \quad (11)$$

3.1.3 Estimation of probit model

In the collection of household survey data, it is common to record zero purchases for commodities. These can be a 'true' zero, indicating that households do not consume these items for reasons such as inability to afford or low preference for them. For example, beef is often not consumed by many Indian households because cow is deemed as a sacred animal by Hinduism. Zero consumption might also be driven by the fact these items are not available during the time that a household is surveyed. Alternatively, a zero could occur where households just happen to not make any purchase within the reporting period even though they normally consume that commodity (Deaton, 1997). These zeros are considered as 'false' zeros, causing a downward bias to the observed expenditure.

To deal with this issue, we follow Shonkwiler and Yen (1999) and employ a two-stage estimation procedure.[8] The demand system of equations is first modelled as follows:

[8] Banks et al. (1997) deal with sample selection bias by estimating the demand system using GMM. As households in the NSS are not sampled repeatedly, this technique is not feasible.

$$\omega_i^* = z'_i\kappa_i + \upsilon_i$$

$$\omega_i = \begin{cases} 1 & \text{if } \omega_i^* > 0 \\ 0 & \text{if } \omega_i^* \le 0 \end{cases} \qquad (12)$$

$$w_i = \omega_i w_i^*$$

where w_i indicates the observed budget share of food group i and ω_i is the binary outcome which equals one if that item is consumed by the household, and zero otherwise. Their corresponding unobservable latent variables are indicated by w_i^* and ω_i^*. z'_i denotes the set of independent variables determining the consumption decision, which includes the logarithm of food group prices, logarithm of MFE and the household characteristics used in first stage demand estimation. υ_i is a random error.

In implementing this procedure, we compute the household-specific standard normal probability density function $\phi\,(z'_i\kappa_i)$ and the cumulative distribution function $\Phi\,(z'_i\kappa_i)$ for each food group using a probit model, and we then incorporate them into the budget share equation (7), such that:

$$w_i = \Phi(z'_i\kappa_i)w_i^* + \varphi_i\phi\,(z'_i\kappa_i) + \varepsilon_i \qquad (13)$$

With this correction for zero observation, the right-hand side of equation (12) does not add up to one in the demand system. Hence, the adding-up restriction defined above no longer holds, which removes the need for dropping one arbitrary equation in the QUAIDS estimation (Ecker and Qaim, 2011).

3.1.4 Expenditure and Price Endogeneity

It has become reasonably common with demand system estimation to consider issues associated with expenditure and price endogeneity. With regard to expenditure endogeneity this problem occurs because expenditure is employed on both sides of the demand system equations. This issue can be resolved following Dhar, Chavas, and Gould (2003), but it requires the use of income data. Unfortunately, the NSS does not collect household level income so it is not possible to deal with expenditure endogeneity in this way. However, we also note that when dealing with this issue in demand estimation Zhen et al. (2014) note that this type of endogeneity is unimportant (see page 5), which is the result reported by other researchers.

Turning to price endogeneity there have been a number of different approaches proposed within the literature e.g., Hovhannisyan and Gould (2017). However, because of limitations with the NSS it is feasible to correct for potential price endogeneity by regressing food prices on supply side factors in the case of India. However, within our model specification we already include regional dummies and take account of the fact that Indian households living in different regions face different food prices. Moreover, we also consider the effect of supply seasonality on food prices and as such, we indirectly account for the effect of supply-side changes on food prices and hence mitigate the price endogeneity bias. In addition, we also control the potential bias arisen from measurement error and differences in household preferences through incorporating household demographics in the demand equation. More generally, given that we are employing household level micro data, we note the point made by Zhen et al. (2014), *"supply-demand simultaneity may not be a major issue with micro data because individual household purchase decision may not significantly affect market* *equilibrium prices."* (Page 5). Finally, as part of our estimation strategy, we adopted Majumder et al. (2012) to address issues relating to estimation of prices from unit values. There are many papers within the demand literature that address this data limitation, e.g., Capacci and Mazzocchi (2011). Importantly, they note the steps involved in generating prices given unit values means that the resulting prices used in estimation *"can be safely treated as exogenous variables for aggregate food groups."* (Page 93). Based on these arguments, we are of the view that since the prices used in our study are adjusted for measurement errors, demographic differences and supply side factors, price endogeneity is unlikely to constitute significant bias effecting the trends of our elasticity estimates.

3.2 Demand elasticities

To identify changes in the underlying utility parameters, demand elasticities for all rounds are evaluated based on the representative urban and rural households in 1987-88 (i.e. who faced the mean value of food prices and had average income and household characteristics). The average budget share of food (w_F) is therefore held constant at the 1987-88 level in the following equations. From equation (2), the preference-based demand elasticities for food can be calculated as follows:

YED:

$$E_F^x = 1 + \frac{\gamma_F}{w_{F,8788}} \tag{14}$$

Uncompensated PED:

$$E_F^u = \frac{\beta_F}{w_{F,8788}} - 1 \tag{15}$$

Compensated PED (i.e. using the Slutsky equation):

$$E_F^c = E_F^u + w_{F,8788} E_F^x \tag{16}$$

Next, using the procedure given in Banks et al. (1997) and the formula from Edgerton (1997), the preference-based demand elasticities for aggregated food groups are derived as:

YED:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln m} = \left[\beta_i + \frac{2\lambda_i}{b(\mathbf{p})}\left\{\ln\left[\frac{m_{8788}}{a(\mathbf{p})}\right]\right\}\right] \Phi\,(\mathrm{z}'_i\kappa_i) \tag{17}$$

$$E_i^x = E_F^x\left(\frac{\mu_i}{w_{i,8788}} + 1\right) \tag{18}$$

Uncompensated PED and XED:

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \left[\gamma_{ij} - \mu_i\left(\alpha_j + \sum_k^n \gamma_{ik} \ln P_{k,8788}\right) - \frac{\lambda_i\beta_j}{b(\mathbf{p})}\left\{\ln\left[\frac{m_{8788}}{a(\mathbf{p})}\right]\right\}^2\right] \Phi\,(\mathrm{z}'_i\kappa_i) \tag{19}$$

$$E_{ij}^u = \left(\frac{\mu_{ij}}{w_{i,8788}} - \delta_{ij}\right) + E_i^x w_{j,8788}[1 + E_F^u] \tag{20}$$

Compensated PED and XED:

$$E_{ij}^{c} = \left(\frac{\mu_{ij}}{w_{i,8788}} - \delta_{ij}\right) + w_{j,8788}\left(\frac{\mu_{i}}{w_{i,8788}} + 1\right) + E_{i}^{x} w_{j,8788} E_{F}^{c} \quad (21)$$

where P_k is a price index calculated as the arithmetic mean of prices for all k food groups. δ_{ij} is the Kronecker delta which equals to one if $i = j$ and zero if $i \neq j$. Note that the mean value of food prices, income and household demographics in 1987-88 is used in the computation of price indices ($a(\mathbf{p})$ and $b(\mathbf{p})$), and constant (α_j). The decision to consume (i.e. $\Phi\ (\mathrm{z'}_i \kappa_i)$) is also evaluated based on the representative urban and rural households in 1987-88. This leaves changes in utility parameters the only possible cause of any variation in the estimates of preference-based demand elasticities. For the purpose of comparison, we also compute the "standard" demand elasticities using the mean data point of the current period.

4. Empirical results

4.1 Food expenditure decision

The estimates of the Working-Leser model provide strong evidence supporting that households in both sectors allocate relatively less additional income to food when facing an increase in income.[9] The coefficients of shares of meals consumed outside home are significant and negative, which is in line with the finding of Ecker and Qaim (2011). Using distance to the nearest daily market as a parameter, they find that Malawian households spend proportionally more on food if they live farther away from the market. In the case of India, the level of market access, proxied by the share of meals consumed outside home, has larger negative impact on the budget share on food for rural households than those in the urban sector. The positive and significant coefficients of the share of adult female and male in both sectors reflect that adults have a higher calorie need and hence households with more adults spend relatively more on food. In addition, older household heads tend to spend more on food than their younger counterparts.

4.2 Demand elasticities for food

In Table 3, we report two forms of demand elasticities for food of urban and rural India: (i) columns 1 and 2 give the preference-based elasticities, which are computed using the mean data point in 1987-88; (ii) columns 3 and 4 provide the standard elasticities calculated at the mean data point of the current period. Given that the period 1987-88 is the reference point, the preference-based and standard elasticities are exactly the same in this period. All these elasticities are strongly statistically significant.

{Approximate Position of Table 3}

From Table 3 we can see that for both urban and rural sectors, the preference-based YED for food is smaller than unity. This conforms to the fact that food is a necessity and Engel's Law which states that the proportion of total expenditure spent on food is greater for poorer households. As predicted by demand theory, the sign of uncompensated and compensated PEDs for food is negative. The rural demand for food is shown to be more income and price elastic than that of urban households. For both sectors, there are limited changes in the value of preference-based YEDs and PEDs over the survey rounds, suggesting the preferences for food are reasonably stable over the period of interest.

[9] The regression results are reported in the appendix.

Next, we look at standard demand elasticities in columns 3 and 4. While these estimates also confirm to Engel's law and demand theory, they display more variations than the preference-based ones. From 1987-88 to 2011-12, the rural and urban standard YEDs decreased from 0.727 to 0.651 and 0.822 to 0.717 respectively, indicating that the proportion of additional income allocated to food expenditure decreases with income increase. In both sectors, the demand for food has become more sensitive to changes in food price as suggested by the rising trend of PED. Thus, these estimates indicate that although food remains a necessity, its importance within the household budget in both rural and urban India has declined. These results are consistent with the observation of Deaton and Drèze (2009) who report limited real change in per capita expenditure on food in spite of the rising MPCE. As shown by the trend of standard YED, the rise in total expenditure of Indian households triggers a less than proportional increase in expenditure on food and the magnitude of the increase tends to fall over time. Deaton and Drèze (2009) also show that the real price of calories increased from 1987-88 to 1999-2000. The estimates of PED suggest that the increase in calorie prices causes a rising negative substitution effect over time, making it more likely to cancel out the falling positive income effect and leaving the real food expenditure unchanged.

4.3. QUAIDS estimates

The QUAIDS is estimated with the iterative feasible generalised non-linear least square estimator through the NLSUR command in STATA. To keep the analysis focused on the nutrition transition, we report the model estimates in the Appendix and only discuss key results here. For both urban and rural sectors, most of the parameters estimated are statistically significant. The highly significant quadratic terms for income (λ) supports the non-linearity of the budget share Engel curve of Indian households for their consumption of various food groups and thus establishes the superiority of QUAIDS over AIDS. The QUAIDS results also signal the importance of correction in zero consumption as the coefficients of the probability density functions (φ) are generally statistically significant.

4.4. Demand elasticities for cereals and the nutrition transition

The demand elasticities for cereals for urban and rural sectors are presented in Table 4.[10]

{Approximate Position of Table 4}

The elasticities reported in Table 4 capture the short run (i.e. a year) cereal demand response to changes in income and prices and they tend to be smaller. In other words, the demand for cereals is generally income and price inelastic. The elasticity estimates in columns 1 and 2 of Table 4 show that urban demand for cereals has become more income and price elastic compared to the rural sector since the 2010s. The estimates of XEDs are predominately negative, suggesting that most food groups are viewed as complements to cereals by Indian households. The variations in preference-based elasticities across periods provide evidence in support of the changes in underlying utility parameters of Indian food demand and thus shifts in their food preferences.

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[10] We report the estimated demand elasticities for other food groups in the appendix.

Turning to our standard elasticity estimates that are reported in Table 4, we see that they are generally in line with the results of Anand et al. (2016) even though they do not account for sample selection bias arising from the inclusion of zero observations. Using the same dataset, they find that the Indian cereal demand is income and price inelastic. Their estimate of XED for cereals in response to price changes in eggs, fish and meat is 0.02 and that to price changes in pulses is 0.008.

In addition, our standard demand elasticities are consistent with the findings of Mittal (2010) and Kumar et al.(2011) in which the Indian demand for other food are generally more income and price elastic than other food groups. It should be noted that the elasticities reported in this paper are not directly comparable to those estimated in the above studies due to two reasons. First, their data periods are 1983, 1987-88, 1993-94 and 1999-2000, which differ from the ones used in this paper. Second, they estimate QUAIDS using a pooled dataset from these rounds of NSS data with no attempt to account for the time trend across rounds. Their elasticities thus capture the long-term response rather the short-term changes reported in this paper.

In addition to Table 4, we provide a series of graphs to illustrate the time profile of demand elasticities for cereals. As seen from the left panel of Figure 1, the urban preference-based YED is relatively stable over the period of interest. In contrast, the rural YED has decreased from 1.490 to 0.664 from 1987-88 to 2011-12.

{Approximate Position of Figure 1}

This decrease in responsiveness of cereal demand towards income changes confirms our hypothesis that less additional income has been allocated over time to cereal consumption as this commodity is losing the favour of rural households over time. Turning to the right panel of Figure 1 reveals that cereal demand in urban sector has become more price elastic due to changes in food preferences. During the survey period, the absolute value of urban PED for cereals increased from 0.413 to 0.845. For rural households, their PED for cereals decreased slightly in 1993-94 but remained rather stable after. The increasing trend of preference-based PED provides support to our proposition that the decline in consumer preferences for cereals has made urban households more willing to adjust their cereal consumption in response to the rise in cereal prices.

Next consider Figure 2 that shows the time profile for the XEDs for cereals.

{Approximate Position of Figure 2}

The results shown in Figure 2 support our proposition that the preference-based XEDs for cereals and its complements have generally decreased in absolute value over time. For instance, the estimate of XED between cereals and eggs, fish and meat in rural India decreased from 0.623 to 0.286 in absolutive term from 1987-87 to 2004-05. During the same period, the responsiveness of urban cereal demand to price changes in edible oils dropped from 0.577 to 0.156 in absolute value. Overall, the time profiles we observe for XEDs provide support for the shift in food preferences of Indian households away from cereals.

We next consider the standard elasticity time profiles in Figures 3 and 4.

{Approximate Position of Figures 3 and 4}

In Figure 3, we plot the time profile for the standard YED and uncompensated PED for cereals, which exhibit similar trends to the preference-based elasticities. The left panel illustrate that while the standard YED has been declining in rural India, it is relatively stable in urban India. The increasing urban PED in the right panel reveal that urban demand for cereals has become less income elastic. The PED of rural demand has, however, decreased slightly.

Figure 4 illustrates a general decrease in the absolute value of standard XEDs, in other words, Indian cereal demand has become less responsive to price change of its complements. The magnitude of this declining trend in standard XEDs is similar to the preference-based ones in Figure 2. The only exception is the case when the rural price of other food changes, the standard XED of cereal demand is shown to have decreased more in absolute term than the preference-based one.

Overall, the evolution of the standard elasticities over time is very similar to those of the preference-based estimates. This highlights that changes in utility parameters, and thus food preferences, are crucial determinant of demand responsiveness towards income and price changes. The evolution of these estimates rejects the normal assumption of constant elasticities in demand studies. More importantly, the demand for cereals is found to have become less income elastic but more sensitive to changes in cereal prices. There is also evidence in support of the declining complementary relationship between cereals and other food groups. These changes in the demand elasticities confirm our hypothesis that food preferences of Indian households have shifted away from cereals in the last few decades.

4.5 Robustness check

The demand elasticity estimates we have reported may be biased as the selection of Indian households in the survey may not be entirely random. Due to the use of the two-stage stratification strategy, the probability of Indian households being selected varies across each sample village and urban block. One way to address this issue is to apply survey weights in the regression analysis. As stated by Winship and Radbill (1994), this is not necessary if sampling weights are solely a function of the observed independent variables included in the model. They argue that the use of unweighted data is preferred if the parameter estimates produced by OLS and Weighted Ordinary Least Squares (WOLS) are substantively similar as OLS estimates are more efficient and the estimated standard errors are smaller. To examine if our estimates are biased, we re-estimate the QUAIDS with the application of survey weights. The demand elasticities only differ slightly from the ones in Table 4.[11] Therefore, the use of sampling weights is unlikely to alter the trend of preference-based demand elasticities observed above.

Another possible source of bias relates to the food prices used in this paper. As noted by Majumder et al. (2012), the quality adjustments do not completely eliminate the bias arising from using unit values as proxies for market prices. Nevertheless, if the distortions in unit values are consistent across regions and survey

[11] We present the results of robustness check on preference-based demand elasticities in the appendix.

rounds, the impact on the patterns of demand elasticities will be minimal. Given that it is difficult to measure the magnitude of potential measurement bias, we have checked whether our results are robust if no quality adjustment is performed at all. To do this, we re-estimated the QUAIDS specification with the median unit value of each food group in each region. This yielded a pattern of demand elasticities that are the same as the ones already considered.

5. The nutrition transition

How has this shift in food preferences contributed to the decline in dietary importance of cereals? To answer this question, we perform two simulation exercises which are reported in Table 5.

{Approximate Position of Table 5}

In these exercises, we estimate the cereal demand response towards income and price changes using the preference-based demand elasticities obtained from the different data periods. In both cases, we assume all other factors remain constant and take the cereal consumption in 2011-12 as the base level. Recall that these preference-based elasticities are independent of changes in income, prices and socio-economic variables, which implies, the difference in the predicted level of cereal consumption can only be explained by the changes in the underlying utility parameters, in other words, the preferences towards cereals.

In Table 5, panel A shows the estimated change in cereal demand in response to income growth. Assuming income increased by 10%, the rural households would have increased their cereal consumption by 199 kcal if YED had not change since 1987-88. Nevertheless, because their demand for cereals has become less income elastic over time, the rise in consumption would only be 89 kcal under the demand elasticity estimated with the 2011-12 data. This difference in predicted change in cereal consumption is not observed in urban India due to its relatively stable YEDs.

In panel B, we consider a cereal price increase by 10%. Using the preference-based PED in 1987-88, it is predicted that the cereal consumption would decrease by 49 kcal in the urban sector and 137 kcal in the rural sector. But when the elasticities are estimated with 2011-12 data, the estimated decrease in urban becomes 100 kcal. This illustrates that by making cereal demand more price elastic, the decline in preferences towards cereals in urban India have increased the magnitude of the fall in cereal intake in respond to the price rise. For rural sector, the decline in consumption would, however, be smaller (i.e. 95 kcal) due to the drop in its PED discussed before.

Panel C combines the results from the above two panels. It can be seen that with equal percentage increases in income and cereal price, rural and urban households would have consumed more cereals if their preferences towards cereals had not change; in other words, if the preference-based elasticities remained at 1987-88 levels. This is because the income-induced increase in cereal consumption is larger than the decrease triggered by price changes. However, as cereals have become less preferred over time, the rise in income and cereal prices will result in a smaller increase in cereal intake or even a decrease instead. This is apparent when elasticities estimated with 2011-12 data are used for simulation. With a 10% rise in income and cereal price, rural households would consume 6 less cereals as the price-induced fall in cereal intake becomes larger than the increase caused by income growth. For urban India, while the net change in cereal consumption remains positive, the magnitude of the increase is much smaller when estimated with the preference-based elasticities at 2011-12 levels.

The above simulation exercises reveal the impact of changing food preferences in nutrition transition. Weaker preferences for cereals have slowed the rate of increase in cereal consumption in response to the recent income growth in India. It has also made households more sensitive to the increase in cereal prices and hence led to a larger fall in cereal intake. These changes have contributed to a dietary shift away from cereals in India despite the various policy efforts implemented in India to deal with food insecurity and nutrition.

Finally, an additional insight from our simulation results is the potential error in demand projection arisen from the use of demand elasticities from previous years. If one were to use elasticities estimated derived with data from earlier years of the NSS survey to forecast future food demand, then we could generate relatively inaccurate estimates. This issue is likely to be more problematic if the analysis covers a long time period or if the country of interest is experiencing dramatic changes, which appears to be the case for India. Equally, if we select only two years of a long standing survey to estimate elasticities and these two years are unusual or outliers, then our resulting estimates will reflect these limitations. Therefore, as we have done here, there is good reason to select several years of data to reduce this potential source of bias.

6. Limitations

While the trend of demand elasticities is robust, there are some caveats that should be kept in mind. As highlighted by Strauss and Thomas (1995), expenditure survey data does not adequately control for food wastage. Since rich households are likely to waste more food than the poor ones, their actual food consumption may be overstated. Besides, the NSS does not account for meals that are given to guests and employees and the ones that are received in kind, causing a potential upward bias on demand elasticities. Smith (2015) also raises a concern about the inadequacy of NSS in capturing consumption of meals consumed away from home, which leads to an underestimation of actual cereal consumption. This downward bias would be greater if the meals consumed away from home contained relatively more cereals than those eaten at home. Nonetheless, these measurement errors are likely to be mitigated with the inclusion of demographics in our model estimation since the likelihood of food wastage and the patterns of giving and receiving meals and eating out are likely to be correlated with household characteristics. Furthermore, given that these errors tend to be consistent over time, its impact on the trend of demand elasticities is expected to be minimal.

Another issue with our approach is that we have taken the view that income determines the level of food consumption and have neglected the “efficiency-wage hypothesis” which argues that households with better food intakes are likely to have higher work productivity and hence higher income earnings. This reverse causation in the relationship between income and food consumption gives rise to an endogeneity bias on the estimates of demand elasticities. However, the existing evidence for efficient wages with a developing economy context is thin (Strauss and Thomas, 1998). In the case of India, Dawson and Tiffin (1998) examine the long-run relationship between per capita calorie intake and per capita income using aggregate data from 1961 to 1992. In their co-integration analysis, they find that calorie intake is Granger caused by income and not vice versa, suggesting that income generation is not constrained by food intake in India. Hence, the bias caused by reverse causation is unlikely to be a major concern in our case.

7. Discussion and conclusion

This paper identifies the influence of changing preferences towards cereals and its impact on dietary patterns from 1987-88 to 2011-12. We estimated two types of elasticities: standard elasticities and preference-based elasticities. Our preference-based elasticities are calculated by holding income, food prices and demographic characteristics fixed at 1987-88 levels for all years of data examined. This means that these elasticities only capture variations in the utility parameters of the demand functions estimated, making them a good indicator of changes in food preferences.

Our results show that rural demand for cereals has become more sensitive to income changes as a result of the changes in utility parameters. The increasing trend of preference-based PEDs reflects that the urban demand for cereals has become more price elastic. In terms of preference-based XED, there is a general decline in the complementary relationship between cereals and other food groups. These findings are generally consistent with our prior beliefs, confirming that cereals have become less favored by Indian households over time.

The decline in dietary importance of cereals may come at a nutritional cost for Indian households. As pointed out by Meenakshi (2016), because cereals have traditionally be consumed in large quantities, they are a major source of dietary iron. Therefore, there has been a decrease in aggregate iron intake by Indian households over time largely because of reduce cereal consumption. Furthermore, as non-cereals are generally more expensive than cereals in terms of price per nutrient, the decline in cereal intake may lead to a reduction in overall nutritional intake unless food expenditure increases. However, Indian households are unlikely to increase their food budget under the rising pressure of non-food expenses, as evidenced by the estimates of demand elasticities for food in this paper and the limited changes in real food expenditure observed by Deaton and Drèze (2009). Their nutritional intake is therefore vulnerable to changes in the price or availability of non-cereals.

With the reduced demand for cereals this raises questions regarding the historical focus on cereals in Indian food security policy. Policy remains heavily biased towards staple grains. For example, the main focus of the Public Distribution System food safety-net program is the provision of subsidised sugar, rice and wheat to the poor (Kishore and Chakrabarti, 2015). There is also a historical bias in Indain agricultural policy which subsidies rice and wheat production at the expense of diversification towards nutritious crops and livestock products (Pingali et al., 2017). As Pingali (2015) observes, *"There is a growing disconnect between agricultural policy and contemporary nutritional challenges."* (page 583). To correct this policy mismatch, the Indian government needs to look beyond cereals and expand the basket of food covered by current policies. The development of a more diversified food system that enhances accessibility and availability of key non-cereal food is required to help deal with current food insecurity and nutritional challenges. Therefore, as proposed by Narayanan and Gerber (2017) there is potentially a need to make existing policies such as the Public Distribution System more nutrition sensitive by widening the commodities being made available to the poor and marginalized. Equally, it has been argued by Kadiyala et al. (2014) that there is a need to refocus agricultural policy to better meet the changing nutritional needs of society.

Finally, a useful extension of the current study would be to consider the rising consumption of processed food and beverages, another key feature of nutrition transition. These food items have become widely available in developing countries because of globalization and the rise of supermarkets and fast food outlets (Reardon, 2015). Owing to the association between processed food and obesity, there have been rising concerns over this newly developed dietary pattern. These food items are excluded in this paper due to data limitation. Future research might look into analyzing the changes of preferences over processed food and beverages, which will provide valuable insight on the design of public health and food policies.

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Table 1: Descriptive statistics

	Urban Sector				Rural Sector			
	1987-88	1993-94	2004-05	2011-12	1987-88	1993-94	2004-05	2011-12
MPCE (in Indian rupee)	310	575	1113	2561	181	327	689	1599
MFE (in Indian rupee)	132	229	382	751	98	172	315	598
Share of food in total expenditure	0.51	0.48	0.42	0.37	0.58	0.57	0.52	0.43
Household size	4.90	4.57	4.61	4.32	5.44	5.17	5.10	4.80
Share of adult female	0.39	0.40	0.40	0.41	0.33	0.34	0.35	0.37
Share of adult male	0.32	0.33	0.35	0.37	0.33	0.34	0.35	0.37
Age of household head	42.97	43.33	45.22	46.29	44.48	44.65	46.21	47.05
Share of meals consumed outside	0.05	0.05	0.05	0.06	0.02	0.02	0.03	0.04
Household size	4.90	4.57	4.61	4.32	5.44	5.17	5.10	4.80
Food consumption (per capita calorie intake per day)								
Cereals	1323	1220	1225	1182	1684	1501	1426	1336
Eggs/ fish/ meat	43	45	42	44	32	32	35	35
Edible oils	190	191	202	237	114	127	160	199
Pulses	124	110	99	109	107	96	88	98
Vegetables & fruits	133	134	126	121	101	112	114	108
Other food	354	365	316	342	268	287	272	294
No of households	79303	68342	78819	59306	43166	45098	44543	41260

Table 2: Average quality-adjusted prices of food groups

	Urban				Rural			
	1987-88	1993-94	2004-05	2011-12	1987-88	1993-94	2004-05	2011-12
Cereals	3.44	6.42	10.75	21.34	3.00	5.57	9.14	17.45
Eggs, fish & meat	24.06	41.70	62.93	113.77	20.12	35.85	57.24	109.46
Edible oils	25.67	35.14	55.23	81.99	26.13	33.82	55.63	80.37
Pulses	9.04	16.54	28.97	61.48	8.04	14.90	27.58	58.00
Vegetables & fruits	3.15	6.33	10.31	23.09	2.56	4.78	8.47	18.35
Other food	5.00	10.22	15.16	44.68	4.30	8.40	12.03	30.83

Note: Prices are in Indian Rupee per kilogram. For items which consumption is reported in numbers, they are converted into kilograms based on the following weights: 1 liter milk=1 kilogram; 1 coconut=1 kilogram; 1 egg = 0.058 kilograms; 1 lemon = 0.06 kilograms; 1 banana = 0.1 kilograms; 1 pineapple = 1.5 kilograms; 1 orange=0.015 kilograms.

Table 3: Demand elasticities for food

	Preference-based		Standard	
	Urban	Rural	Urban	Rural
	(1)	(2)	(3)	(4)
YED				
1987-88	0.727	0.822	0.727	0.822
1993-94	0.714	0.809	0.698	0.806
2004-05	0.715	0.760	0.660	0.730
2011-12	0.748	0.791	0.651	0.717
Uncompensated PED				
1987-88	-0.843	-0.922	-0.843	-0.922
1993-94	-0.940	-1.009	-0.937	-1.009
2004-05	-0.904	-0.941	-0.885	-0.934
2011-12	-0.921	-0.961	-0.891	-0.947
Compensated PED				
1987-88	-0.443	-0.475	-0.443	-0.475
1993-94	-0.538	-0.579	-0.546	-0.601
2004-05	-0.498	-0.542	-0.555	-0.605
2011-12	-0.500	-0.543	-0.638	-0.653

Note: The preference-based demand elasticities are calculated using the mean data point in 1987-88 while the standard elasticities are computed based on data of the current period. All estimates are statistically significant at the 99% confidence level. The standard errors of demand elasticities are not reported to save space.

Table 4: Demand elasticities for cereals

	Preference-based		Standard	
	Urban	Rural	Urban	Rural
	(1)	(2)	(3)	(4)
YED				
1987-88	**0.949**	**1.490**	**0.949**	**1.490**
1993-94	**1.058**	**1.112**	**1.051**	**1.135**
2004-05	**0.897**	**0.994**	**0.836**	**1.014**
2011-12	**0.962**	**0.664**	**0.880**	**0.532**
Uncompensated PED				
1987-88	**-0.413**	**-1.026**	**-0.413**	**-1.026**
1993-94	**-0.415**	**-0.819**	**-0.375**	**-0.782**
2004-05	**-1.308**	**-0.801**	**-1.297**	**-0.751**
2011-12	**-0.845**	**-0.709**	**-0.803**	**-0.580**
Compensated PED				
1987-88	-0.257	**-0.623**	-0.257	**-0.623**
1993-94	-0.240	**-0.518**	-0.218	**-0.503**
2004-05	**-1.160**	**-0.532**	**-1.184**	**-0.550**
2011-12	**-0.687**	**-0.529**	**-0.715**	**-0.508**
XED in response to price changes of eggs, fish and meat				
1987-88	-0.095	**-0.623**	-0.095	**-0.623**
1993-94	-0.137	**-0.252**	-0.154	**-0.271**
2004-05	-0.385	**-0.186**	**-0.418**	**-0.188**
2011-12	-0.017	0.120	-0.036	0.081
XED in response to price changes of edible oils				
1987-88	**-0.577**	**0.155**	**-0.577**	**0.155**
1993-94	**-0.298**	**-0.370**	**-0.289**	**-0.372**
2004-05	**-0.156**	-0.068	-0.140	-0.052
2011-12	-0.219	**0.035**	-0.173	**0.127**
XED in response to price changes of pulses				
1987-88	**-0.226**	**-0.322**	**-0.226**	**-0.322**
1993-94	**-0.448**	**-0.225**	**-0.469**	**-0.259**
2004-05	**-0.606**	**-0.074**	**-0.629**	**-0.098**
2011-12	0.038	0.127	0.014	0.082
XED in response to price changes of vegetables & fruits				
1987-88	**-0.530**	**-0.299**	**-0.530**	**-0.299**
1993-94	**-0.828**	**-0.302**	**-0.873**	**-0.350**
2004-05	**-0.501**	-0.256	**-0.557**	-0.345
2011-12	**-0.195**	**-0.327**	**-0.244**	**-0.215**
XED in response to price changes of other foods				
1987-88	**-2.601**	**-2.098**	**-2.601**	**-2.098**
1993-94	**-2.834**	**-1.965**	**-2.937**	**-1.848**
2004-05	**-2.503**	**-1.911**	**-2.595**	**-2.040**
2011-12	**-2.339**	**-1.501**	**-2.674**	**-1.193**

Note: The preference-based demand elasticities are calculated using the mean data point in 1987-88 while the standard elasticities are computed based on data of the current period. The estimates highlighted are statistically significant at the 95% confidence level.

Table 5: Predicted cereal consumption (in per capita daily calories) in response to income and price changes, 2011-12

Data period of preference-based YEDs/ PEDs	Urban			Rural		
	Base level (i.e. 2011-12) (1)	Predicted change (2)	Predicted level (3)	Base level (i.e. 2011-12) (4)	Predicted change (5)	Predicted level (6)
Panel A: Income increases by 10%						
1987-88	1182	112	1294	1336	199	1535
1993-94	1182	125	1307	1336	149	1485
2004-05	1182	106	1288	1336	133	1469
2011-12	1182	114	1296	1336	89	1425
Panel B: Price increases by 10%						
1987-88	1182	-49	1133	1336	-137	1199
1993-94	1182	-49	1133	1336	-109	1227
2004-05	1182	-155	1027	1336	-107	1229
2011-12	1182	-100	1082	1336	-95	1241
Panel C: Net changes from panels A and B						
1987-88	1182	63	1245	1336	62	1244
1993-94	1182	76	1258	1336	40	1222
2004-05	1182	-49	1133	1336	26	1208
2011-12	1182	14	1196	1336	-6	1176

Figure 1: Preference-based mean income and price demand elasticities (in absolute value) for urban and rural India

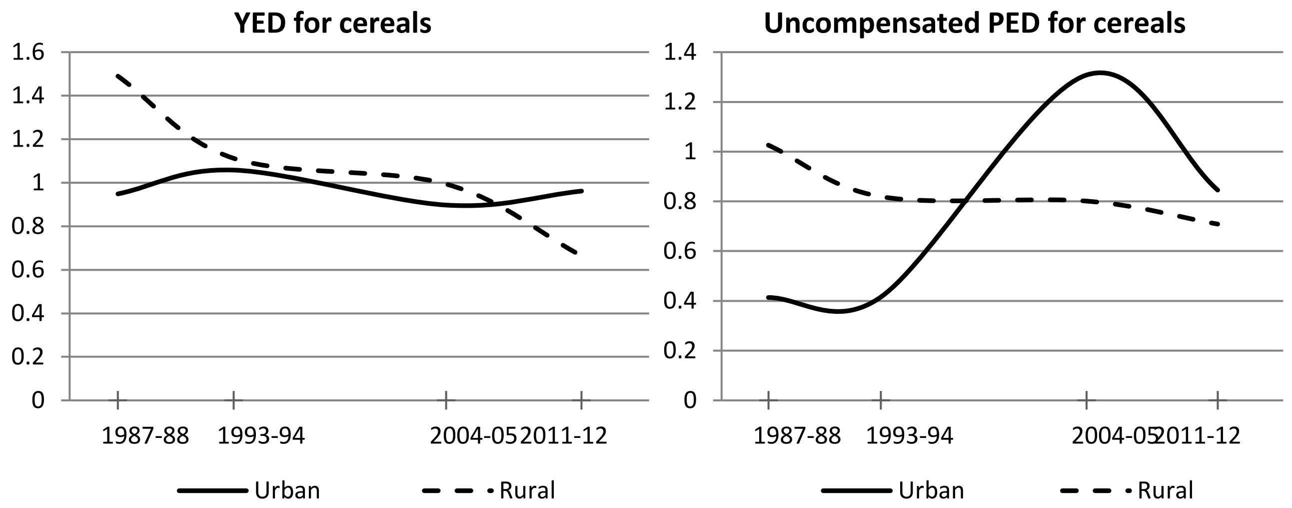


Figure 2: Preference-based cross price demand elasticities for urban and rural India

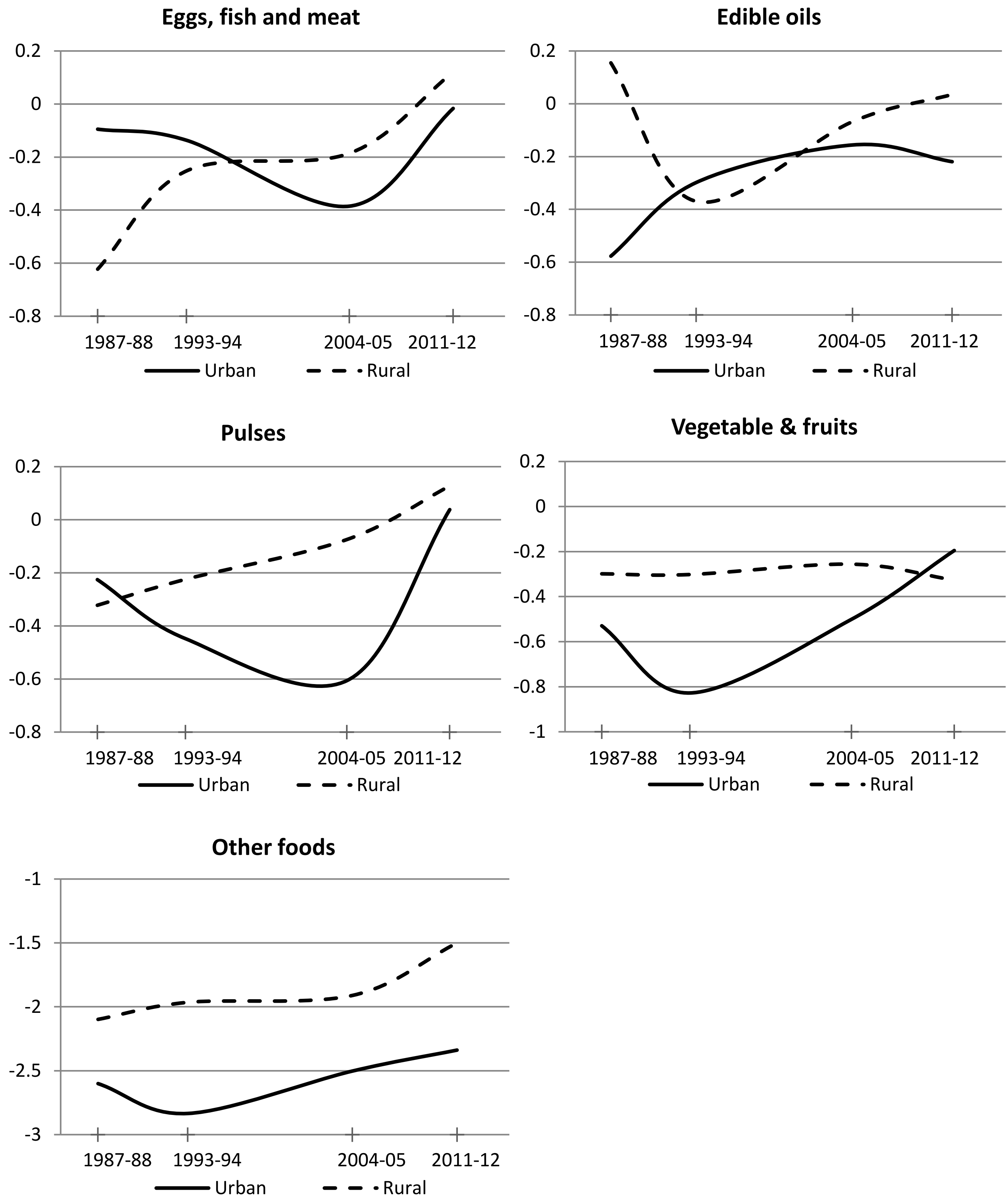


Figure 3: Standard income and price demand elasticities (in absolute value) for urban and rural India

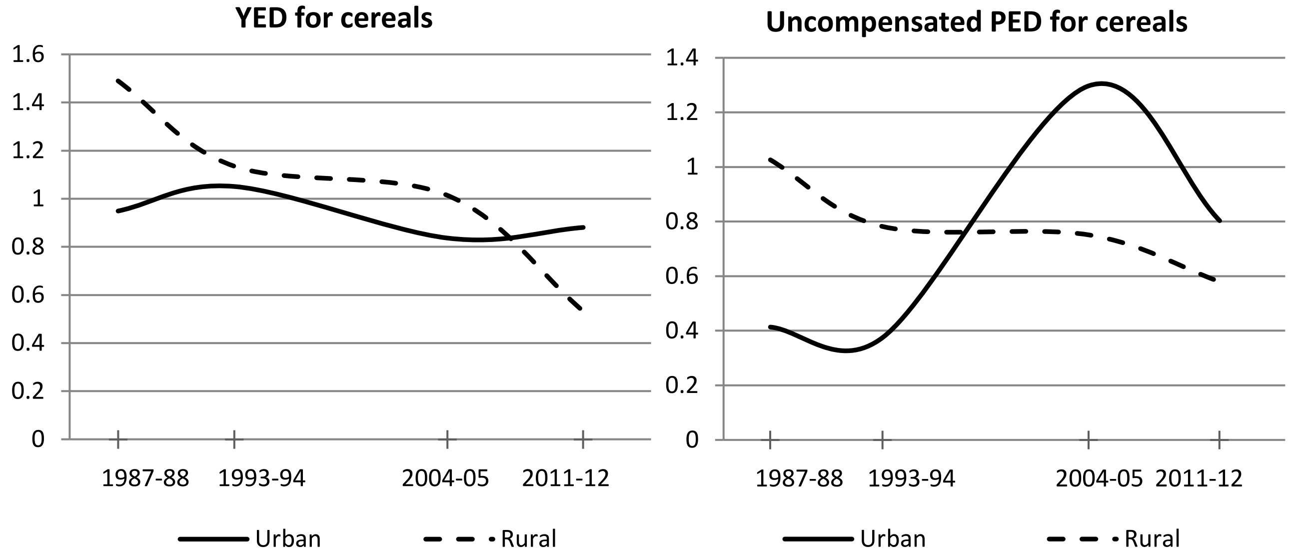
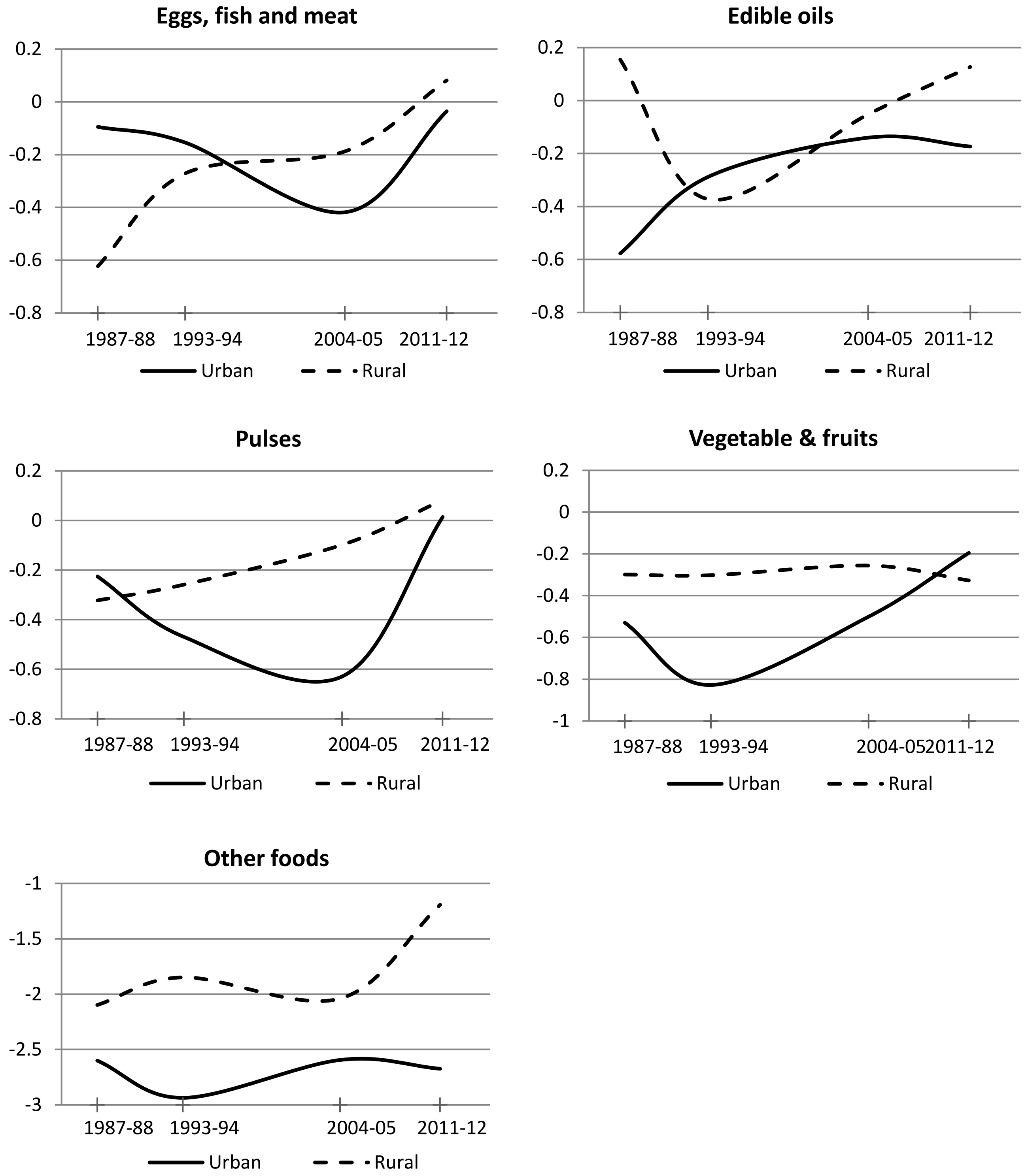


Figure 4: Standard cross price demand elasticities for urban and rural India



Appendix

Table A1. Estimates of the Working-Leser model

	Urban				Rural			
	1987-88	1993-94	2004-05	2011-12	2004-05	1987-88	1993-94	2011-12
Food price index	0.079***	0.030***	0.049***	0.040***	0.045***	-0.005**	0.034***	0.023***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
MPCE	-0.138***	-0.145***	-0.144***	-0.128***	-	-	-	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share of meals consumed outside	-0.328***	-0.326***	-0.301***	-0.264***	-	-	-	-
	(0.004)	(0.004)	(0.004)	(0.003)	(0.008)	(0.008)	(0.006)	(0.005)
Gender of household head	-0.012***	-0.006***	-0.000	-0.001	0.003	0.006***	0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Household size	-0.004**	-0.004***	-0.004***	-0.014***	0.018***	0.006***	0.002*	-
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share of adult female	0.021***	0.023***	0.020***	0.019***	0.055***	0.041***	0.016***	0.016***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)
Share of adult male	0.048***	0.050***	0.016***	0.014***	0.043***	0.030***	0.012***	0.013***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Age of household head	0.041***	0.033***	0.030***	0.025***	0.008***	0.004**	0.014***	0.013***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Constant	0.948***	1.161***	1.145***	1.111***	0.937***	1.171***	1.252***	1.180***
	(0.012)	(0.012)	(0.010)	(0.009)	(0.010)	(0.010)	(0.008)	(0.009)
Observations								
R-squared	43,166	45,098	44,543	41,260	79,303	68,342	78,819	59,306

Note: Food price index, MPCE, household size and age of household head enter in logarithm form. Gender of household head is a dummy variable which takes the value of 1 for female and 0 for male. The remaining independent variables are percentages. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2: QUAIDS Parameters

	Urban sector				Rural Sector			
	1988-89	1993-94	2004-05	2011-12	1988-89	1993-94	2004-05	2011-12
β_1	0.201	0.273	0.069	0.133	0.400	0.329	0.130	0.180
	(20.50)	(32.33)	(8.39)	(7.57)	(34.39)	(33.42)	(8.33)	(4.31)
β_2	0.051	0.027	0.056	0.095	0.050	0.118	0.002	0.009
	(12.60)	(9.51)	(15.19)	(18.79)	(12.05)	(24.24)	(0.41)	(0.97)
β_3	0.018	-0.045	0.228	0.120	-0.091	-0.111	0.178	0.183
	(2.53)	(-7.71)	(26.78)	(10.39)	(-13.38)	(-9.26)	(10.44)	(5.51)
β_4	-0.031	-0.177	-0.110	-0.083	-0.106	-0.110	-0.060	-0.219
	(-5.93)	(-24.90)	(-12.14)	(-6.36)	(-12.77)	(-11.58)	(-4.52)	(-6.77)
β_5	-0.150	-0.084	-0.191	-0.219	-0.131	-0.132	-0.250	-0.153
	(-19.86)	(-13.92)	(-22.60)	(-30.83)	(-16.33)	(-8.41)	(-10.36)	(-8.82)
β_6	-0.034	0.086	-0.024	-0.009	-0.059	0.051	-0.011	-0.001
	(-7.38)	(19.84)	(-7.20)	(-1.43)	(-9.85)	(7.39)	(-1.24)	(-0.05)
β_{1a}	-0.017	0.017	0.018	0.002	0.002	0.019	-0.025	-0.005
	(-4.91)	(5.20)	(4.62)	(0.64)	(0.88)	(3.11)	(-7.68)	(-1.32)
β_{2a}	-0.005	-0.005	-0.006	0.000	-0.002	-0.001	0.000	0.001
	(-18.37)	(-18.58)	(-8.48)	(0.35)	(-6.88)	(-1.55)	(0.71)	(0.58)
β_{3a}	-0.003	-0.003	-0.001	0.006	-0.002	0.002	0.002	0.002
	(-4.40)	(-5.14)	(-1.88)	(3.76)	(-1.91)	(5.93)	(2.58)	(1.87)
β_{4a}	0.005	-0.002	0.001	-0.003	0.000	-0.002	0.001	-0.001
	(10.40)	(-5.91)	(1.56)	(-6.99)	(-0.25)	(-7.52)	(3.47)	(-1.06)
β_{5a}	0.003	0.001	0.019	0.012	0.003	0.009	0.002	0.002
	(3.31)	(1.21)	(9.11)	(6.03)	(3.99)	(8.60)	(2.46)	(2.64)
β_{6a}	0.007	0.007	0.015	0.005	0.007	0.003	0.004	0.002
	(5.13)	(8.23)	(7.24)	(3.87)	(4.90)	(4.89)	(7.66)	(1.43)
β_{1b}	0.006	-0.021	0.005	0.019	0.054	0.015	0.007	0.052
	(2.99)	(-10.72)	(1.26)	(4.02)	(4.13)	(2.12)	(0.87)	(4.67)
β_{2b}	0.000	0.001	0.004	0.006	0.003	-0.007	0.003	0.018
	(-0.03)	(2.69)	(5.83)	(3.45)	(3.14)	(-11.85)	(1.11)	(2.55)
β_{3b}	0.006	0.003	0.002	-0.001	-0.004	-0.001	-0.003	0.008
	(4.38)	(4.24)	(2.09)	(-0.82)	(-3.28)	(-1.12)	(-1.78)	(2.59)
β_{4b}	-0.005	-0.002	-0.002	0.005	0.002	0.000	0.009	0.008
	(-4.21)	(-3.60)	(-2.57)	(2.81)	(1.71)	(0.08)	(6.51)	(3.37)
β_{5b}	0.012	0.011	0.003	0.016	-0.001	0.003	0.004	0.004
	(6.64)	(7.69)	(1.78)	(2.80)	(-0.46)	(1.67)	(0.56)	(0.47)
β_{6b}	0.001	-0.002	-0.001	0.011	0.001	0.001	0.026	-0.009
	(0.86)	(-1.91)	(-0.70)	(2.17)	(0.30)	(0.53)	(5.41)	(-0.85)
β_{1c}	0.017	-0.006	-0.004	0.011	-0.041	-0.003	0.026	0.014
	(6.58)	(-2.31)	(-1.35)	(2.79)	(-6.59)	(-0.37)	(5.66)	(1.51)
β_{2c}	-0.004	-0.006	-0.006	-0.014	0.000	-0.005	-0.001	-0.016
	(-11.98)	(-14.55)	(-9.47)	(-8.36)	(1.02)	(-7.87)	(-0.63)	(-3.46)
β_{3c}	0.000	0.004	0.001	-0.017	0.000	0.002	-0.002	0.020
	(0.57)	(4.14)	(1.91)	(-8.08)	(0.61)	(2.42)	(-2.52)	(4.53)
β_{4c}	-0.004	0.000	-0.001	0.000	0.001	-0.001	-0.006	0.001
	(-5.94)	(-0.92)	(-1.80)	(-0.25)	(1.54)	(-2.53)	(-5.39)	(0.53)
β_{5c}	0.004	0.007	0.003	-0.008	0.000	0.003	0.006	0.021
	(4.08)	(5.74)	(1.91)	(-2.01)	(0.10)	(1.96)	(2.78)	(2.32)
β_{6c}	0.003	-0.002	-0.004	0.016	0.001	-0.002	-0.002	0.010

	(2.79)	(-2.21)	(-2.14)	(3.74)	(1.35)	(-1.42)	(-0.52)	(1.03)
β_{1d}	-0.035	-0.019	-0.044	-0.063	0.007	0.038	-0.001	-0.047
	(-11.87)	(-7.45)	(-8.77)	(-20.65)	(1.54)	(2.72)	(-0.09)	(-6.00)
β_{2d}	0.012	0.007	-0.003	0.007	0.002	0.006	-0.002	0.011
	(9.83)	(9.49)	(-2.46)	(6.37)	(2.52)	(3.77)	(-0.85)	(2.95)
β_{3d}	0.006	0.002	-0.021	0.000	-0.006	-0.001	0.013	0.003
	(1.98)	(1.21)	(-3.18)	(-0.10)	(-3.30)	(-0.81)	(4.70)	(1.28)
β_{4d}	0.005	0.018	0.035	0.005	0.007	0.006	0.012	0.001
	(2.56)	(12.26)	(12.29)	(3.81)	(6.55)	(2.65)	(5.31)	(0.63)
β_{5d}	-0.029	-0.007	0.003	-0.015	0.002	-0.002	0.002	-0.008
	(-8.17)	(-2.87)	(0.63)	(-6.21)	(0.74)	(-0.63)	(0.33)	(-2.07)
β_{6d}	-0.028	0.004	0.049	-0.011	0.008	0.000	-0.003	-0.011
	(-7.07)	(1.47)	(6.94)	(-3.56)	(2.30)	(0.11)	(-0.58)	(-1.72)
β_{1e}	-0.012	-0.006	-0.047	-0.017	0.040	0.003	-0.094	-0.047
	(-3.82)	(-2.68)	(-10.13)	(-4.67)	(4.91)	(0.26)	(-10.05)	(-5.57)
β_{2e}	0.004	0.011	0.008	-0.006	0.009	0.009	0.007	-0.035
	(5.35)	(12.00)	(3.47)	(-2.33)	(11.25)	(11.63)	(2.73)	(-5.10)
β_{3e}	-0.001	-0.007	0.009	0.013	-0.006	0.001	-0.005	-0.017
	(-0.48)	(-3.63)	(2.20)	(2.78)	(-4.27)	(0.41)	(-1.63)	(-2.01)
β_{4e}	0.008	0.001	0.010	0.020	0.000	0.012	0.021	0.034
	(5.75)	(0.77)	(3.62)	(5.97)	(-0.32)	(12.01)	(6.94)	(6.32)
β_{5e}	0.005	-0.011	-0.006	0.006	0.000	0.005	-0.006	0.033
	(2.13)	(-3.72)	(-0.80)	(0.87)	(0.11)	(1.84)	(-0.66)	(2.93)
β_{6e}	0.007	-0.001	-0.009	-0.007	-0.008	0.001	-0.002	0.064
	(3.22)	(-0.58)	(-1.20)	(-0.99)	(-2.97)	(0.30)	(-0.28)	(4.20)
β_{1f}	0.367	0.246	0.163	0.105	0.377	0.268	0.193	0.093
	(35.68)	(43.31)	(18.54)	(14.35)	(56.19)	(70.45)	(32.17)	(9.10)
β_{2f}	0.057	0.047	0.057	0.041	0.091	0.037	0.013	0.029
	(17.85)	(25.42)	(27.47)	(34.16)	(29.70)	(26.88)	(11.96)	(22.52)
β_{3f}	0.069	0.046	0.155	0.055	0.237	0.066	0.102	0.055
	(10.37)	(14.28)	(20.76)	(15.32)	(20.87)	(6.50)	(14.52)	(16.23)
β_{4f}	-0.007	0.092	-0.076	0.052	-0.037	0.156	0.009	0.062
	(-0.87)	(21.26)	(-12.36)	(31.03)	(-4.72)	(28.93)	(1.98)	(48.17)
β_{5f}	0.803	0.470	0.695	0.748	0.582	0.583	0.840	0.446
	(36.91)	(32.67)	(24.47)	(34.97)	(28.27)	(13.83)	(14.18)	(18.49)
β_{6f}	0.100	0.137	0.099	0.112	0.067	0.078	0.084	0.096
	(33.07)	(61.65)	(17.45)	(29.88)	(15.80)	(34.69)	(24.26)	(46.42)
γ_{11}	0.165	0.017	0.004	0.031	-0.344	0.030	0.063	0.008
	(13.40)	(1.90)	(0.92)	(5.56)	(-14.82)	(3.06)	(5.67)	(0.89)
γ_{12}	-0.008	-0.013	0.020	0.037	-0.056	-0.055	0.019	0.040
	(-2.56)	(-4.24)	(9.74)	(24.73)	(-9.28)	(-13.24)	(7.99)	(25.79)
γ_{13}	-0.101	0.022	0.018	-0.017	0.106	-0.059	-0.002	-0.017
	(-16.36)	(5.82)	(5.47)	(-6.82)	(15.14)	(-12.74)	(-0.38)	(-5.09)
γ_{14}	-0.079	-0.004	0.008	-0.035	0.046	-0.024	-0.047	0.004
	(-23.49)	(-1.00)	(3.69)	(-14.16)	(5.14)	(-5.38)	(-10.37)	(1.19)
γ_{15}	-0.005	-0.039	-0.058	-0.050	0.193	0.120	0.012	-0.048
	(-0.63)	(-6.25)	(-11.04)	(-12.16)	(13.65)	(11.69)	(0.90)	(-6.32)
γ_{16}	-0.017	-0.077	-0.032	0.024	0.057	-0.119	-0.043	0.018
	(-3.55)	(-23.46)	(-15.50)	(9.41)	(5.61)	(-25.62)	(-6.42)	(5.60)

γ_{22}	-0.028	-0.018	-0.050	-0.018	-0.046	-0.050	-0.009	-0.009
	(-12.64)	(-12.20)	(-31.94)	(-18.38)	(-23.24)	(-17.17)	(-18.18)	(-20.05)
γ_{23}	-0.016	0.003	-0.023	0.007	0.006	-0.012	-0.004	0.001
	(-6.44)	(2.44)	(-12.98)	(5.81)	(2.95)	(-4.66)	(-2.55)	(3.26)
γ_{24}	-0.011	0.005	0.007	-0.045	0.019	0.032	-0.001	-0.033
	(-6.51)	(5.15)	(6.35)	(-32.94)	(11.30)	(13.46)	(-1.01)	(-25.42)
γ_{25}	0.040	0.030	0.040	0.011	0.017	0.042	-0.002	-0.001
	(10.30)	(12.39)	(18.89)	(9.71)	(6.55)	(9.98)	(-1.06)	(-2.18)
γ_{26}	0.017	-0.012	0.000	0.003	0.050	0.024	-0.005	0.000
	(12.26)	(-6.54)	(0.40)	(4.60)	(19.77)	(15.37)	(-15.86)	(2.56)
γ_{33}	0.054	0.010	-0.121	0.028	-0.009	0.139	-0.036	0.039
	(16.63)	(3.18)	(-17.63)	(11.49)	(-2.06)	(25.71)	(-5.12)	(14.67)
γ_{34}	0.009	-0.022	0.007	-0.002	0.004	0.004	0.001	-0.016
	(4.62)	(-10.33)	(1.56)	(-1.14)	(1.22)	(1.05)	(0.24)	(-6.08)
γ_{35}	0.046	-0.023	0.079	-0.010	-0.080	-0.031	0.041	0.002
	(8.42)	(-7.32)	(16.39)	(-3.43)	(-25.27)	(-8.64)	(4.73)	(0.63)
γ_{36}	0.012	0.034	0.010	-0.013	-0.021	-0.005	0.000	-0.010
	(6.22)	(19.75)	(7.77)	(-14.62)	(-6.57)	(-2.57)	(0.19)	(-6.60)
γ_{44}	0.073	0.080	0.033	0.073	0.011	0.052	0.023	0.040
	(41.68)	(21.08)	(10.16)	(24.01)	(2.48)	(12.91)	(8.58)	(12.11)
γ_{45}	0.024	-0.021	-0.016	0.020	-0.040	-0.057	0.011	-0.001
	(7.33)	(-9.30)	(-4.14)	(6.51)	(-11.11)	(-20.96)	(2.06)	(-0.21)
γ_{46}	0.002	0.012	0.001	-0.007	-0.016	0.014	0.014	0.000
	(1.77)	(8.61)	(1.54)	(-8.70)	(-8.51)	(11.98)	(13.61)	(0.29)
γ_{55}	-0.061	0.032	-0.025	0.032	-0.062	-0.082	-0.074	0.035
	(-8.05)	(7.61)	(-6.77)	(4.84)	(-7.57)	(-8.59)	(-3.08)	(4.80)
γ_{56}	-0.034	0.032	-0.001	0.008	-0.020	0.030	0.010	0.012
	(-8.74)	(7.18)	(-0.32)	(3.21)	(-4.45)	(8.73)	(2.35)	(4.00)
γ_{66}	0.025	-0.006	0.026	-0.013	-0.041	0.043	0.022	-0.020
	(6.80)	(-1.39)	(11.80)	(-4.75)	(-7.60)	(14.20)	(3.35)	(-15.87)
λ_1	-0.020	-0.003	0.004	-0.055	-0.027	-0.029	-0.008	-0.056
	(-9.37)	(-1.71)	(1.32)	(-7.20)	(-12.66)	(-13.07)	(-1.42)	(-2.28)
λ_2	-0.001	0.001	-0.017	-0.020	-0.005	-0.015	-0.003	-0.004
	(-2.34)	(2.38)	(-7.77)	(-8.61)	(-4.93)	(-10.84)	(-3.54)	(-0.78)
λ_3	-0.003	0.014	-0.041	-0.043	0.004	0.022	-0.046	-0.085
	(-2.10)	(11.57)	(-16.13)	(-7.50)	(3.14)	(10.43)	(-6.57)	(-3.65)
λ_4	0.006	0.027	0.025	0.039	0.006	0.024	0.002	0.031
	(6.46)	(24.76)	(11.73)	(7.49)	(6.23)	(11.41)	(0.55)	(1.95)
λ_5	0.000	-0.027	-0.010	0.029	-0.003	-0.002	0.027	0.001
	(0.13)	(-18.85)	(-2.82)	(5.29)	(-2.26)	(-0.77)	(3.32)	(0.09)
λ_6	0.014	-0.017	0.030	0.043	0.019	-0.016	0.029	0.113
	(12.59)	(-13.88)	(18.34)	(8.23)	(11.44)	(-11.75)	(7.76)	(5.65)
λ_{1a}	0.092	-0.058	-0.049	-0.034	-0.047	-0.106	0.102	0.025
	(5.24)	(-2.79)	(-4.76)	(-5.08)	(-2.28)	(-3.84)	(8.01)	(2.70)
λ_{2a}	0.023	0.032	0.042	-0.003	0.010	0.003	-0.001	-0.004
	(19.95)	(21.03)	(24.72)	(-2.54)	(7.12)	(1.86)	(-1.00)	(-1.29)

λ_{3a}	0.018	0.029	0.006	-0.026	0.015	-0.011	-0.015	-0.007
	(4.10)	(7.60)	(3.03)	(-4.44)	(1.89)	(-4.80)	(-3.97)	(-2.01)
λ_{4a}	-0.023	0.013	-0.006	0.005	0.009	0.006	0.000	0.003
	(-11.63)	(6.28)	(-3.75)	(6.81)	(2.87)	(7.91)	(0.13)	(2.73)
λ_{5a}	-0.011	-0.002	-0.121	-0.050	-0.021	-0.057	-0.013	-0.006
	(-3.35)	(-0.40)	(-17.75)	(-9.14)	(-2.71)	(-7.84)	(-3.02)	(-3.32)
λ_{6a}	-0.023	-0.053	-0.090	-0.019	-0.059	-0.012	-0.012	-0.005
	(-2.54)	(-9.38)	(-11.21)	(-6.61)	(-4.25)	(-5.80)	(-8.92)	(-1.21)
λ_{1b}	-0.027	0.094	0.041	-0.031	-0.324	-0.095	-0.019	-0.100
	(-3.37)	(11.49)	(2.32)	(-3.31)	(-5.35)	(-2.83)	(-1.02)	(-6.48)
λ_{2b}	0.000	-0.030	-0.022	-0.024	-0.023	0.021	-0.019	-0.044
	(-0.02)	(-13.50)	(-11.82)	(-6.53)	(-5.66)	(6.35)	(-3.04)	(-3.88)
λ_{3b}	-0.042	-0.027	-0.006	0.002	0.025	0.004	0.009	-0.015
	(-4.42)	(-6.61)	(-2.46)	(0.62)	(3.83)	(1.24)	(1.82)	(-2.69)
λ_{4b}	0.043	0.017	0.003	-0.016	-0.002	0.005	-0.028	-0.023
	(4.53)	(6.18)	(1.53)	(-4.72)	(-0.45)	(1.00)	(-7.99)	(-5.41)
λ_{5b}	-0.077	-0.091	-0.012	-0.034	0.012	-0.006	-0.006	-0.001
	(-6.75)	(-13.44)	(-2.39)	(-2.93)	(0.88)	(-1.11)	(-0.38)	(-0.10)
λ_{6b}	-0.003	0.015	-0.009	-0.027	-0.005	-0.009	-0.065	0.019
	(-0.40)	(2.65)	(-1.65)	(-2.47)	(-0.41)	(-0.80)	(-5.45)	(0.99)
λ_{1c}	-0.160	0.061	0.014	0.002	0.357	0.084	-0.056	0.063
	(-9.11)	(3.27)	(1.85)	(0.24)	(8.37)	(1.56)	(-4.77)	(4.12)
λ_{2c}	0.019	0.032	0.017	0.030	-0.003	0.010	0.002	0.076
	(13.04)	(14.61)	(9.62)	(7.95)	(-1.31)	(4.06)	(0.89)	(7.90)
λ_{3c}	-0.002	-0.023	-0.004	0.055	-0.006	-0.008	0.006	-0.051
	(-0.68)	(-3.56)	(-1.94)	(10.06)	(-1.48)	(-2.60)	(2.47)	(-5.57)
λ_{4c}	0.036	0.001	0.016	-0.008	0.002	0.002	0.045	-0.008
	(8.50)	(0.59)	(4.42)	(-2.72)	(0.65)	(1.26)	(6.65)	(-1.88)
λ_{5c}	-0.035	-0.045	-0.009	0.048	0.002	-0.017	-0.013	-0.051
	(-7.50)	(-6.02)	(-2.21)	(5.45)	(0.38)	(-2.02)	(-2.32)	(-3.24)
λ_{6c}	-0.011	0.011	0.031	-0.034	-0.007	0.009	0.043	-0.035
	(-2.53)	(2.52)	(4.11)	(-3.88)	(-1.30)	(1.85)	(1.80)	(-1.90)
λ_{1d}	0.135	0.080	0.130	0.116	-0.022	-0.138	0.008	-0.008
	(11.70)	(7.15)	(12.19)	(16.35)	(-1.14)	(-3.92)	(0.56)	(-0.41)
λ_{2d}	-0.058	-0.024	0.016	-0.005	0.011	-0.018	0.011	-0.013
	(-10.16)	(-8.05)	(4.48)	(-3.54)	(2.16)	(-3.37)	(2.15)	(-2.79)
λ_{3d}	-0.038	-0.034	0.051	0.000	0.029	0.006	-0.032	-0.004
	(-2.97)	(-3.70)	(2.87)	(-0.08)	(3.53)	(1.00)	(-4.71)	(-0.99)
λ_{4d}	-0.020	-0.088	-0.090	-0.005	-0.055	-0.028	-0.018	0.016
	(-2.26)	(-13.78)	(-11.43)	(-2.04)	(-8.76)	(-3.80)	(-2.63)	(4.20)
λ_{5d}	0.122	0.026	0.003	0.030	-0.046	-0.011	0.003	0.024
	(7.80)	(2.50)	(0.18)	(8.87)	(-2.34)	(-0.88)	(0.15)	(4.56)
λ_{6d}	0.140	0.006	-0.108	0.025	-0.065	-0.014	0.025	0.040
	(7.90)	(0.53)	(-5.45)	(4.14)	(-3.63)	(-0.94)	(2.04)	(5.21)
λ_{1e}	0.106	0.058	0.138	0.034	-0.272	0.022	0.227	0.067
	(6.86)	(7.20)	(12.39)	(4.24)	(-5.95)	(0.67)	(9.83)	(3.76)
λ_{2e}	-0.022	-0.037	-0.029	0.014	-0.066	-0.026	-0.008	0.034
	(-5.74)	(-10.84)	(-5.41)	(3.68)	(-15.96)	(-11.87)	(-1.32)	(5.10)
λ_{3e}	0.001	0.051	-0.025	-0.032	0.022	-0.002	0.016	0.042

	(0.22)	(5.27)	(-2.42)	(-3.78)	(4.40)	(-0.50)	(2.25)	(3.16)
λ_{4e}	-0.067	-0.016	-0.041	-0.025	0.001	-0.043	-0.086	-0.028
	(-8.17)	(-2.63)	(-4.96)	(-3.69)	(0.26)	(-10.33)	(-6.36)	(-3.84)
λ_{5e}	-0.017	0.093	0.064	-0.020	-0.049	-0.013	-0.031	-0.050
	(-1.72)	(7.03)	(3.10)	(-1.70)	(-2.85)	(-1.66)	(-1.32)	(-3.34)
λ_{6e}	-0.038	0.005	0.041	0.018	0.047	-0.007	-0.046	-0.112
	(-4.03)	(0.43)	(2.01)	(1.33)	(3.58)	(-1.04)	(-1.89)	(-5.72)
λ_{1f}	0.044	0.062	0.082	0.061	-0.061	-0.057	0.079	0.036
	(12.01)	(13.84)	(10.23)	(9.43)	(-4.30)	(-4.02)	(8.81)	(2.68)
λ_{2f}	-0.007	-0.009	0.003	0.006	-0.012	-0.001	-0.008	0.021
	(-4.78)	(-7.83)	(1.56)	(1.30)	(-6.43)	(-0.56)	(-3.06)	(2.77)
λ_{3f}	-0.008	0.002	0.011	0.003	0.016	-0.001	-0.004	-0.014
	(-2.13)	(0.71)	(2.35)	(0.51)	(3.61)	(-0.42)	(-1.03)	(-1.47)
λ_{4f}	-0.009	-0.017	-0.043	-0.028	-0.010	-0.017	-0.036	-0.044
	(-2.82)	(-12.19)	(-18.25)	(-5.41)	(-4.24)	(-6.30)	(-10.48)	(-7.24)
λ_{5f}	0.006	0.004	-0.014	-0.004	-0.004	-0.013	-0.007	-0.050
	(1.22)	(1.06)	(-1.99)	(-0.39)	(-0.56)	(-2.33)	(-0.88)	(-3.13)
λ_{6f}	0.009	-0.003	-0.045	-0.013	-0.006	-0.002	-0.020	-0.056
	(1.95)	(-1.00)	(-6.71)	(-1.19)	(-0.78)	(-0.36)	(-2.41)	(-3.01)
ϕ_1	0.011	0.597	0.305	-0.211	-0.280	-0.144	-0.014	-0.234
	(3.22)	(13.81)	(7.98)	(-18.51)	(-5.92)	(-2.23)	(-1.85)	(-18.51)
ϕ_2	-0.044	0.000	0.035	0.012	-0.035	0.002	0.000	0.046
	(-6.24)	(-3.40)	(10.17)	(13.39)	(-9.92)	(2.61)	(-0.47)	(15.07)
ϕ_3	-0.134	0.000	-0.017	-0.005	0.011	-0.021	-0.025	-0.014
	(-6.02)	(0.31)	(-3.26)	(-2.08)	(1.30)	(-3.70)	(-6.07)	(-3.53)
ϕ_4	0.102	0.000	-0.002	-0.001	0.017	0.002	0.061	0.067
	(3.76)	(0.29)	(-8.12)	(-3.95)	(8.48)	(2.37)	(3.65)	(13.92)
ϕ_5	-0.235	-0.004	0.001	-0.007	-0.365	-0.209	-0.112	-0.031
	(-9.66)	(-6.08)	(0.53)	(-4.01)	(-13.61)	(-12.66)	(-8.24)	(-9.56)
ϕ_6	0.012	-0.007	0.000	-0.027	-0.120	-0.107	0.060	0.000
	(1.14)	(-4.72)	(-0.55)	(-11.66)	(-8.40)	(-8.89)	(2.15)	(2.15)
α_1	0.108	-0.460	0.001	0.218	-0.834	-0.006	0.000	-0.001
	(6.94)	(-27.02)	(4.32)	(23.12)	(-23.93)	(-2.40)	(-0.42)	(-2.35)
α_2	0.005	0.003	0.222	0.004	0.019	-0.087	0.079	0.100
	(2.87)	(6.67)	(10.07)	(4.41)	(1.62)	(-5.97)	(7.26)	(23.87)
α_3	0.000	0.003	-0.078	-0.001	0.377	-0.032	0.005	0.004
	(-0.05)	(13.65)	(-4.94)	(-4.91)	(17.40)	(-3.20)	(2.20)	(3.80)
α_4	0.017	0.209	0.107	0.097	0.334	-0.001	0.222	0.408
	(6.07)	(11.14)	(8.16)	(13.93)	(11.28)	(-1.39)	(15.34)	(33.17)
α_5	0.668	0.960	0.777	0.646	0.904	0.765	0.722	0.422
	(46.29)	(124.97)	(74.42)	(84.80)	(21.79)	(41.61)	(43.94)	(31.70)
α_6	0.000	-0.001	0.007	0.006	-0.016	0.051	0.005	0.089
	(-0.27)	(-0.98)	(5.73)	(9.69)	(-2.86)	(6.24)	(4.58)	(15.24)
α_{1a}	-0.095	0.000	0.009	0.073	0.175	0.178	-0.107	-0.037
	(-3.22)	(-0.00)	(9.33)	(13.44)	(5.04)	(5.68)	(-6.27)	(-6.48)
α_{2a}	-0.001	-0.047	-0.117	0.000	0.000	0.000	-0.001	0.000
	(-1.25)	(-14.29)	(-18.37)	(-0.68)	(-0.93)	(-0.42)	(-1.68)	(-0.73)
α_{3a}	-0.010	-0.057	-0.002	0.043	-0.031	0.010	0.036	0.006
	(-1.07)	(-7.40)	(-1.82)	(5.70)	(-1.78)	(1.84)	(5.69)	(2.35)

α_{4a}	-0.002	-0.024	0.000	0.000	-0.054	0.000	-0.015	-0.005
	(-1.02)	(-5.76)	(1.36)	(0.03)	(-6.58)	(1.50)	(-4.14)	(-6.52)
α_{5a}	0.002	0.000	0.274	0.066	0.038	0.105	0.028	0.000
	(1.08)	(-5.19)	(21.12)	(12.35)	(2.09)	(6.20)	(3.73)	(0.87)
α_{6a}	-0.046	0.092	0.182	0.005	0.091	0.001	0.000	-0.008
	(-2.01)	(8.36)	(10.60)	(2.81)	(3.05)	(0.33)	(0.59)	(-3.90)
α_{1b}	0.002	-0.047	-0.263	-0.007	0.305	0.162	-0.001	0.025
	(0.38)	(-18.94)	(-8.16)	(-6.78)	(8.75)	(3.04)	(-1.02)	(2.30)
α_{2b}	-0.001	0.098	0.056	0.030	0.039	0.012	0.039	0.025
	(-6.29)	(31.45)	(15.28)	(22.09)	(9.85)	(2.49)	(11.36)	(10.73)
α_{3b}	0.085	0.053	0.002	0.001	-0.012	0.000	0.000	0.001
	(3.84)	(10.50)	(2.77)	(2.78)	(-5.42)	(-0.60)	(-1.29)	(0.95)
α_{4b}	-0.116	-0.042	0.000	0.010	-0.028	-0.042	0.000	0.000
	(-4.57)	(-10.27)	(-1.11)	(14.59)	(-13.24)	(-4.81)	(-2.94)	(2.33)
α_{5b}	0.146	0.190	0.002	0.003	-0.008	0.000	-0.002	-0.005
	(5.80)	(24.92)	(3.60)	(5.61)	(-5.24)	(0.22)	(-1.86)	(-2.80)
α_{6b}	0.000	-0.001	0.052	0.016	0.006	0.034	0.000	0.001
	(-0.04)	(-9.47)	(14.76)	(10.50)	(5.72)	(2.33)	(1.47)	(2.55)
α_{1c}	0.436	-0.198	0.021	-0.087	-0.651	-0.303	0.001	-0.121
	(11.00)	(-5.22)	(8.11)	(-8.82)	(-10.21)	(-3.24)	(1.25)	(-12.61)
α_{2c}	-0.013	-0.044	-0.001	0.000	0.000	0.025	0.000	-0.076
	(-13.72)	(-9.50)	(-4.13)	(-0.43)	(1.46)	(6.09)	(-1.20)	(-22.61)
α_{3c}	0.000	0.031	0.002	-0.057	0.023	0.011	0.001	0.031
	(0.16)	(2.35)	(0.93)	(-10.97)	(3.44)	(2.42)	(0.81)	(6.20)
α_{4c}	-0.109	0.000	-0.060	0.009	-0.028	0.001	-0.101	-0.002
	(-10.93)	(-1.33)	(-8.55)	(5.11)	(-6.14)	(1.37)	(-8.83)	(-7.15)
α_{5c}	0.095	0.069	0.000	-0.092	0.007	0.033	-0.004	0.033
	(15.10)	(4.80)	(0.15)	(-19.09)	(1.46)	(2.27)	(-1.79)	(9.42)
α_{6c}	-0.001	-0.012	-0.092	0.002	0.005	-0.001	-0.117	0.029
	(-0.47)	(-2.25)	(-7.21)	(3.29)	(1.06)	(-0.99)	(-2.80)	(6.89)
α_{1d}	-0.015	0.044	0.047	0.230	0.010	0.193	0.185	0.313
	(-4.96)	(18.86)	(18.38)	(45.32)	(1.60)	(7.62)	(11.32)	(17.36)
α_{2d}	0.050	-0.001	0.004	-0.041	-0.093	-0.017	-0.031	0.002
	(10.41)	(-5.91)	(18.70)	(-33.22)	(-11.32)	(-11.33)	(-8.84)	(6.85)
α_{3d}	0.050	0.092	0.017	0.004	0.002	0.002	-0.002	0.004
	(4.97)	(22.32)	(8.94)	(6.21)	(0.55)	(3.45)	(-3.96)	(3.65)
α_{4d}	-0.023	-0.009	-0.050	-0.056	0.073	0.000	-0.069	-0.081
	(-6.71)	(-6.63)	(-17.15)	(-18.10)	(12.09)	(2.43)	(-11.53)	(-13.56)
α_{5d}	0.015	0.023	-0.086	0.036	0.171	0.111	-0.001	0.011
	(5.01)	(11.86)	(-21.56)	(40.05)	(6.08)	(10.01)	(-1.24)	(6.63)
α_{6d}	-0.028	-0.062	-0.098	0.007	0.127	0.069	-0.042	-0.047
	(-4.75)	(-11.07)	(-22.61)	(7.18)	(6.48)	(14.00)	(-6.36)	(-11.02)
α_{1e}	-0.102	0.008	0.002	0.108	0.472	0.032	-0.075	0.050
	(-4.19)	(4.75)	(1.08)	(13.12)	(8.33)	(1.67)	(-3.70)	(4.71)
α_{2e}	0.038	0.001	0.000	0.000	0.108	0.001	-0.016	0.000
	(6.38)	(3.97)	(-1.60)	(0.26)	(15.40)	(4.77)	(-4.60)	(1.18)
α_{3e}	0.006	-0.126	0.002	0.029	0.002	0.004	0.000	-0.026
	(1.39)	(-9.99)	(0.32)	(5.49)	(0.52)	(1.59)	(0.99)	(-5.42)
α_{4e}	0.154	0.073	0.089	0.036	0.006	0.058	0.123	0.021

	(8.94)	(13.71)	(11.24)	(9.94)	(2.77)	(9.44)	(6.21)	(6.98)
α_{5e}	-0.028	-0.179	-0.072	0.033	0.157	0.000	0.107	0.000
	(-3.44)	(-14.69)	(-7.51)	(8.27)	(6.37)	(-0.74)	(6.82)	(1.34)
α_{6e}	-0.001	0.044	0.003	0.002	-0.059	0.003	0.104	0.024
	(-0.77)	(3.71)	(1.18)	(4.52)	(-3.49)	(2.50)	(4.39)	(5.62)
α_{1f}	-0.209	-0.437	-0.324	-0.149	0.288	0.155	-0.237	-0.053
	(-15.25)	(-17.03)	(-13.65)	(-11.91)	(4.71)	(2.71)	(-12.87)	(-2.37)
α_{2f}	0.034	0.032	-0.015	-0.011	0.063	0.001	0.018	-0.047
	(5.41)	(6.50)	(-3.09)	(-1.32)	(7.49)	(0.23)	(3.08)	(-3.59)
α_{3f}	0.063	0.000	-0.024	-0.009	-0.080	0.008	0.011	0.032
	(3.41)	(0.03)	(-1.84)	(-0.87)	(-3.74)	(0.75)	(1.17)	(2.02)
α_{4f}	0.028	0.081	0.125	0.053	0.049	0.060	0.085	0.040
	(1.58)	(14.08)	(18.80)	(5.12)	(4.64)	(6.83)	(6.45)	(4.18)
α_{5f}	0.019	-0.023	0.024	-0.001	0.097	0.080	0.052	0.073
	(0.84)	(-1.52)	(1.27)	(-0.02)	(3.00)	(3.72)	(2.47)	(2.97)
α_{6f}	-0.045	0.000	0.112	0.032	0.062	0.030	0.049	0.091
	(-2.46)	(-0.03)	(6.02)	(1.52)	(1.69)	(1.33)	(1.84)	(3.10)
Observations	43166	45098	44543	41260	79303	68342	78819	59306

Note: The subscripts of parameters, γ, denote the corresponding food group (1 = cereals; 2 = eggs, fish and meat; 3 = edible oils; 4 = pulses; 5 = vegetables and fruits; 6 = other food). For α, β and λ, the first number in the subscript indicates food groups as above. The second letter subscript indicates the corresponding demographics: a= market access; b=age of household head; c=gender of household head, d=household size, e=share of adult female, f=share of adult male. Food prices, MPCFE, household size and age of household head enter in logarithm form. Market access is measured by the percentage of meals that members of households consumed outside of home. Gender of household head is a dummy variable which takes the value of 1 for female and 0 for male. The remaining demographic variables are percentages. Robust standard errors are reported in parentheses.

Table A3 Demand elasticities of other food groups[12]

	Urban				Rural			
	1987-88	1993-94	2004-05	2011-12	1987-88	1993-94	2004-05	2011-12
Panel A: Preference-based income elasticity of demand								
Eggs, fish & meat	**0.898**	**0.728**	**0.223**	**0.229**	**-0.498**	**0.382**	-0.099	**0.437**
Edible oils	**0.726**	**1.037**	**1.765**	**0.761**	**1.427**	**0.349**	**1.363**	**0.798**
Pulses	0.229	**-0.315**	-0.648	**1.084**	**-0.995**	0.196	**0.715**	**0.549**
Vegetables & fruits	**0.246**	**0.275**	**0.242**	**0.628**	**0.466**	0.128	-0.067	-0.038
Other food	**1.795**	**1.498**	**1.775**	**2.317**	**2.168**	**2.465**	**2.182**	**3.047**
Panel B: Preference-based uncompensated price elasticity of demand								
Eggs, fish & meat	**-1.640**	**-0.776**	**-0.404**	-0.208	0.701	**-0.375**	**-1.016**	-0.149
Edible oils	**-0.427**	**-0.743**	**-1.387**	**-0.316**	**-1.173**	**0.939**	**-1.795**	-0.481
Pulses	3.139	**1.295**	-0.589	**0.844**	0.077	0.997	**-0.708**	0.625
Vegetables & fruits	**-1.032**	0.018	**-0.318**	**-1.689**	**-1.235**	**-0.743**	**-1.214**	**-2.345**
Other food	**-4.205**	**-4.395**	**-3.725**	**-4.481**	**-6.489**	**-5.099**	**-5.508**	**-5.743**
Panel C: Standard income elasticity of demand								
Eggs, fish & meat	**0.898**	**0.701**	**0.221**	**0.277**	**-0.498**	**0.426**	0.053	**0.440**
Edible oils	**0.726**	**1.049**	**1.800**	**0.699**	**1.427**	**0.303**	**1.323**	0.759
Pulses	0.229	**-0.349**	-0.753	0.927	**-0.995**	0.126	**0.645**	0.361
Vegetables & fruits	**0.246**	0.309	**0.268**	**0.555**	**0.466**	**0.224**	**0.139**	**0.376**
Other food	**1.795**	**1.431**	**1.718**	**1.961**	**2.168**	**2.288**	**2.095**	**2.491**
Panel D: Standard uncompensated price elasticity of demand								
Eggs, fish & meat	**-1.640**	**-0.763**	**-0.404**	**-0.338**	**0.701**	**-0.380**	**-0.829**	-0.591
Edible oils	**-0.427**	**-0.685**	**-1.435**	**-0.058**	**-1.173**	**1.124**	**-1.710**	-0.389
Pulses	3.139	**1.447**	-0.385	0.630	0.077	0.927	**-0.796**	-0.028
Vegetables & fruits	**-1.032**	-0.089	**-0.400**	**-1.679**	**-1.235**	**-0.788**	**-1.235**	**-0.948**
Other food	**-4.205**	**-4.125**	**-3.808**	**-4.018**	**-6.489**	**-4.083**	**-4.607**	**-3.514**

Note: The preference-based demand elasticities are calculated using the mean data point in 1987-88 while the standard elasticities are computed based on data of the current period. The estimates highlighted are statistically significant at the 95% confidence level.

[12] Like other studies in the demand literature, a few estimates of PED have a positive value, contradicting economic intuition. This may be due to the fact that the adjusted unit values may not be entirely exogenous. As remarked by Majumder et al. (2012), the corrections do not completely eliminate the distortion in unit values and produce imperfect proxies for market prices. The positive signs may also reflect a supply-demand simultaneous bias, especially for households who rely on producing and selling agricultural products for a living. Nevertheless, with the absence of market price information, these adjusted unit values remain the second best option available in capturing price changes.

Table A4: Preference-based demand elasticities computed with survey weights and median food prices

	With survey weight		Median food price	
	Urban	Rural	Urban	Rural
YED				
1987-88	0.927	1.433	0.906	1.377
1993-94	1.460	1.287	1.056	1.242
2004-05	0.735	0.999	0.837	0.872
2011-12	0.708	0.704	0.719	0.604
Uncompensated PED				
1987-88	-0.312	-1.130	-0.432	-1.225
1993-94	-0.392	-0.687	-0.263	-0.734
2004-05	-1.259	-0.833	-1.384	-0.900
2011-12	-0.754	-0.728	-0.886	-0.633
Compensated PED				
1987-88	**-0.157**	-0.731	-0.283	-0.853
1993-94	-0.636	-0.328	-0.089	-0.398
2004-05	-1.136	-0.555	-1.246	-0.664
2011-12	-0.636	-0.532	-0.767	-0.470
XED to price changes in animal products				
1987-88	0.001	-0.288	-0.061	-0.301
1993-94	-0.388	-0.166	-0.200	-0.228
2004-05	-0.138	0.082	-0.216	-0.188
2011-12	0.158	0.308	-0.089	0.236
XED to price changes in edible oils				
1987-88	-0.396	-0.043	-0.500	-0.119
1993-94	-0.242	-0.176	-0.270	-0.467
2004-05	-0.201	0.094	-0.171	-0.129
2011-12	-0.189	0.112	-0.292	0.145
XED to price changes in pulses				
1987-88	-0.051	-0.151	-0.228	0.006
1993-94	-0.246	-0.052	-0.443	-0.180
2004-05	-0.442	0.123	-0.432	-0.065
2011-12	0.004	0.024	-0.154	0.111
XED to price changes in vegetables & fruits				
1987-88	-0.261	-0.170	-0.640	0.021
1993-94	-1.248	-0.113	-0.935	-0.300
2004-05	**-0.733**	0.016	-0.423	-0.087
2011-12	-0.116	-0.197	-0.189	-0.306
XED to price changes in other food				
1987-88	-2.476	-1.710	-2.745	-1.626
1993-94	-2.839	-1.690	-2.782	-2.315
2004-05	-2.247	-1.514	-2.330	-1.542
2011-12	-2.167	-1.289	-2.143	-1.512

Note: These demand elasticities are calculated using the mean data point in 1987-88.