Working Paper Series

No. 177

Welfare Analysis of Changing Food Prices: A Nonparametric Examination of Export Ban on Rice in India

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(January, 2013)

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Abstract

During the world food crisis of 2007-08, the price of staples soared rapidly. Higher food price impacts poor households more as they spend approximately three quarters of their income on food. Together rice and wheat provide more than 50% of the calorific intake in India. Apart from providing food security, millions of poor and small farmers depend on rice for their livelihoods. Using Indian Consumer Household Expenditure surveys for the years 2007-08 and 2009-10 the paper analyses the welfare generated by a ban on export of rice by the Indian government. The paper finds that the net impact of the ban on export of rice was positive, as it was able to cushion the Indian population (87% of whom are net consumers) from the adverse effects of the crisis. It also found that the poor in India aren't homogeneous in nature. The majority of the rice-producing households that stand to gain from increased prices are relatively poor farmers. At the same time, the poor households that do not cultivate rice are most affected by price increase, as their budget share of rice is higher than richer households, who are more resilient to price rise. In particular, the wage labourers are affected significantly.

1. Introduction

Since the world food crisis of 2007-08, increasing food prices have agitated civilians across the world, leading to dethroning of political powers in some countries. In India, the government has always cushioned the agriculture sector due to the sector's contribution to the GDP, and also because of its political importance to every Indian government that has been in power. Agricultural pricing policies not only impact different aspects of the economy differently, but also vary in scale amongst different sections of the poor. Datt and

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Ravallion's[1] study on India for the period 1958–94 reports that in the long-run the price effect of food crop productivity (followed by the wage effect) is better at reducing poverty relative to the direct impact of increase in farm incomes, which dominates this relationship in the short-run. The duality of change in price of food grains leads to conflicting policy objectives.

A decline in price can adversely affect farmers, but at the same time increase the ability of the poor to consume more, leading to an improved standard of living. Neo-populist economists such as Lipton[2] and Griffin suggest that lower prices of staples benefit the rural poor, as they are net consumers of food. While a rise in price tends to create an "urban bias", where rich households are better able to provide for them. In such a scenario, the neo-populists call for greater government intervention in support of the farmers. However, neoclassical economists assert that higher pricing policies intended to boost production are important as the rural poor "still rely on selling their produce for a significant part of their income So, changes in market prices matter"[3] to reduce rural poverty. Both the schools of thought tend to ignore the diversity amongst the poor. Thus, policy makers need a better understanding of the section of poor they are targeting than simply relying on the trickle-down effects of pricing policy. In India, the agriculture sector employs more than 58% of the total workforce and contributed 15% towards the GDP in 2009-10[4]. Due to the extent of dependency of the Indian economy and population on the agriculture sector it is important to determine which groups are most vulnerable, and how they are affected by agriculture price policies.

The purpose of this paper is to measure the impact of changing food prices, through a nonparametric examination of the Indian government's move to ban the export of rice in the light of the world food crisis of 2007-08. The paper follows Angus Deaton's[5] non-parametric techniques for regression and density estimation on Indian Consumer Household Expenditure surveys for the years 2007-08 and 2009-10. Section 2 gives an overview of agriculture sector in India and volatility of rice prices between 2007 and 2010. Section 3 describes the empirical framework for the analysis. This section also explains the source of the dataset and the censored data problem faced. The results are analysed in section 4. Section 5 is the conclusion. The paper concludes that the export ban had a net positive impact on the Indian

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[1] Cited in WDR (2008) p.33
[2] Lipton (1986)
[3] World Bank (1994) p.167
[4] Indian Economic Survey (2011-12)
[5] Deaton (1989)

population, 87% of whom are net consumers of rice. We also find that the poor in India are heterogeneous in nature. Thus agriculture-pricing policies do not have a homogenous impact on the poor. Majority of rice producers are poor farmers who benefited from the rise in price of rice, while the wage labourers were worse off.

2. Overview of the Indian Agriculture Sector

For an agrarian economy such as India, where three-fifths of the labour force depends on the agriculture sector for livelihood, the agriculture sector is not only important for economic growth, but also to maintain political and social stability in the country. Thus, historically the various Indian governments have treated this sector with a lot of love in the form of subsidies and tax relaxations[6].

In 2007-08 the price of rice almost doubled across the globe. Foreseeing a global rise in rice prices, the Indian government reacted by exercising an import ban on non-basmati rice in February 2008 and increased export tariffs on basmati rice in April 2008[7]. Where globally prices more than doubled, in India they only increased by 40% from 2007-2010. Compared to the rest of the world the impact of the world food crisis of 2007-08 on the Indian economy was low, due to the self-sufficiency and cushioning policies of the Indian government since independence. India's protectionist agricultural policies have been criticised by advocates of free trade. According to the Food and Agriculture Organization (FAO), India's decision to ban the export of rice even with surplus quantities of it was a political move rather than a result of real shortage of grain[8]. Traditional trade models suggest that free trade maximises economic welfare. However, when the aim is to maximise national welfare, free trade may not be the obvious policy choice for a developing nation. The objective of the export ban was to increase supply of rice within the country and hence contain the increasing price of rice to insulate the consumers against the negative impact of rising food prices. At the same time the Indian rice producers would receive lower prices relative to the rest of the world, creating a possible negative welfare impact for farmers. The ban was uplifted in February 2012[9].

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[6] James (1992) p.224
[7] FAO (2009)
[8] FAO (2009) p.36
[9] The Economic Times, February 2012
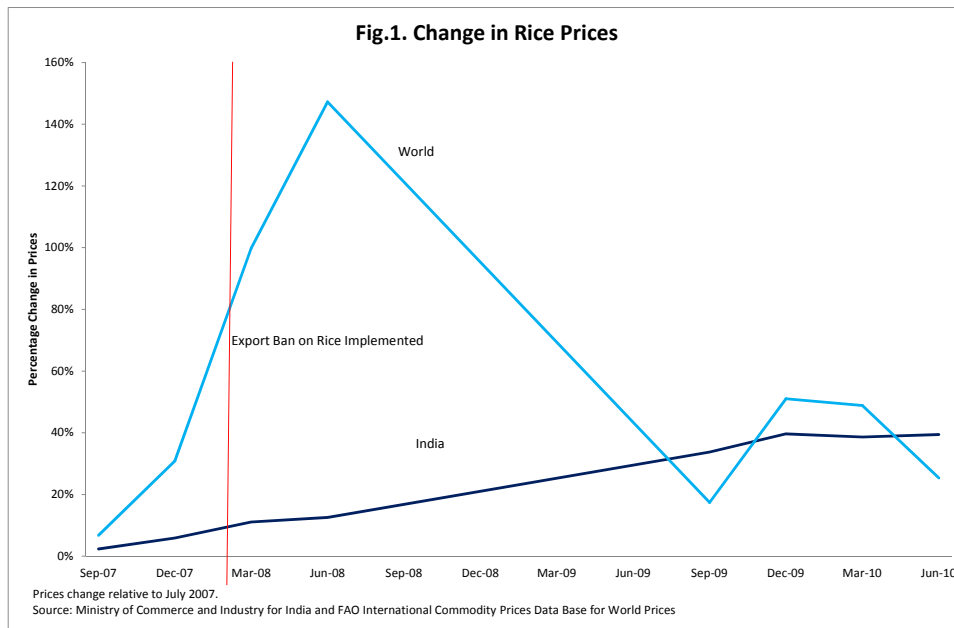
Fig.1. Change in Rice Prices

Figure 1 shows the change in price of rice relative to July 2007 for India and worldwide. The horizontal red line indicates the implementation of ban on exports on rice in India in February 2008. In India, the price of rice increased by 11% between July 2007 and March 2008. During the same period, world rice prices[10] doubled. In June 2008 prices in India increased by 13% from July 2007 whereas, globally, prices increased by 150%.

3. Methodology and Data

The paper is based on nonparametric approach[11] for regression and density estimation and heavily relies on graphical representation of the relationships between indicators of welfare, providing a comprehensive description of the data allowing us to tackle a wide variety of policy issues that can be illuminated by flexible displays of bivariate relationships. Although the first-order approximation neglects the substitution effects[12], the demand[13] and supply[14] for rice are highly inelastic in India. Some papers[15] have analysed the impact of food price inflation in India employing almost ideal demand system (AIDS) model. An important underlying assumption for the AIDS model is that the good considered is homogenous, i.e. perfectly substitutable. This assumption does not hold in reality and as there exist high consumer preference for rice in both the Indian and international markets, making the

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[10] Price of White Broken Rice, Thai A1 Super, f.o.b Bangkok (USD/Ton) is used.
[11] Also used by Deaton (1989), Budd (1993), Barrett and Dorosh (1996), Davila (2010)
[12] Pons (2011) p.4
[13] IFPRI (2010) p.8
[14] USDA (2007) p.31
[15] Pons(2011), Ghosh and Raychaudhuri(n.d), Lind and Frandsen(2000)

substitutability low[16]. India mainly exports basmati rice, which is a high-grade variety; while the domestic market consumes medium and low grades non-basmati rice varieties[17].

a) Empirical Framework

Let us consider a household that consumes and possibly produces rice and participates in the economy by producing and selling other commodities and/or participating in the labour market. The household living standards can be represented by the indirect utility function given as

$$u_h = \theta \ (wt + T + \ \pi, p) \tag{1}$$

where u_h is utility (or real income) of household h, w is the wage rate, t is the total time available, T is rental income, property income, or transfers, p is a price vector of commodities consumed, and π is the household's profits from producing rice or other economic activities. As profits are maximised, π is taken as the value of a profit function, π *(p, v, w)*, where v is a price vector of input prices, w is the wage rate, or vector of household wages, and p in this context is the vector of output prices for commodities produced by the household. The impact of change in price on the profits is captured by a standard property of the profit function given below.

$$\frac{\partial \pi_h}{\partial p_i} = \ y_i \tag{2}$$

where y_i is the (gross) production of good i by the household h. If price of i, i.e. rice changes the effect on the real income of the household h, can be derived by taking the first derivative of the indirect utility function given by equation (1).

$$\frac{\partial u_h}{\partial p_i} = \frac{\partial \theta}{\partial T}\frac{\partial \pi}{\partial p_i} + \ \frac{\partial \theta}{\partial p_i} = \frac{\partial \theta}{\partial T}(y_i - \ q_i) \tag{3}$$

where q_i is the consumption of good i (rice), and the second part of the equation is derived from the Roy's identity.

The welfare benefit is defined as the amount of money (positive or negative) required by the household in order to maintain its previous level of living. So, if the change in price is dp_i, then the required compensation dB is given by the equation,

$$d\beta = (q_i - y_i) \, dp_i = \ p_i(q_i - \ y_i)d \ ln \ p_i \tag{4}$$

dβ can be expressed as a fraction of household expenditure x, we divide the above equation by x to get,

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[16] FAO(2002)
[17] FAO(2002)

$$\frac{d\beta}{x} = \left(S_i - \frac{p_i y_i}{x}\right) dln\, p_i \tag{5}$$

Where $S_i = (p_i\, q_i/x)$ is the budget share of good i, and $p_i\, y_i/x$ is the value of production of i as a fraction (or multiple) of total household expenditure[18].

This equation will be used as a measure of welfare for households. $\frac{d\beta}{x}$ is called the *net benefit ratio (NBR)* in the paper. The equation calculates the elasticity of the cost of living with respect to the price of good i (rice). The elasticity will be negative for net producers of rice and positive for net consumers.

b) Data Source

The paper uses Household Consumer Expenditure survey sets provided by National Sample Survey Office (NSSO) in India. The 64th and 66th Round (Type-1) rounds for the year 2007-08 and 2009-10 respectively are used[19]. The survey period is divided into quarterly sub-rounds starting from July. Household occupation and region is used as a classification to identify the vulnerable groups, while monthly per capita expenditure (MPCE) is used as the main determinant of living standards. Wholesale prices[20] are used for change in price $(dln\, p_i)$. Price for July 2007 is used as a base and change in log of prices is calculated for each quarter to calculate the NBR. The quarterly change in net benefit is then analysed to recognise the groups most vulnerable to price change. To estimate the welfare generated by implementing the export ban, the net benefit for Indian consumers is calculated using change in world prices[21] $(dln\, p_i)$. The predicted benefit (calculated with world prices) is then compared to the actual change in benefit (using Indian prices) to examine the net benefit of the export ban on the Indian economy. As the export ban on rice took place in February 2008, the paper measures the difference in welfare keeping July 2007 price as the base and compares results for the following sub-rounds, July-September 2007, April-June 2008, July-September 2009 and April-June 2010. This allows us to capture the change in welfare over a time period due to the increase in supply of rice intended by the export ban.

c) Censored Data Problem

To measure the change in welfare generated by the export ban, we require the quantity of rice consumed and produced by households for both the years. Both the NSSO rounds measure

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[18] For the purpose of the paper it is assumed that the farmers sell and buy rice only.
[19] There was no household consumer expenditure survey conducted for the year 2008-09.
[20] Sourced: Ministry of Commerce and Industry of India.
[21] Soured: FAO

the total quantity of rice consumed by the household, but only the 2009-10 round had the value of rice produced by the households. Thus we are able to measure the net benefit based on the production values of 2009-10. Also, the variable for quantity of rice produced by a household was censored from above if the production of rice for a household is greater than the total consumption, leading to a censored data problem. For example: if a household produced 100kg of rice and consumed 12kgs, the quantity produced was censored at 12kg only. To solve the censored data problem this paper uses the tobit model for censored normal distribution to estimate production values where data is censored. The quantity of rice produced by households in 2009-10 is used to estimate the values for 2007-08. A test to check for correlation between the estimated values and uncensored observations was conducted and the results were highly correlated and robust. It is recognised that the estimation of production data for 2007-08 based on 2009-10 values may underestimate the net welfare generated by the export ban for the net sellers. However, the welfare for net consumer (87% of the households) is neither under or overestimated, as the consumers do not produce rice.

4. Demand and Supply Patterns for Rice in India

This section starts with a descriptive analysis of the dataset. It then evaluates the data by expenditure level and budget share of rice. Following which the probability of a household being a net producer and a net seller is estimated. The next sub-section measures the net welfare generated in 2009-10. Finally, the paper generates the scenarios in case the export ban was not implemented to assess the net effect of export ban.

a) Descriptive Statistics

Table 1 presents sample means for selected variables. Ignoring any price differences, in general urban households are better off than rural households as they spend more. But, households classified as casual labourers in the urban areas have a lower MPCE than most rural household types. The price of rice is the average of individual household rice prices, which is calculated by dividing the monetary value of rice consumed by the total quantity consumed by the household.

The difference in rice prices indicates the different qualities of rice consumed by the households. The price of rice increased for all households from 2007-08 to 2009-10. It is

observed that the average size of households self-employed in agriculture is the highest. Presumably this is because of the high dependency on family members for farm labour in agrarian households. As expected the budget share of rice is indirectly proportional to MPCE; i.e., the expenditure on rice as a ratio of expenditure decreases as monthly expenditure increases. Thus the budget share of rice for rural households is higher than that for urban households, as the poor spend more on food. The distribution by household type describes in general those households that benefit and lose from the change in pricing policy. However, there exist both rich and poor households within these classification types. To analyse the results of table 1 better the data is presented graphically using density distribution graphs.

Year 2007-08	Price of Rice per Kg in Rupees	Household Size	Monthly Per Capita Expenditure in Rupees	Budget Share of Rice in %
Household Types in Rural Areas				
Self-Employed In Non-Agriculture	13.28	5.33	1198.97	9.15
Agricultural Labour	10.10	4.50	649.61	10.58
Other Labour	11.34	4.85	837.50	8.71
Self-Employed In Agriculture	12.96	5.78	1070.31	9.60
Others - Rural Areas	14.05	4.60	1516.19	8.94
Household Types in Urban Areas				
Self-Employed	16.65	4.75	1818.39	5.72
Regular Wage/Salary Earning	16.93	4.03	2201.08	5.34
Casual Labour	11.66	4.34	916.22	7.17
Others - Urban Areas	16.93	2.91	2587.35	5.61

Year 2009-10	Price of Rice per Kg in Rupees	Household Size	Monthly Per Capita Expenditure in Rupees	Budget Share of Rice in %
Household Types in Rural Areas				
Self-Employed In Non-Agriculture	15.36	4.97	1151.56	10.49
Agricultural Labour	12.14	4.41	819.80	9.16
Other Labour	13.59	4.62	958.30	8.34
Self-Employed In Agriculture	16.25	5.47	1243.11	9.96
Others - Rural Areas	17.33	4.40	1597.76	9.40
Household Types in Urban Areas				
Self-Employed	20.32	4.98	1687.16	7.52
Regular Wage/Salary Earning	22.01	4.30	2243.86	6.53
Casual Labour	14.38	4.62	1008.68	7.69
Others - Urban Areas	20.64	3.20	2320.06	7.40

Source: Authors calculations based on NSSO survey data

b) Distribution by Expenditure

Figure 2 showcases the distribution of living standards across households for rural and urban areas for the two rounds. The estimated density of logarithm of MPCE is plotted. The logarithmic transformation is chosen because the distribution of expenditure (like that of income) is usually skewed to the right and taking logs increases symmetry[22]. The density

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[22] Deaton (1989)

functions are estimated by kernel smoothing. These graphs are similar to histograms, except they are smoothed-out into a curve. The height of the curve at a given point determines the number of observations close to that particular point. We start by mapping the log of monthly per capita expenditure (lmpce) of the households by using the kernel density-smoothing graph.
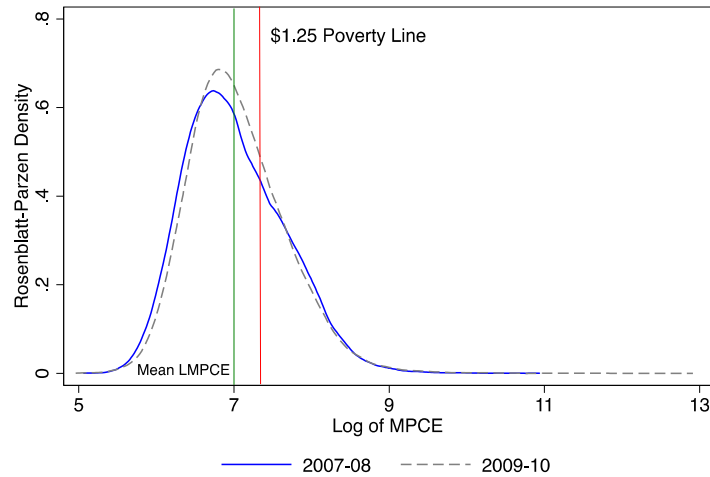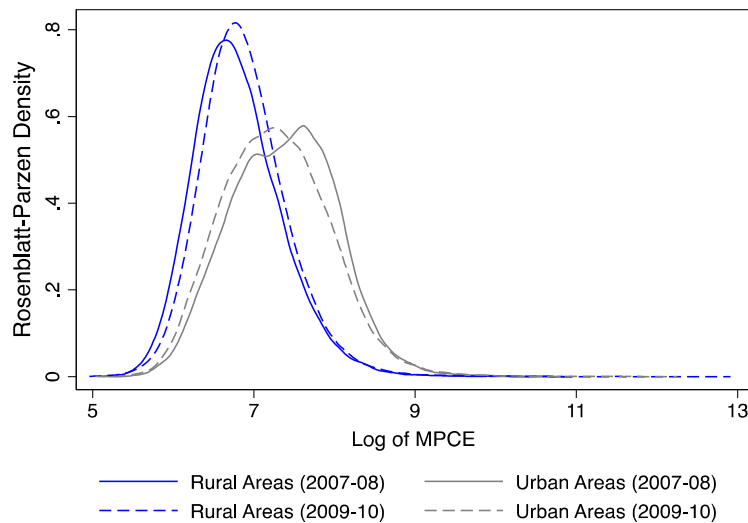

Fig.2.Round-wise Distribution

Fig.3. Sectoral Distribution

The vertical green line indicates the average log of monthly per capita household expenditure, while the red line represents the $1.25 per day global poverty line[23]. The placement of these lines suggests that majority of rice consumers in India live in poverty. The tip of the curves in figure 2 and 3 indicate the modal lmpce value of the households. Fig.2 showcases the shift in the height of the two curves, implying that the density of households with lmpce between 6.5 and 7.5 increased in 2009-10. Majority of the 2009-10 curve is on the right side of the 2007-

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[23] Chen and Ravallion, 2010

08 curve, implying an increase in MPCE for the households over the two rounds. To assess the size of disparity, we need to consider the real value of MPCE rather than the logarithmic scale. We can recollect that a difference of 1 on a logarithmic scale corresponds to scale factor of 2.7 and a difference of 2 to a scale factor of 7.4. The distribution (even after transforming the data logarithmically) has a long right tail, indicating the inequality in household expenditure across the population, in spite of the very low mode.

The most obvious feature of Fig.3 is the relative positions of the rural and the urban sectors. The dash lines represent the distribution for the year 2007-08, while the solid lines are for 2009-10. The peaks of the curves showcase the difference in modes for urban and rural households, and as expected the urban households are relatively better off compared to the rural households. The average monthly expenditure for rural areas has increased, as the dash curve is on the right side of the solid curve, while that for urban areas has decreased. The decrease in lmpce for urban areas is due to the reduced expenditure for households classified as 'others' and 'self-employed' in urban areas. Fig.3 also shows that the households in the urban areas are more diverse than those in rural areas. The lmpce for households in rural areas is concentrated between 6 and 7, which is below the average lmpce for all households. The urban households as anticipated are richer and their lmpce levels are concentrated between 6.8 and 8.5[24]. The income disparity between the two regions is evident, although this has decreased over the two years. The majority of the richer households are situated in urban areas, but overlapping tails suggest that there exist both rich and poor households in both the urban and rural areas.

c) Distribution of Budget Share of Rice

Fig.4 plots Engel curves for both rural and urban areas for each round. The curves present how the budget share of rice varies as the expenditure increases. The curves represent the average welfare effect of price changes on consumption levels. The downward sloping curves confirm Engel's law, i.e. the budget share of rice declines as living standards increase. The poor households (from both urban and rural areas) spent around 16% of their budget on rice in 2007-08 and 14% in 2009-10. There is no difference in the budget share for urban and rural households that are at the very bottom or top of the expenditure distribution. The Engel curves for 2009-10 intersect the 2007-08 curves, indicating that the expenditure on rice increased for middle-income households in both rural and urban areas. The curves intersect

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[24] Notice the increase in range relative to rural households.

again as the households become richer. The rice share is more or less the same for rural households above lmpce equal to 6. The rice share for urban households has clearly increased for the middle-income households. When comparing rural and urban households it's observed that not only are urban households richer on average, but at the same expenditure levels they spend less on rice.
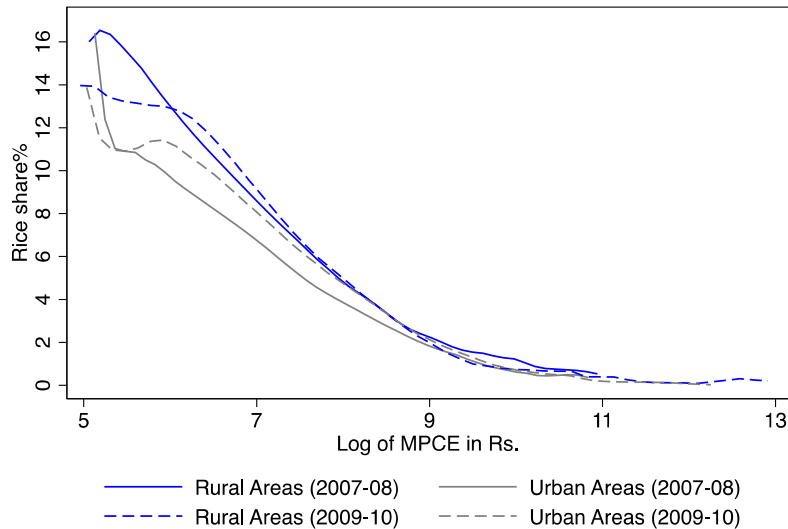

Fig.4. Rice Share Regressions

At this point we are not sure about the factors responsible for the difference in rice share, whether it is lower prices, or less tangible factors associated with urbanisation. Budget share Engel curves such as those in Fig.4 describe only the average welfare effects of price changes that operate through consumption. These curves do not account for the change in price from the production side. They can also be faulted for giving no impression of the variability in consumption patterns at different levels of expenditure[25]. Fig.4. shows that on average, poor consumers spend 16% of their monthly budget on rice, but the effects of pricing policy on poverty are subject to whether such an average is typical, or whether there are substantial numbers of poor households that spend much more than 16%. Therefore, it is important to understand the underlying distribution better.

The following sunflower[26] plots estimate of the joint density of the logarithm of MCPE (lmpce) and the rice share%. These plots show the empirical distribution of the underlying

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[25] Deaton (1989) p.11

[26] Deaton's paper on rice pricing policy in Thailand uses contour graphs generated on Gauss. This paper has used sunflower plots instead to represent the data. Both graph types are similar as they show the bivariate density. The visual impact of contours may be dominated by information about the tails of the distribution where very few observations exist, which is not the case in sunflower plots as these points are presented by the blue circles in these plots.

data[27] in a manner similar to histograms, but in three dimensions. The height represents the portion of households at various levels of lmpce, while the co-ordinates along the base represent the rice share.
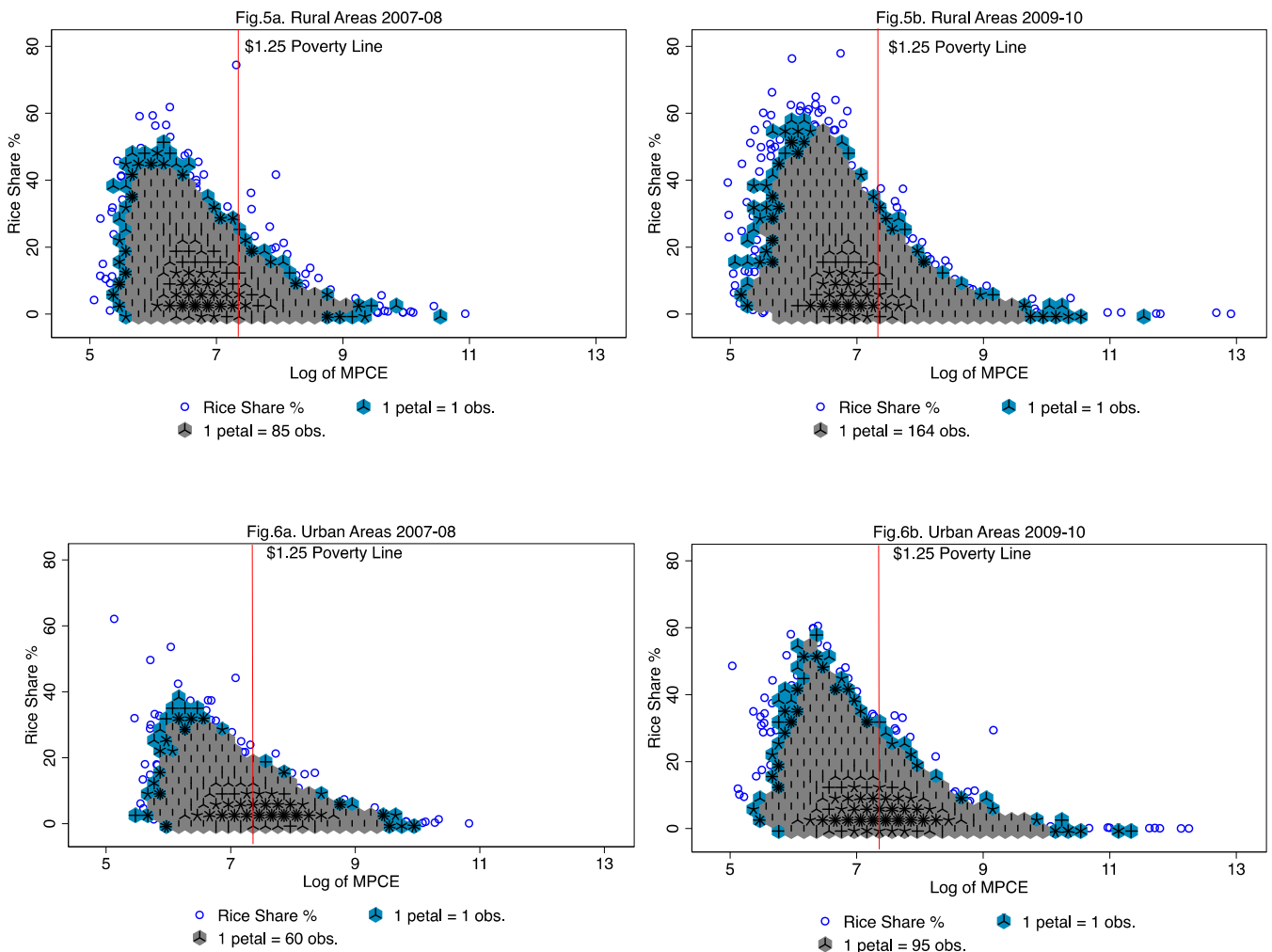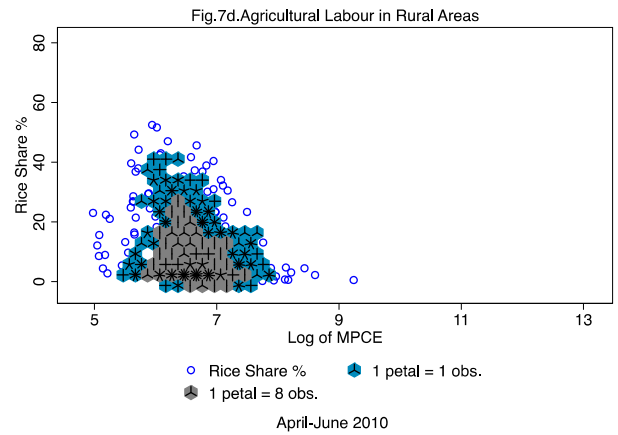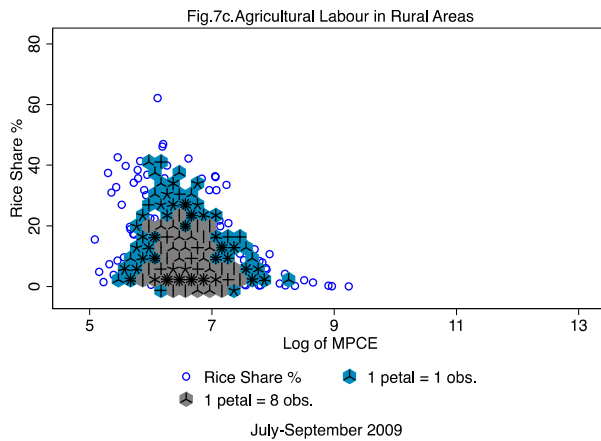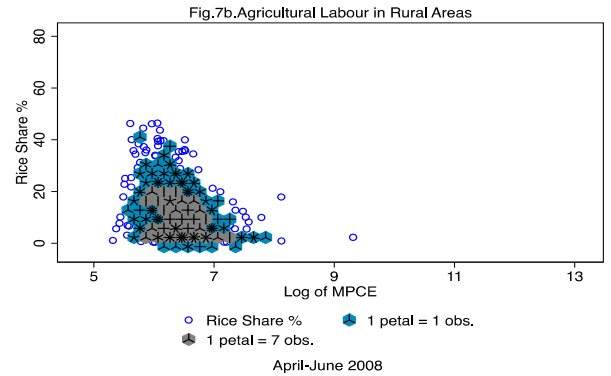

Fig.5a. Rural Areas 2007-08

Fig.5b. Rural Areas 2009-10

Fig.6a. Urban Areas 2007-08
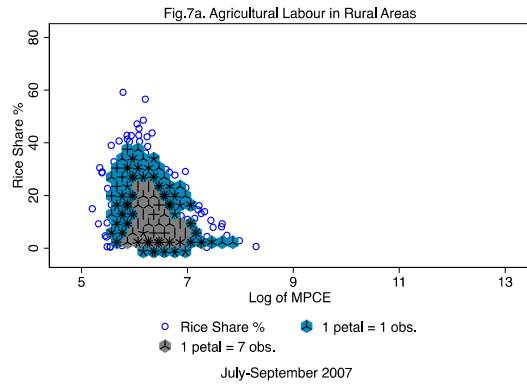

Fig.6b. Urban Areas 2009-10

Fig.4 shows that on average rural households below the average lmpce of 7, i.e. households that spend about Rs.1100[28] per person per month spend between 9-16% of their monthly budget on rice. But when we observe the distribution of households in figures 5 and 6, we see that there exists no fixed expenditure pattern (budget share of rice ranges from 0.1 to 60%). The regression line flattens out and the variance drops sharply as we move from poor to richer households (left to right on the x-axis), i.e. richer households not only spend less on rice, but also have a homogenous consumption pattern when it comes to rice.

The rice share distribution for agricultural labour households suggests that these households spent the most of rice. Majority of the households in this category spend less than Rs.1100

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[27] Hardle (1990)

[28] Approximately £13 per month per person.

per person per month. Figure 7 shows the heterogeneity in consumption pattern for these households. These figures also suggest that the monthly per capita expenditure increased in 2009-10, as there is a shift in density of households towards the right.

Fig.7a. Agricultural Labour in Rural Areas
July-September 2007

Fig.7b.Agricultural Labour in Rural Areas
April-June 2008

Fig.7c.Agricultural Labour in Rural Areas
July-September 2009

Fig.7d.Agricultural Labour in Rural Areas
April-June 2010

Fig.8a.Other Labour in Rural Areas

Fig.8b.Other Labour in Rural Areas

July-September 2007

April-June 2008

Fig.8c.Other Labour in Rural Areas

Fig.8d.Other Labour in Rural Areas
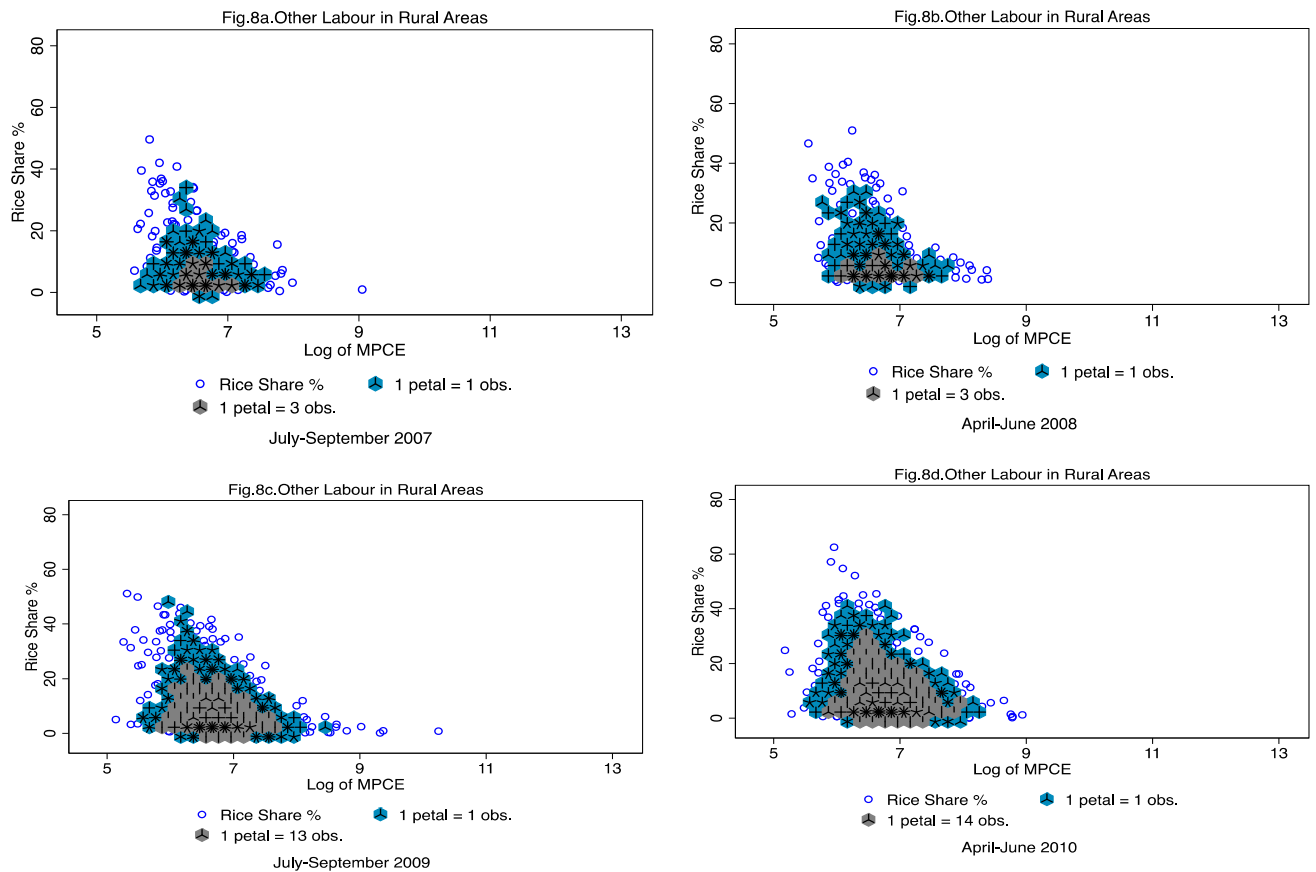
July-September 2009

April-June 2010

Fig. 8 shows that the budget share of rice for non-agricultural labour in rural areas, ranges between 0.1-40% with majority of the households below the 20% line. The density of observations with less than 7 lmpce and more than 20% rice share increased significantly in 2009-10, implying a rise in rice share. Similar patterns are observed for casual labour households in urban areas. In 2007-08 only a small number of rural households that were self-employed in non-agricultural activities spent more than 20% on rice. By September 2009 the density of households that spent between 20-60% on rice had increased by a large extent. Rural households self-employed in agriculture also have a heterogeneous consumption pattern, which did not vary much over the two rounds. Agrarian households with lmpce below 7 spent approximately 0.1-40% of their budget on rice, while households with lmpce above 7 spent less than 20%. The number of households with lmpce below 7 and spending more than 40% of their budget increased, indicating that poor households are affected by the price rise, while the rich are more resilient.

The consumption pattern for urban households that were self-employed was less diverse than its counterpart in rural areas. The rice share varied between 0.1-33% in the 2007-08 and then increased to 0.1-60% in 2009-10, indicating a negative effect on these households. The

consumption for urban households with a regular salary earning capacity was least affected. Only the middle-income households (lmpce between 6 and 8) spent more on rice in 2009-10 than they used to previously.

Fig.9 and 10 are a different representation of the same data underlying figures 6 and 7. It gives a visual impression of the surface of the joint density; although such graphics conceal some of the information given in the sunflower plots, they give a clearer impression of relative heights and thus the concentration of the majority of observations. These figures illustrate the surface of the joint density[29] of the two variables. The open 'caves' illustrate that the density does not fall to zero as the rice share tends to zero.
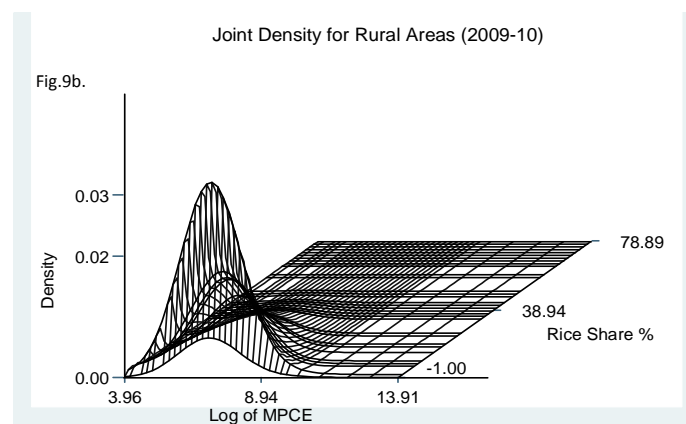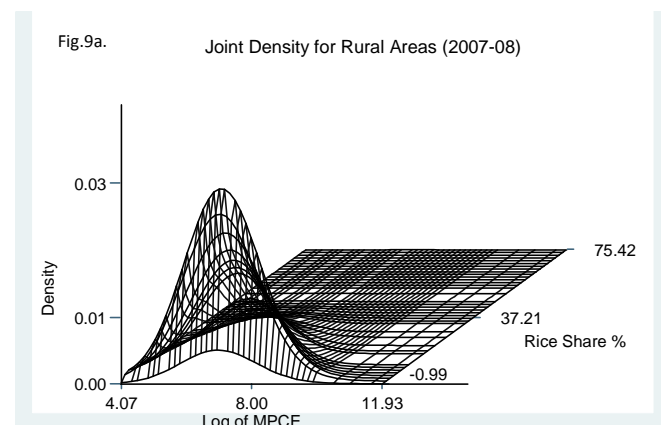
Fig.9a.

Joint Density for Rural Areas (2007-08)

Joint Density for Rural Areas (2009-10)

Fig.9b.

Fig.10a.

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[29] These graphs are generated using the 'kdens2' add-in on Stata. Kdens2 produces bivariate kernel density estimates using a Gaussian kernel and graphs the result using surface plots.

Fig.10b.

Joint Density for Urban Areas (2007-08)
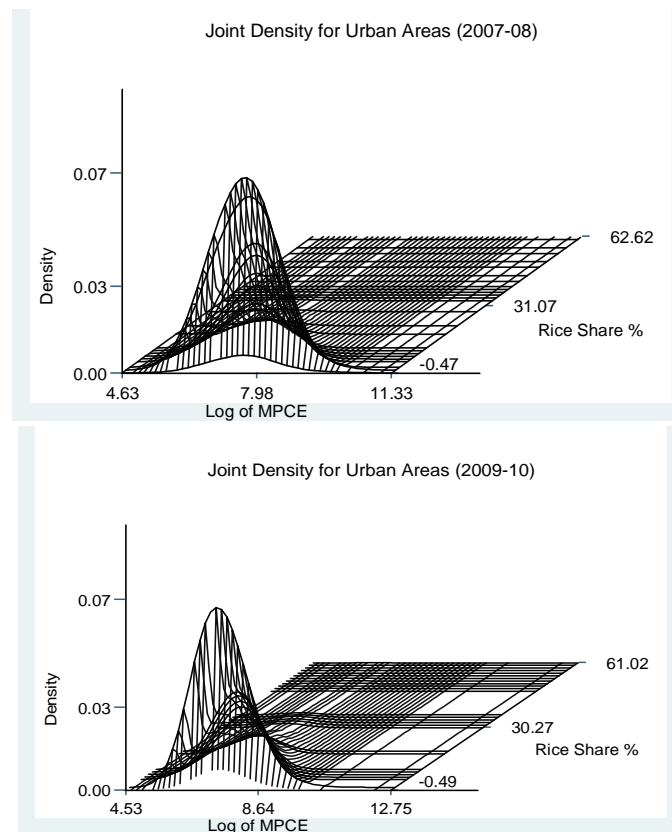

Joint Density for Urban Areas (2009-10)

Fig.9 shows how the observations are concentrated in the left corner of the plot. In numerical terms in 2007-08 majority of the rural households have less than 8 lmpce and spend less than 20% of their budgets on rice[30]. We can see the shift in rice consumption patterns more clearly for urban areas.

d) Who Stands to Gain by Increased Prices?
Estimating the Probability of Being a Net Producer and a Net Seller

Next we look at the production side to examine the net effect of price changes. For this analysis we shall mainly look at the household types that are more likely to be affected on the production side, i.e., rural households and those self-employed in agriculture[31]. The figures below estimate the proportion of households that produce rice as a function of lmpce. In this regression lmpce is treated as the independent variable and the dummy variables created to represent sellers and producers are the dependent variables. The blue curve estimates the

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[30] Stata's own mechanisms for graphing almost always choose values beyond the range of the data on the axis; therefore the starting value for rice share % is below 0 when the minimum value observed is 0.01%.

[31] Note in all the sunflower plots there are blue markers detached from the petals, which represent the outliers in the data. As the density is very small at these points when we present the data in a form of a regression these outliers increase the roughness in the Engel curves. The roughness can be dealt by widening the bandwidth of the curve. However, that may lead to oversmoothing of the curve and thus de-shape the curve. Therefore, for this graph the households below lmpce 10 (81 respectively from 95,593 observations) have not been considered for analysis.

probability of a household being a net producer[32]. The dummy variable created is equal to unity if the household produces rice and zero if not. The grey curve estimates the probability of a household being a net seller of rice. The dummy for this curve is equal to unity if the household sells rice and zero if not. The blue curve lies above the grey, as a household needs to be a producer to be a seller.
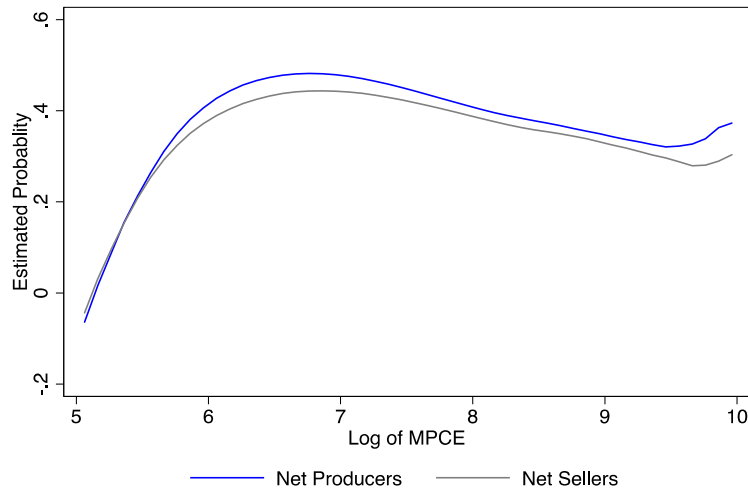
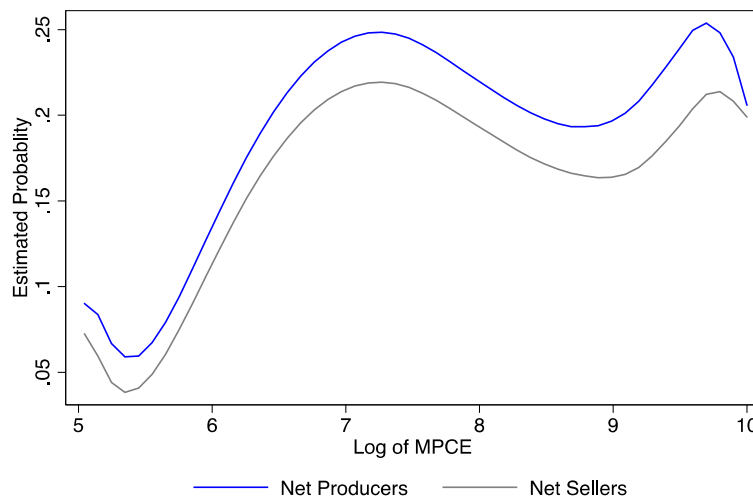Fig.11. Rice Farming: Self-Employed in Agriculture in Rural Areas (2009-10)

Fig.12. Rice Farming: Rural Areas (2009-10)

The fig.11 shows that the probability of poor households being a seller is much lower than the probability of richer households. After 5.8 lmpce the (unconditional) probability of a household being a net seller is more or less constant and does not vary as a function of expenditure. This implies that the proportion of households that benefit from a price rise is

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[32] Note that net consumers are different from net producers as net producers are those households, which produce rice, however small or large the quantity may be. While, net consumers are those households, which irrespective of producing or not producing rice have to go to the market to buy rice for consumption. Net sellers are the households, which produce enough rice for household consumption and also sell rice in the market.

the same among the poor and rich farmers. Therefore we can say that a rise in price doesn't only benefit a few large rich farmers[33]. This is with the exception of extremely poor households with lmpce below 5.8. Presumably these households are in poverty and therefore have to cultivate rice for subsistence purposes. When we look at the underlying data of households with lmpce below 5.8 it is observed that these households belong to other backward classes (OBC)[34] and schedule tribes[35] classes of the Indian society. About 60% of these households are scheduled tribes and the rest are from OBC. About 15% of the households in the 66th round are net producers of rice and 13% are net sellers. Approximately 90% of net producers and 80% of net sellers were based in rural areas. The dip in the curves above suggests that the households with lmpce around 8.5 and 9.5 are less likely to be producing rice than households with higher or lower lmpce. This is because the majority of households in this bracket are based in urban areas[36].

e) Net Welfare Generated

The figures above suggest that an increase in rice price would have direct benefits for rice producing households who are mainly based in the rural areas. We shall now proceed to quantify this benefit per household and analyse the pattern of net sales in relation to the distribution of living standards. For the figures below the sign of NBR is changed, so that the beneficiaries are on the top and the losers are on the bottom of the x-axis. The figures below depict the joint density of the NBR and lmpce. The sunflower plot is used to map the distribution of net buyers and net sellers. The horizontal line is the zero net purchase line that divides the net buyers from the net sellers. The net buyers (87%) are the losers as their ability to consume rice is compromised. The net sellers are the obvious winners as they earn more (approximately 13% of the households) and less than 1% of the households are on the line. The heterogeneity in welfare for the seller is visible as the petals are spread out above the x-axis. The net buyers are concentrated just below to the x-axis, suggesting that the negative impact was contained due to the export ban. We can observe a bell shape in density of the sunflower plot. For net sellers the benefit increases as the expenditure level increases until lmpce is equal to 7 and then starts to decrease. While, for the net buyers the negative impact increases until lmpce equal to 6 and then decreases with increase in expenditure. Fig.13

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[33] Note that there exist farmers who produce goods apart from rice in this group.

[34] OBCs are defined as people economically and socially backward other than schedule castes and tribes(Jain et el(2012)).

[35] Schedule tribes are a historically disadvantaged community in India (Jain et el(2012)).

[36] Refer to fig.3 and A4 where the kernel density distribution is given for rural and urban areas. We observe that the inequality in expenditure is really high in the rural areas and majority of the households in the 8.5 to 9.5 range are urban households.

suggests that the net benefit (positive or negative) rises with increase in expenditure levels for households with expenditure levels below the average and then starts to decline for households that have above average spending levels. Therefore, the middle-income households are most vulnerable to change in prices of rice.

Fig.13. Net Purchases (2009-10)
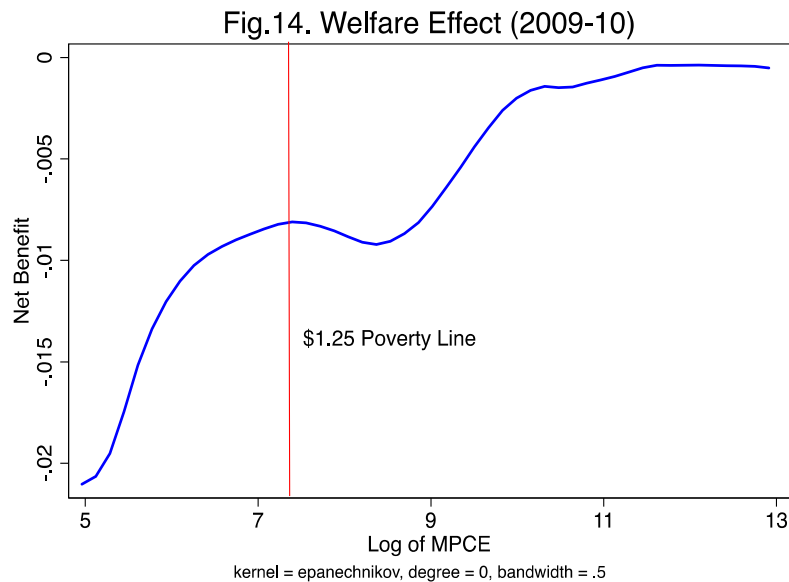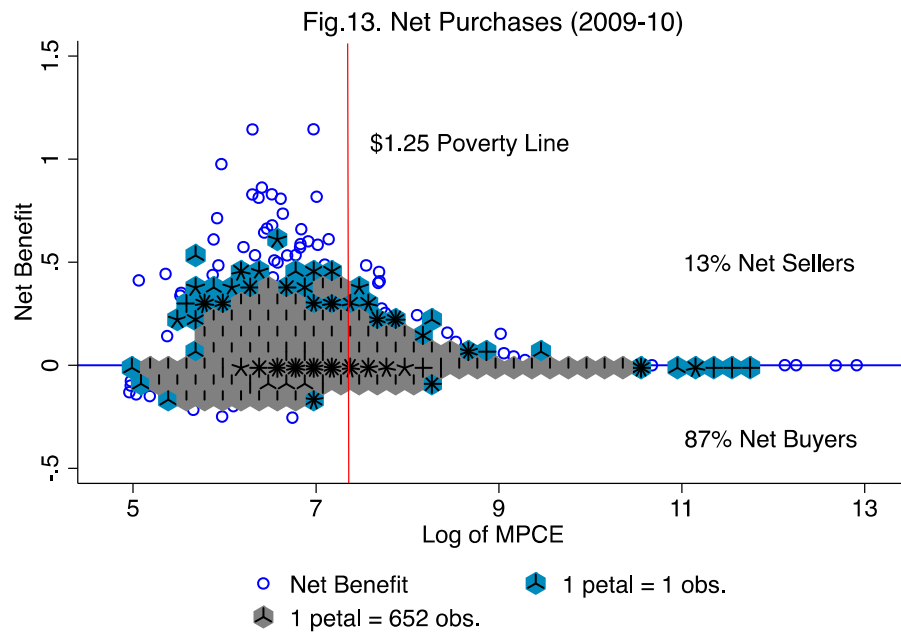
The impact of price change among rural households is heterogeneous, describing the vulnerability of these households. Therefore their sunflower plots for July-September 2009 and April-June 2010 were generated to better understand the change in welfare during 2009-10. We realise that while the situation of net buyers did not change, the net sellers were the beneficiaries.

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The heterogeneity in net benefit pattern for rural agricultural labour increased over the year. The average of positive net benefit increased from 0.12 to 0.17 with the standard deviation also increasing. Thus, implying increased heterogeneity in welfare. Similar, to the studies on Mexico[37] and Thailand[38] we were unable to establish a pattern between welfare generated and expenditure. It is important to note that the majority of the households in this category are net buyers who stand to lose from increased prices. The ones who stand to win are subsistence producers, who cultivate on small farms for consumption purposes and also work as casual agricultural labour on other farms.
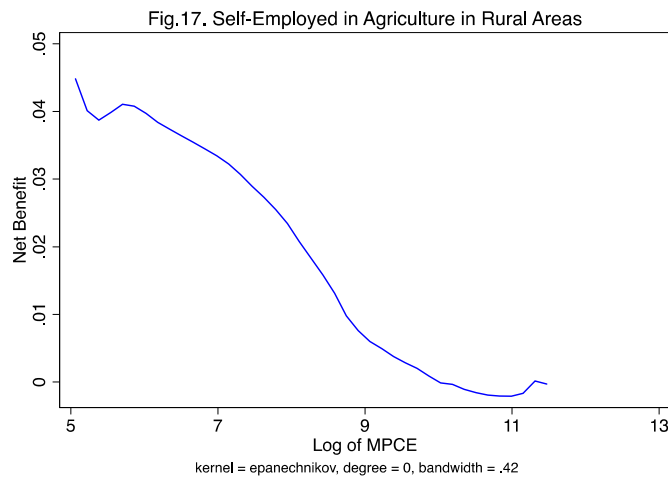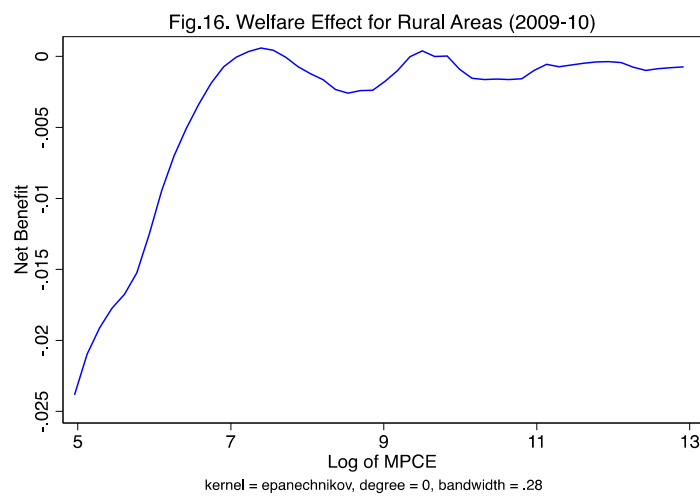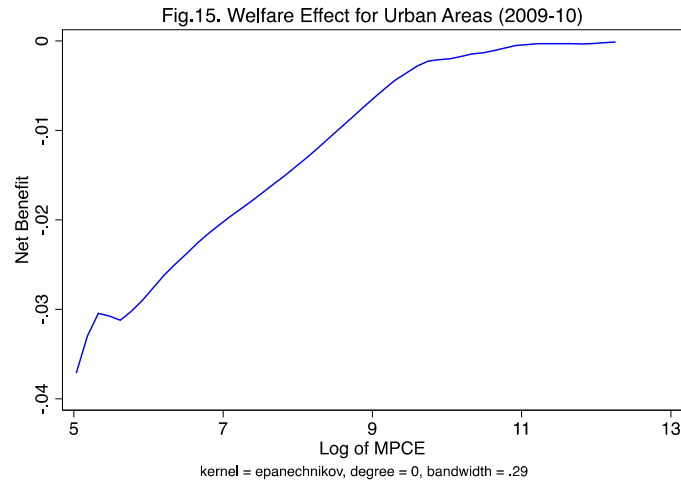
There was a marginal rise (0.09 to 0.12) in welfare for net sellers in the rural agrarian household category. 46% of these households are net producers and 43% are net sellers. Only 3% grow rice for subsistence purposes. We expected this group to observe a higher average welfare, as this category includes the rice farmers. A possible reason behind such low net benefit figures could be that the complete benefit of rising prices did not trickle down to the producers.

Fig.14 estimates the regression function from fig.13. The regression line is below the x-axis, therefore on average households stand to lose from higher rice prices irrespective of how much they spend. For example, for a household with average monthly per capita expenditure of Rs.1100, a 1% increase in the price of rice will create negative impact of 0.01% (approx.). But as the curve is upward sloping, the negative impact is more likely to decrease with a rise in expenditure levels. The curve dips for the middle-income group as these households are based in urban areas and as the frequency of them being a producer of rice is low. Thus, price change affects these middle-income households more than the households with higher or lower expenditure levels[39]. The net welfare effect for rural and urban areas is presented below. There exists great diversity in pattern and scale across these households. On average the welfare impact of increase in price of rice is negative. The only exceptions are the rural agrarian households, as they are net sellers of rice. However, even this curve (fig.17) is downward sloping, meaning the benefit declines with increase in expenditure, implying that most rice producers are small-scale farmers. For the rest of the households the trend is similar where the poorer the household the more they stand to lose from price rise.

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[37] Davila (2010)
[38] Deaton (1989)
[39] Refer to figure3 for the gap between the dash curves from 7.8<lmpce <8.5.

Fig.15. Welfare Effect for Urban Areas (2009-10)

kernel = epanechnikov, degree = 0, bandwidth = .29

Fig.16. Welfare Effect for Rural Areas (2009-10)

kernel = epanechnikov, degree = 0, bandwidth = .28

Fig.17. Self-Employed in Agriculture in Rural Areas

kernel = epanechnikov, degree = 0, bandwidth = .42

The curve for urban households is upward sloping. The net benefit curve for rural households is upward sloping until lmpce equal to 7, after which is does not follow a particular pattern. Apart from the shape of the curve, the second most striking feature of the two curves is their scale. On average urban households are much worse off than their rural counterparts.

f) Welfare Analysis in the Absence of the Ban on Rice Exports

We know predict the quarterly net benefit values if the export ban was not implemented and if the prices in India would have risen in accordance with international rice prices. The fig.18 shows the predicted net benefit for the following quarters; July-September 2007, April-June 2009, July-September 2009 and April-June 2010, and the fig.19 represents the change in net benefit over the period using the Indian rice prices[40].
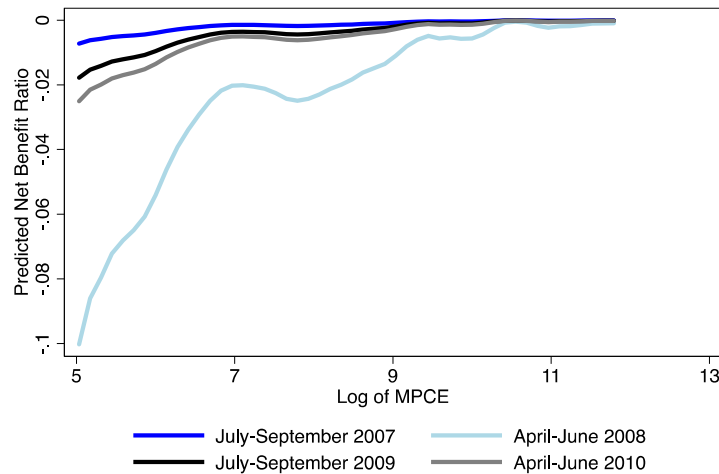

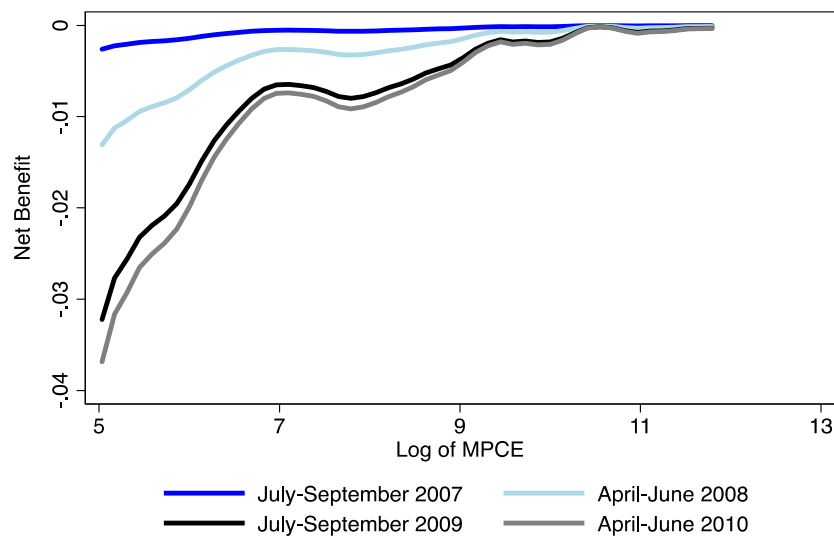Fig.18. Predicted Change in Net Benefit

Fig.19. Actual Change in Net Benefit

The poor households would have been much worse off than the richer households, if the export ban was not implemented. Let us consider the quarter April-June 2008, when the impact of the crisis was the most. In case of implementation of the export ban, a 1% increase

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[40] To predict these values consumption and production of rice and expenditure levels for July-September 2009 are kept as constant (as we only have production data for 2009-10). Therefore the predicted net benefit is relative to the consumption and production values of July-September 2009, i.e. how much money the household would require in order to maintain the living standards observed during July-September 2009.

in the price of rice would require the poor household to spend 0.013% more of its household expenditure to enjoy the same living standard; while, the richer households would have to spend less than 0.005% more. In real terms, if a household's lmpce is equal to 5; its monthly per capita expenditure is approximately equal to Rs.150. With a -0.013 net benefit the household and a 13% rise in price (rice price inflation in India for this quarter) will have to spend 0.2% more of their current expenditure per person, to maintain their living standard. But, in the absence of the export ban the same household would have experienced a negative impact of 0.1 and 150% increase in price (represented by the light blue line in fig.31), which would require the household to spend 15% more. Net this particular household spent Rs.22 less than it would have if the export ban was not implemented.

We now compare actual and predicted net benefit curves for each quarter. If the actual net benefit is above the predicted curve, the net impact of the ban on rice exports is positive. For fig.33 shows us the scenario pre-crisis. The Indian consumers were better off than their international counterparts. The gap between the actual and predict net benefit curve decreases as the households get richer. This is line with our previous analysis that the poor households are more vulnerable, while the rich are resilient to price change.

Fig.20. Net Benefit Comparison

July-September 2007

Fig.21. Net Benefit Comparison

April-June 2008
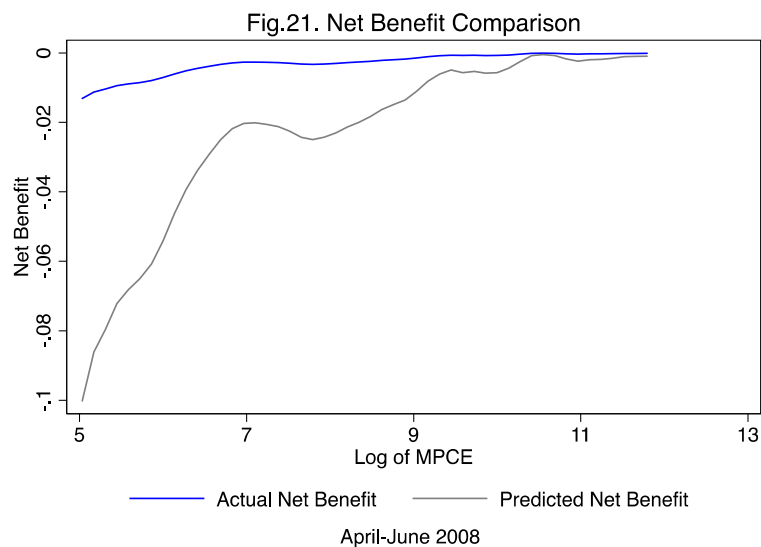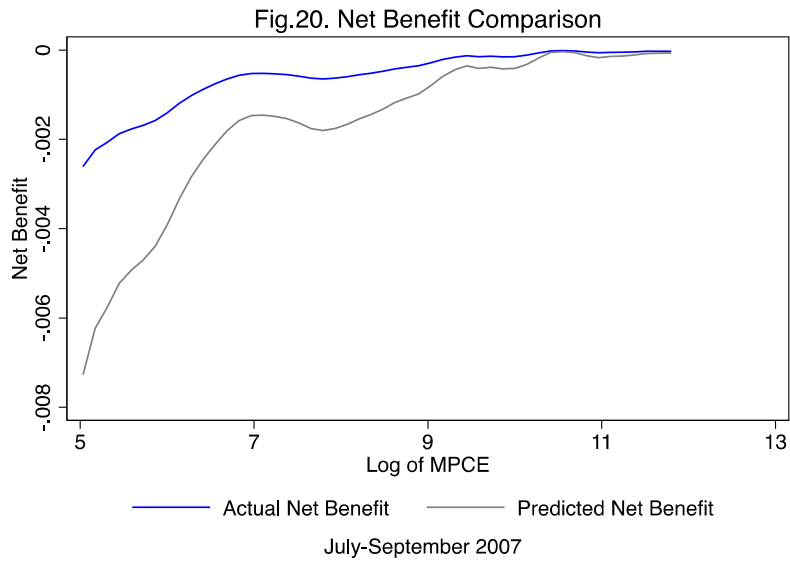
By March 2008 the international rice prices had increased by 100% relative to the June 2007 price levels. In India the rice inflation equalled only 11%. The shift in net benefit pattern is evident in fig.34 as the scale of curves increases drastically for both the scenarios. The gap between the blue and grey curve has also increased. In the absence of the export ban on average the households would have to decrease their living standards as the net benefit declines to -0.1 for poor households. In reality the net benefit did not vary much across households and was less than -0.2.

In September 2009, the international rice prices increased by 18% in comparison to June 2007 prices, while in India the price rose by 34%. The following year the rice price inflation equalled 40% in India, while globally the prices increased by 25%. The figures below show that the price of rice did not fall along the lines of international prices. But the gap between

the actual and predicted curves is around -0.01 for households below lmpce equal to 7 and below -0.005 for households with lmpce above 7.

Fig.22. Net Benefit Comparison

July-September 2009

Fig.23. Net Benefit Comparison

April-June 2010
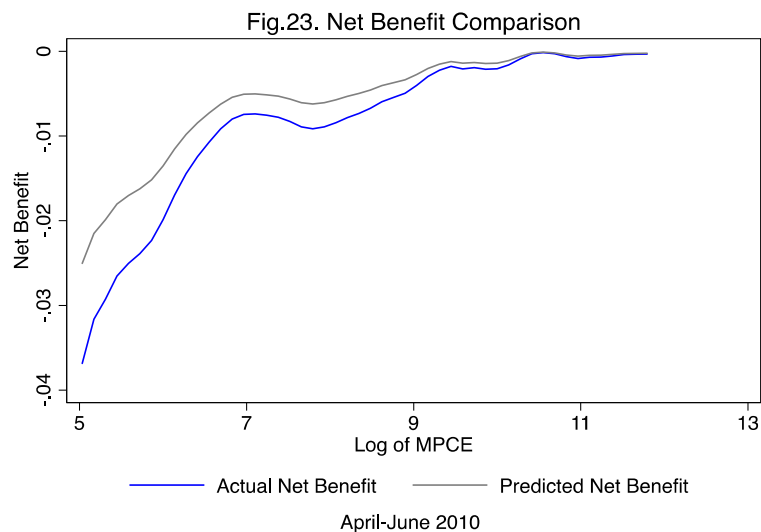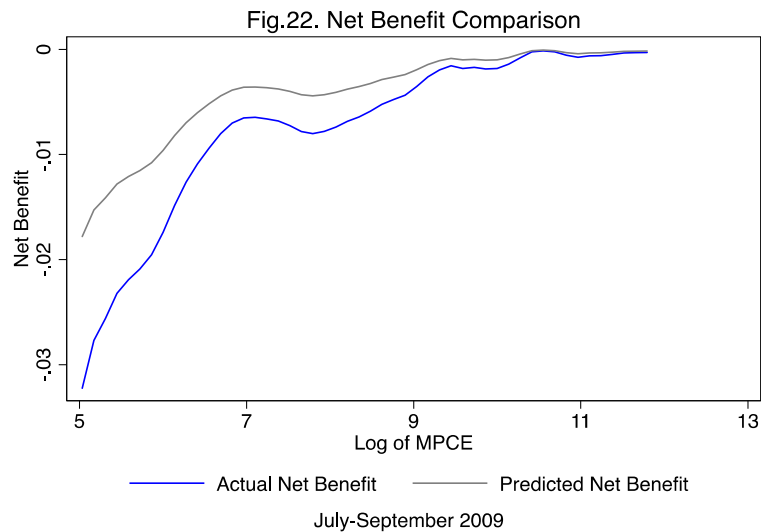
Conclusion

The impact of changing food prices depends crucially upon whether the household is a net seller or buyer of food. The results suggest that 78% of the rural households and 96% of the urban households are net buyers of rice. Thus even though 58% of the Indian labour force depends on agriculture for their livelihoods, higher prices of rice do not benefit the majority. However, the welfare generated by the export ban on rice was positive, as it was able to cushion the Indian population from the adverse effects of the world food crisis of 2007-08. The net welfare was positive mainly for two reasons: firstly, on average the Indian population constitutes of net consumers. Secondly, even though the price of rice in India did not fall in

line with the international prices after the crisis, the net benefit lost was much lower in comparison to the impact of a 150% increase in rice prices.

In terms of identifying the vulnerable groups, the results suggest that the labour class in both urban and rural areas was affected the most, as they belong to the bottom of the pyramid. On average urban poor are worse off as they do not produce for subsistence purpose. Thus policymakers need to pay special focus to this group when considering the impact of agriculture pricing policies.

The extent of impact on the urban middle class is relatively higher than the households with expenditure levels around them, as the frequency of them being a net producer is very low. But these households are more resilient to the change in price as their budget share of rice is lower compared to the rural households.

Compared to Thailand and Mexico where the middle-income households were the beneficiaries of increased price of rice and maize respectively, in India this is not the case. Results suggest this is because rice-producing farmers in India are mainly poor smallholder farmers. 46% of the rural households self-employed in agriculture are rice producers and 43% are sellers. Therefore, not many households in this category produce for subsistence purposes. It is observed that price rise does not only benefit a few large rich farmers but the group as a whole, with the exception of households below lmpce of 5.8, who belong to the OBC and Scheduled Tribe caste.

Also, the welfare generated for rural agrarian households was not as high as we expected, implying that the full benefit of higher prices was not transferred to the farmers. One of the reasons for the world food crisis was the soaring price of oil. The oil subsidies provided by the government did not let the cost transfer to the consumers. However, in the light of the recent policy decisions[41] of the Indian government to reduce its oil subsidies, the price of staples may rise due to the increase in cost of production. However, this rise in price will not reach the producers who are benefited from the increase in price, creating a lose-lose situation for both the consumers and the producers.

It is important to note the rice prices in India were contained due to the prevailing administrative reforms made by the Indian government since independence. Implementation of the export ban of rice was possible due to existing mechanisms. To a large extent the excessive government intervention in the sector has had a positive effect on the consumers. However, the increasing price of rice in 2009-10 while the international rice prices were

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[41] Financial Times (September 2012)

declining indicate that their exist problems more specific to the domestic economy which require the governments attention, such as the public distribution system, storage facilities and reduction in oil subsidies. Thus, the results suggest considerable attention may be needed to protect the vulnerable groups identified.

Appendix

A1. Non-Parametric Estimation of Density and Regressions

A brief description of density estimation and regression is given below to explain the techniques used for the purpose of the paper.

Similar to Deaton I have used 'kernel' estimators. The kernel is a continuous, bounded ad symmetric function K which integrates to unity. Kernel estimators can be used for both density and regression function estimation. This approach allows us to set a bandwidth, i.e., distance between observations; which determines the contribution of the observations to the average at each point.

Sliding a moving band along the x-axis, and counting the number of observations that fall into the bandwidth construct figures 2 and 3. The count is then divided by the number of observations to estimate the density at a given point. In case the bandwidth is wide the curve becomes really smooth and curve loses the details of the underlying data. At the same time if the bandwidth is narrow, the curve is a series of spikes, indicating individual observations. The advantage of the technique used here is that the data are allowed to choose the shape of the function is not a model structure specified a priori that forces the points to lie along a straight line, or along a low-order polynomial.

For example, if we take a kernel estimator and set the bandwidth at 0.25, and at each value of log of monthly per capita expenditure (lmpce) to calculate the average budget share of rice for households whose lmpce is within the 0.25 bandwidth. If we decrease the bandwidth by 0.05, the weighted average will give greater weightage to households whose lmpce value is within 0.20 distance of the value of lmpce being considered.

Formally, the estimate of the regression corresponding to a point X, $\hat{m}(X)$, say, is

$$\hat{m}(X) = \sum w_i(X, X_i)Y_i \qquad (A1)$$

where Xi and Yi are the x and y values for observation i. The (nonnegative) weights wi will be zero for Xi which are not within the bandwidth. Although it is also possible to allow all observations to contribute, but this decreases the weights as the distance between X and Xi increases.

The equation A1 is a kernel estimator when the weights take the specific form

$$w_i\left(X, X_i\right) - K_h(X - X_i) \frac{\square}{\square} \sum' K_h\left(X - X_i\right)$$

(A2)

here Kh is the kernel, and h is the bandwidth. Kh is a symmetric monotone decreasing function that integrates to unity over the range of its argument. K determines the shape of the kernel weights, whereas the size of the weights is parameterized by h, the bandwidth42. A commonly used kernel function43, also used here is of parabolic shape called the Epanechnikov kernel, which is defined by the equation

$$K_h(X - X_t) = \frac{3}{4h}\left[1 - \left(\frac{X - X_i}{h}\right)^2\right] I(|X - X_i| \le h)$$

(A3)

where I is an indicator function, such that I = 1 if X and Xi are within the bandwidth (h) of one another44. If the X and Xi are not within h, I = 0. The 3/4h is not relevant for calculating the weights in the equation A2, but it is required to ensure that the integral of Kh(X-Xi) is of unit value45.

For example, we are interested in estimating the statistical Engel Curve, the average expenditure for food given a certain level of income. The kernel weights depend on the values of the X-observations through the density estimate.

The formulae A1, 2 and 3 are used for all the non-parametric regressions used in the main text, and illustrated in Figs. 4, 17, 18, 27-36 and A6. In Figs. 4 and 26, the dependent variable y is either the rice share or the net consumption ratio of rice. For figs. 17 and 18, where the probabilities are estimated, the dependent variable is either one or zero depending on whether the household does or does not grow and sell rice. All graphs (except for fig.1.) were

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[42] Hardle (1990)

[43] The choice of the smoothing parameter/bandwidth, h, is theoretically more crucial than choice of a kernel function. Most of the asymptotic optimality results of kernel estimation stem from the bandwidth being chosen optimally, that is, to minimize the mean square error. (Budd, 1993, p.601)

[44] Deaton (1989)

[45] Budd (1993), p.601

generated in Stata12. With the exception of few graphs the bandwidth used were defaults used by Stata.

$$L = \prod_{i}^{N} \left[\frac{1}{\sigma} \phi \left(\frac{y - \mu}{\sigma} \right) \right]^{d_i} \left[1 - \phi \left(\frac{\mu - C}{\sigma} \right) \right]^{1 - d_i}$$

Where d is an indicator variable that equals 1 if y < C i.e. the observation is uncensored and is equal to 0 if y= C, i.e. the observation is censored.

The expected value of a censored variable is

$$E[y] = \{P(uncensored) \times E[y|y > C]\} + \{P(censored) \times E[y|y > C]\}$$
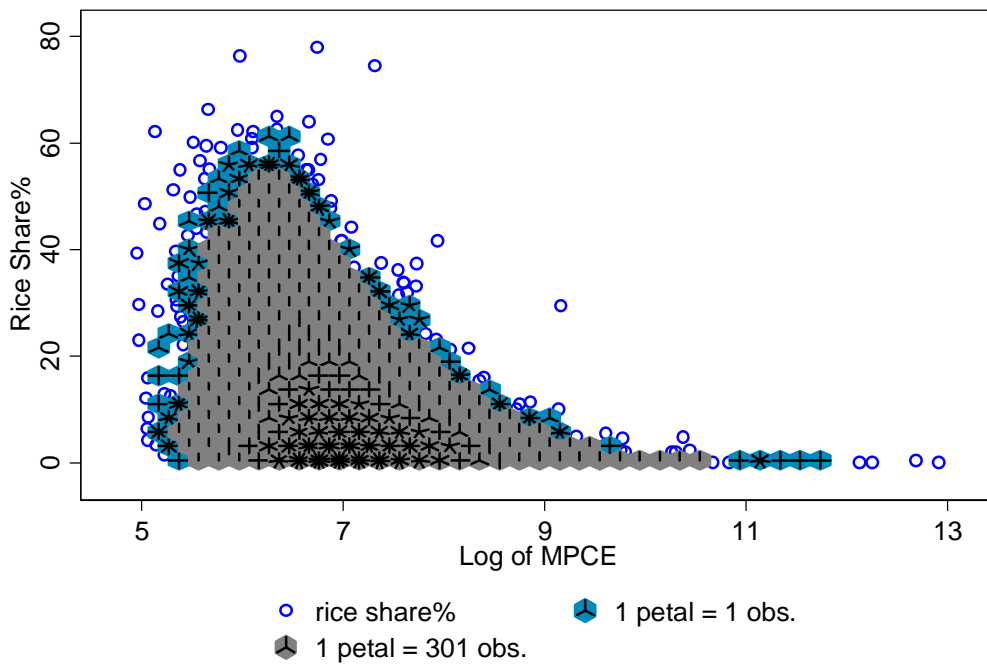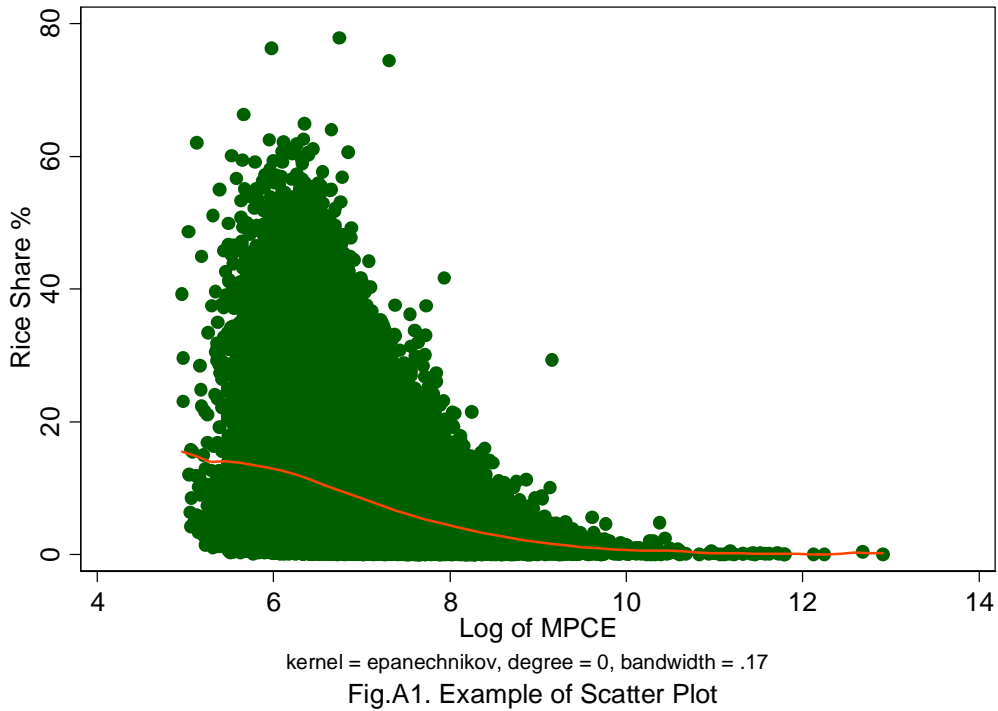
$$= \left\{ \Phi \left(\frac{\mu - C}{\sigma} \right) [\mu + \sigma \lambda] \right\} + \Phi \left(\frac{C - \mu}{\sigma} \right) C$$

Where
$$\lambda = \frac{\phi \left(\frac{\mu}{\sigma} \right)}{\Phi \left(\frac{\mu}{\sigma} \right)}$$

We use the tobit model for censored normal regression and use household characteristics are control variables. After generating the yhat we use the correlate function to see how well related is yhat to the home production values.

A3. Sunflower Plots

kernel = epanechnikov, degree = 0, bandwidth = .17

Fig.A1. Example of Scatter Plot

○ rice share%   🔷 1 petal = 1 obs.

🔶 1 petal = 301 obs.

Fig. A2. Example of Sunflower Plot

The sunflower plot is constructed by defining a net of squares covering the (X, Y) space and counting the number of observations that fall into the disjoint squares. The number of spikes in the hexagon shaped "sunflower blossom" equal to the number of petals in the sunflower. The petals correspond to the number of observations in the square around the sunflower. That is, it shows the empirical distribution of the underlying data. The sunflower plot shows the concentration of the data around an increasing band of densely packed blossoms or the hexagon[46].

Scatter plots of the entire data is very unclear and does not show the areas where the data is concentrated, due to overstriking of plot symbol[47]. It is thus desirable to have a technique that allows us to see the areas where the data is concentrated. The sunflower plot allows us to do so. The graphs given below map the budget share of rice and the log of monthly per capita expenditure (lmpce) for the whole dataset (both rounds). When we compare the local polynomial smooth graph, which is essentially a scatter plot of the two variables we are only able to see the various points where the data is observed. We are also able to the see the regression line cuts the area mapped in the graph in the lower half of the green shaded area, indicating that majority of the observations are in the lower half of the green shaded area. However, when we look at the sunflower plot we can see that the regions where the data is concentrated. This allows us to understand the distribution in a more comprehensive manner. The blue circles depict the individual observations at their exact location when there are less than 3 observations per bin. Light sunflowers are blue and represent one observation for each petal. Dark sunflowers are grey in colour and represent 301 observations per petal. This graph not only shows us the density distribution of the observations, but also allows us to determine the number of observations in a particular region with great precision[48].

 Through this graph we can thus conclude that the budget share of rice as a percentage of the expenditure is concentrated around 20% for households with lmpce between 6 and 8. The sunflower plot also allows us to see the diversity in consumption patterns for households at different expenditure levels. Below the average lmpce levels (7.03) the households are more diverse in the patterns of consumption of rise. The rice share percentage is generally below 40%. For lmpce levels over 8 the rice share percentage drops by half, mostly below 20%. The density of the graph also increases and is generally consistent in terms of the colour. Thus we conclude that the households below the lmpce levels of 7 (mean) are more vulnerable to the change in price of rice as their budget

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[46] Hardle (1990)
[47] Dupont and Plummer(2005)p.372
[48] Dupont and Plummer(2010)p.375

share of rice is more diverse , ranging between 0.004% to 80%. The richer households are fairly resilient to the change in price.

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