The Fight Against Malnutrition: Impact of Public Distribution of Food in India on Consumption of Nutrients.

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Preliminary copy, do not quote or cite.

Abstract

The paper looks at the impact of the public food distribution system (PDS) in India, on the household per capita consumption of calories and proteins. This effect is identified using random shocks introduced into the delivery system of PDS through the impact of rainfall on agricultural output in the state which is the largest supplier of grains to the system. The results suggest that a rise in PDS efficiency has different effect for different regions in the country. Yet, for those who benefit from this system the impact on nutrient consumption and malnutrition is significant and large.

1.Introduction

In the last two decades the Indian economy has experienced a sustained period of high growth.[1] Yet, this economic success has had very limited impact on the incidence of malnutrition in the country. India's child malnutrition levels have been and are still comparable to those in the poorest regions of the world (Gragnolati et al. 2005). Even more alarming is the fact that increasing fractions of the population are slipping below the recommended calorie consumption standards[2] of the government even as their incomes and consumption expenditures are going up (Deaton and Dreze 2009). In the light of this situation, food security has to be one of the biggest concerns for policy-makers.

One recent step taken by the government in this direction is the Food Security Bill 2013. This bill enhances the coverage of the public distribution of subsidised food (PDS) from about 30% of the population to 70%. The move is the latest in a series of government efforts designed to either streamline, re-focus or improve the efficiency of this gigantic public program. From its humble origin as a largely urban based food rationing scheme under British rule, the PDS has now grown into the biggest food security program of the Indian Government, both in terms of its scale,[3] and in terms of the expenditure involved.[4] The important question that is yet to be answered is whether the impact of this program on food security and malnutrition in the country is significant and in proportion to its size and expense. Also, is it possible to achieve the same impact using some other smaller, less

[1] Indian GDP has been growing on an average at more than 5% per annum since the late 1980s.
[2] These standards are 2100 Kilocalories for the urban areas and 2400 Kilocalories for rural areas per person per day.
[3] With more than four hundred and fifty thousand fair price grain outlets spread all over the country.
[4] The subsidy cost to the Central Government was 5.2% of its total expenditure in the 10th Plan period 2002-07. (Source Planning Commission of India)

complicated mechanism? Some of these questions relevant to the PDS debate will be the focus of the present paper.

By most accounts the PDS program is quite popular amongst its beneficiaries.[5] Yet it has been severely criticised for its inefficiency and ineffectiveness by both internal evaluations as well as external agencies like the World Bank and the FAO. For example, it has been pointed out that for every rupee of subsidy passing on to the targeted beneficiary the central government has to spend Rs 27. Also it was estimated that in the absence of PDS poverty in the whole country would have gone up by just 2 percent points, highlighting the ineffectiveness of the PDS in impacting either poverty or food security in proportion to its cost. (Radhakrishna et al. 1997).

Besides ineffectiveness the PDS also suffers from gross inefficiencies mainly due to corruption leading to the leakage of grains into the black market (Jha and Ramaswami 2010). Khera (2011a) estimates that in 2007-08 37.2 percent of the rice and 57.7 percent of the wheat issued to the states for distribution from the central pool, were lost due to diversion. These diversions are generally believed to be the reason why eligible households only consume about 50 percent of their allotted quota (Svedberg 2012, Khera 2011 a, b). Due to such alarming losses many are of the view that the distribution mechanism should be replaced by cash transfers by the amount of the subsidy (Kapur et al. 2008, Kotwal et al. 2011, Svedberg 2012). Others argue that the elasticity of income transfers and the effect of PDS quotas are not equivalent due to the possibility of transferred cash being spent on non-food items (Dreze 2010, Khera 2011b, Himanshu 2011, Cherian 2013). Besides, the

[5] People usually travel the long distances to the PDS shops repeatedly in the hope of getting their share of allocated grain although they are frustrated very often. Khera (2011a)

whole system of procurement and distribution also achieves other state goals like price stability and famine prevention. Nevertheless, everyone would agree that the PDS needs to improve its delivery mechanism[6] and improve its targeting to better serve the needs of the poor.

This paper will attempt to contribute to this debate by answering the fundamental question regarding the relevance of the PDS in terms of raising calorie and protein consumption in the population. In simple terms: What would be the impact of an improvement in the supply of PDS grain on nutritional intake? This efficiency of supply of the PDS could be a measure of the ability of the system to make the allotted amount of food available for the people to buy. The exercise is challenging mainly because of the peculiarities of the PDS system. The government subsidises the grain but also imposes a quota which varies by state of residence, income and over time. Besides, on many occasions, agents are unable to buy their full quotas because of supply-side deficiencies on the part of the government suppliers. This implies that an agent's observed PDS grain consumption is not always her quantity demanded or her full quota (as simple demand theory would tell us), but it may be something rationed by supply failures. This feature may be used to identify the relationship between PDS efficiency and the consumption of nutrients. Factors that may affect the grain delivery mechanism of the PDS would directly influence the amount of grain available for dispensation in the PDS shops. One such factor is rainfall, especially in those areas that are large contributors to the PDS stock. Also stock availability would impact different regions differently. In grain surplus areas locally procured grain may be used in PDS, but in grain scarce areas supplies have to be brought in from outside. A combination of these two is used in

[6] According to Himanshu and Sen (2011) improving delivery is a higher priority than expanding entitlement regarding improving the impact of the PDS.

this paper to identify the effect, after controlling for preferences and demand determinants as best as possible.

There are advantages gained by looking at nutrient (calorie/protein) consumption rather than amount of grains delivered or bought. Firstly, nutrient consumption of the people has to be the ultimate aim of any food-security measure. Secondly, there remains a concern that agents may be buying from PDS shops and then selling them again at higher prices (Bhagwati and Panagariya 2013). Looking directly at calorie consumption should help circumvent this problem. Like all other subsidies, the PDS is also a market intervention and is bound to affect nutrient consumption through various channels including local socio-economic institutions. The first step here would be to properly identify econometrically the net effect of PDS on nutrient intake and then to unravel the mechanisms if possible.

1.1 Institutional Background: Evolution of the Public Distribution System in India

The origins of the PDS go back to the early 1940s during the Second World War. The British regime had introduced rationing of food items due to war time necessities. After independence in 1947 the Government of India decided to continue with the system. According to Dantwala (1993) about 54 million people in the urban areas were covered at this time. The rationale behind urban rationing was that unrestricted markets would draw out food grains from the rural hinterland in times of scarcity. At this stage the main focus was on achieving price stability and preventing famines. Although this approach would soon change, it nevertheless introduced an urban bias in the PDS that would persist for some time.

By 1956, the end of the first five year plan period, it was becoming clear that PDS had to be transformed into a food security program and this transformation took place through the

second five year plan period (1957-1961). The total number of PDS outlets or fair price shops went up from 18,000 to 51,000 (Nawani 1994). Soon the PDS organisation took its present shape with the formation of the Food Corporation of India (FCI) in 1965. Every year the government would announce a minimum support price for food-grains. Any unsold stocks at the declared minimum price would be bought by the FCI and stored. These stocks would then be issued out to state governments for distribution through the PDS and also for maintaining a buffer stock for times of scarcity. The whole country was divided into 5 zones with most of the grain surplus areas located in the North. Today the FCI maintains a huge stock of over 54 million tonnes of food grain and distributes throughout the country via 492,000 fair price shops (11th plan, Planning Commission of India).

After the liberalisation of the Indian economy in 1991, the PDS came back into policy debates mainly because of the huge subsidy burden it was imposing on the government. The total subsidy for running the program had gone up from 0.04% of GDP in 1970-71 to 0.5% of GDP in 1991-92. At this time there were a number of reviews of the PDS and its working. These studies highlighted the large expense being incurred for very small gains. Various recommendations were made for targeting subsidies to the poor in order to curtail the subsidy burden (Ahluwalia 1993, Parikh 1994, Radhakrishna et al. 1997, Dutta and Ramaswami 2000, 2001, Indrakant 2000). Responding to the criticism, the government decided to go in for targeting by income. In 1997 the Targeted Public Distribution System (TPDS) was introduced. This scheme offered 10 Kgs of grains per month to households below poverty line (BPL) at half the cost of procurement to the FCI. At the same time subsidies for households above poverty line (APL) were totally eliminated. The quota for BPL households was eventually raised to 35 kgs per month in 2002. Also many state governments have

tinkered with PDS entitlements on their own. For example Tamil Nadu persisted with the universal PDS system while states like Andra Pradesh and Kerala have reduced their quotas. A good summary of these changes can be found in Khera (2011b), Planning Commission (2005).[7]

In spite of these changes the problems with the PDS still persist. According to the Planning Commission's report for the 11th plan, subsidy cost for maintaining the PDS has gone up from Rs. 51.7 billion in 1996-97 to Rs. 238.3 billion in 2006-07 which is more than an increase of 3.5 times. Also identification of the poor has not been done well by the state governments. According to the Planning Commission's survey report, although uptake by poor households were much higher than previously, only about 57% of the BPL families were being covered by the targeted PDS. Errors in identification exist both in inclusion as well as exclusion with many "ghost" BPL cards going around.

As a remedy to the targeting problems the Government came up with the latest legislation in 2013, increasing the coverage of TPDS to 70% of the income distribution in the rural areas and 50% in the urban areas. Each household will be entitled to 5 Kgs of grains per month at very subsidised prices for the next three years. These changes might bring about a more significant improvement in food security in the future but it is unlikely to be simply due to a rise in entitlement. One major issue is the delivery mechanism and the leakage of grains to the black market. This problem needs to be addressed and some suggested methods are cash transfers or cash cards that take the distribution mechanism out of the equation entirely.

[7] See also the article "Simplifying the food security bill" published in the Hindu Newspaper on 12 March 2012. http://www.thehindu.com/multimedia/archive/00948/Simplifying_the_NFS_948744a.pdf

The main focus of this paper, however, is not to suggest wholesale changes or improvements in supply mechanism but to exploit exogenous changes in supply to estimate the effect of current PDS consumption on nutrition.

1.2. Motivating the Empirical Setup

As mentioned before the objective of this paper is to estimate the effect of PDS grain on the consumption of nutrients by utilising exogenous shocks to PDS supply while controlling for demand related factors as best as possible. This section attempts to explain the economic logic behind this approach and the assumptions required for the purpose. Also, the composition of the sample to be used for analysis is discussed.

The PDS grain consumption that we observe is the outcome of optimization by the households. One of the key determinants of this optimum quantity would be the household's income. Figure 1 plots a kernel estimation of PDS grain consumption as a function of monthly per capita consumption expenditure (MPCE) separately for the years 1999, 2004, 2007 and 2009. There seems to have been a change in the basic shape of these estimated functions after 1999. The 1999 curve rises with income almost until the poverty line and then starts to decline gently. However none of the other three years have the initial positive slope (at least not for any significant range of incomes[8]). After 2000 the curves have more or less the same shape but they are shifting upwards over time indicating that PDS consumption has grown for all levels of income during the last decade. The change in the shape of the function after 2000 seems to indicate a structural change which is possible. Note that 1999 is the only year in this sample where targeting allowed only 10 KG of subsidized grain to BPL

[8] For 2009 there is a rising portion for a small range of the lowest incomes.

households. After 2002 this limit was raised to 35 KG and various states started implementing their unilateral PDS reforms. Almost all of these were in effect by 2004.

Figure 2 is a stylized representation of Figure 1 for purposes of illustration. One needs to acknowledge that there may be two groups of consumers in the sample based on whether they think the PDS is an inferior good or not. Suppose the household with income Y_p, is the income for which PDS grain consumption peaks. Any household with income less than Y_p, for example Y_n, would be treating PDS grain as a normal good. Similarly households to the right of Y_p, like Y_i, will consider PDS grain as an inferior good. However it should be pointed out that households like those with income like Y_n are very few in the sample.

Next let us analyse how these different households might react to an exogenous supply shock to PDS grain. While we expect the demand for PDS grain to be some sort of downward sloping curve in price, the supply curve is dictated by the amount of the quota and the price at which this quota may be bought. The supply curve facing any particular household is contingent upon its income status (APL/BPL) and the state in which it is situated. However, in general the supply function would look something like the curve labelled SS in Figure 3. This figure represents demand and supply of PDS grain for a representative consumer who is allotted a quota of Q kilograms of grain at price P. The quantity supplied is anything between 0 and Q at price P, however at all other prices quantity supplied is 0. This is the supply curve in an ideal situation. But, as described earlier, PDS is seldom able to deliver the promised amount of grains to its consumers due to large scale illegal leakage into black markets. Also buying from the PDS is associated with travelling long distances to reach the Fair Price Shop (FPS) and standing in long queues and then often returning empty handed. In other words, the effective price paid by the consumer is higher than the

official subsidised price. Also, the quantity available for collection is below the quota amount Q. In Figure 3 this is represented as a shift of the supply curve from SS to SE. Now Q_e is the maximum amount available to the consumer and this at an effectively higher price of P_e.

Next we would like to investigate the implications of a positive supply shock to the PDS. In such a case we may imagine that the effective price falls to P_{e1} and quantity available for collection goes up to say Q_{e1}. This means that the supply curve now shifts down (as indicated by the arrow) to SE1. Now consider two different households represented by their demand curves DD and D1.

If these consumers are from the region to the left of Y_p from Figure 2 then DD represents the household with higher income amongst the two. If on the other hand the they are from the range of income to the right of Y_p then D1 is the household with higher income. In either case, however, it is clear that the supply shock leads to higher consumption of PDS grain. Such a supply shock therefore, will lead to an upward shift in PDS grain consumption, as shown in Fig. 2. This observation motivates the empirical specification used in this paper. The supply shock introduced into the PDS system by random rainfall shock in PDS grain supplier states is used to identify the effect of a rise in PDS grain consumption on nutrient consumption in households. Of course, this approach relies on being able to control for the factors affecting the demand curve.

In this exercise the sample restricts attention to households who have a clearly defined PDS entitlement. This excludes agents who do not own a ration-card and are ineligible to buy from the PDS, as well as those who chose not to buy from it. The latter category can again be

sub-divided, based on the possible reason for their choice. The richer households may choose not to consume PDS grain considering it to be of inferior quality. On the other hand, the very poor might be unable to buy from the PDS due to income constraints. However given the drastically subsidised prices of PDS grain (ranging from Re 1/KG to Rs 5.5/KG for households below poverty line (BPL)), it is unlikely that a household will be income constrained to buy at least a portion of its allotted quota. To put this in perspective, consider that the highest possible expenditure on PDS grain for a BPL household is Rs 210 per month (if the highest quota is purchased at the highest price). The official poverty line income per day according to the Planning Commission is Rs. 26-33 per capita per-day, which is a monthly household income of about Rs 2400 assuming a family of three. Therefore, the proportion of households dropping out because of income constraints is likely to be small.

2. Data

National Sample Survey Data

The first exercise is to estimate the impact of PDS grain consumption on calorie/protein intake. For this I use the NSS consumption data from rounds 66th, 64th, 61st and 55th (2009, 2007, 2004 and 1999 respectively). These are mostly the large rounds making the combined sample of more than three hundred and fifty thousand households. This is a very detailed consumption survey at the household level whose sampling method makes it representative at the district, state and national levels[9]. Both quantity and value of consumption are reported in most cases making it possible to calculate nutrient consumption on the one hand and also the price paid by the agent by dividing the value by the quantity.

[9] The 55th round is representative only at the region level which is an intermediate division between the district and the state specially used by the NSS.

The nutrient consumption tables used in this exercise are the same that are used by the NSS and the original source is Gopalan et al. (1991). Data set also provides demographic and household characteristics of the surveyed households.

In the entire sample, about 24% households bought rice from the PDS and about 13% bought wheat. The total number of households who bought anything at all is about 86,000. This number is expected to be far less than the number who are eligible to buy. There is no data about possession of ration cards (cards that show eligibility for PDS) in the 66th round about 76% have ration cards amongst the households sampled in the 61st round. As such it is difficult to identify the households below poverty line (BPL). The best that can be done is to infer the type of household by checking the price paid since it is known that BPL household receive a subsidised price. This information is used to build the main variable of interest which is the gap between allotted quota and uptake of grains. Quotas vary by state, income and type of grain. The source for information about PDS quotas used for this exercise is Khera (2011b), Planning Commission (2005) and the article "Simplifying the food security bill" published in the Hindu Newspaper on 12 March 2012. Although the best efforts were made to ensure accuracy, it has to be admitted that the available information leaves some room for confusion in some cases.

Another issue is the problem of identifying all households who have access to PDS. As described earlier there is no information about ration card holdings in the 66th round data. So most of the analysis here is conducted on a restricted sample of households who have reported some quantity purchased from the PDS. The potential selection problem here arises from people who are eligible yet choose not to consume. But the identification strategy (as hinted at in the introduction) would rely on supply shocks to the PDS and these people would

be unlikely to be affected by these shocks anyway. Besides, by restricting the sample it is made certain that the household has access to a fair price shop and has a ration card.

The summary statistics for some of the key variables for this restricted sample is reported in Table 1a and Table 1b.

There are two interesting aspects in Table 1a. Firstly there are is a clear difference between the sample of PDS users in 1999 and those after 2004. The 1999 sample has a higher consumption of nutrients as well as consumption expenditure. It is possible that the reforms introduced from 2002 onwards had a significant impact on the composition of PDS users. The second interesting aspect is that excepting the year 1999 the sample of PDS users have slowly grown poorer. This could be because the government's constant efforts to achieve better targeting have finally started to show some effect. The gap between quota and uptake is calculated only for households with a clearly defined PDS entitlement. In 1999 only the BPL households had this entitlement and it was equal to 10KG. So the gap is lowest in 1999. Note that APL households may still be purchasing from the PDS in 1999 and BPL households may purchase more than their quota at non-subsidized prices. So average uptake may very well exceed the quota. However in the subsequent analysis only households with defined PDS entitlements will be included.

After 1999 we see that the quota uptake gap has grown. This probably reflects further extension in quotas rather than reduction in uptake. As can be seen from Table 1a, average purchases of rice and wheat from the PDS have been relatively stable.

3. Empirical Strategy and Results

3.1 OLS

We begin the analysis with a pooled OLS estimate where the main variables of interest are household intake of rice/wheat from the PDS and the difference between quota allotted to the household and total uptake.

The equation to be estimated is as follows:

$$Cal_{idts} = \alpha_0 + \alpha_1 QUD_{idst} + \alpha_2 X_{idst} + \delta_s + \tau_t + \theta_{st} + \varepsilon_{idst}$$

Here Cal_{idts} represents the Monthly Per Capita household consumption of calories or proteins in logarithm for household *i* in district *d* in time *t* in state *s*. QUD_{idst} is the main variable of interest. It is either PDS uptake of rice or wheat or the difference between the quota of food grains and the uptake of grains for household *i* in district *d* in time *t* in state *s*. δ_d and τ_t are state and year controls, θ_{st} are state-time controls, X_{idst} are household level economic and demographic characteristics and ε_{idst} is the error.

A number of control variables were included in the estimated specification so as to control for other demand and supply shifters for PDS grain. Firstly there is the set of state fixed effects to control for time invariant state specific effects. Khera (2001a) notes that states can be classified according to their PDS consumption into good, bad and improving. Obviously some states have had a reputation about PDS and these factors have to be taken into account. Also, we know that states have started introducing state-specific reforms to their PDS. Thus it is required to have a state-year fixed effect as well as a year fixed effect. Income is proxied using monthly percapita consumption expenditure as is the general practice in the literature

that has used NSS data. Prices of PDS grain and their open-market substitutes make up the set of price controls. Lastly there is a set of household level controls. There are controls for the number of adults/females in the household, main occupation, landownership, rural/urban, method of lighting/cooking, religion/caste as well as an indicator to show if the household engaged in home production of any of the consumed food items.

The results are reported in Table 2. The sample is restricted to only those households who have a well defined PDS entitlement. However, even if the sample expanded to include all who have purchased anything from the PDS (even sugar) the results are qualitatively the same. There is no significant impact of reducing the quota-uptake gap on either calorie or protein consumption. In fact even we remove the quota calculation and just look at PDS rice and wheat consumption there is no discernible effect on calorie consumption.

3.2 Omitted Variable Bias and the Instrument

If the PDS is to be evaluated on the basis of its impact against malnutrition the pooled OLS results from Table 2 are anything but encouraging. However, it is true that the results are only an average over the entire population. It is quite possible that the PDS is effective only at lower levels of income. If this is true a quantile regression approach may be more appropriate here. But that aside there are still other areas of concern regarding the estimates from Table 2.

One major concern regarding identification is the presence of omitted variables that might have prompted agents to self-select into the sample. Firstly, there are many government

sponsored welfare programs running at the same time (for example NREGA and IRDP[10]). Suppose a politically well connected household has better access to all these programs. Then the political connection variable may explain both higher access to PDS and higher calorie consumption giving us a spurious correlation. The other side of the story is that a politically marginalised households may have very low access to resources and be forced to consume from the PDS which may be looked upon as an inferior good. In either case calorie consumption and PDS efficiency will be found to be spuriously correlated. These factors essentially cause a selection bias where a particular kind of households (e.g. politically aware or well connected) get self selected into the sample. In order to circumvent this potential problem I need an exogenous variation in the quota-uptake difference which will not be correlated with these unobservable factors. Now I will describe the instrument I use for this purpose.

The PDS in India works by procuring grains directly from the farmers and then redistributing them at subsidized prices through fair price shops. As mentioned, for procurement the government declares a minimum price each year and buys up all the grains offered up at that price. This operation of buying, storing, and supplying the grains is done by the Food Corporation of India (FCI). Among the states, Punjab and Andhra Pradesh have been the biggest suppliers of rice to the FCI, whereas the supply of wheat is heavily dominated by Punjab (see Fig. 4 a and b). The salience of Punjab as a supplier of the FCI leads one to expect that any variation in the agricultural production of Punjab would affect the stocks of food grains with the FCI and in turn the supply of grains at the fair price shops.

[10] National Rural Employment Guarantee Act (NREGA) promises 100 days of employment at minimum wages. Integrated Rural Development Programme (IRDP) provides loans to poor households at subsidised rates.

The variation in agricultural production is determined by various factors. Of these some are totally random like rainfall. Although Punjab is a state with large tracts of irrigated land (one of the reasons why it produces large surpluses to be sold to the FCI), its agriculture is still rain dependent. One of the reasons for this is that irrigation itself is rain dependent. Drought years may adversely affect agricultural output. Hence we should observe a link between the rainfall in Punjab and the availability of PDS grain in all states in that year. This variation in rainfall in Punjab is what I will be using to instrument for PDS leakage.

For this purpose I construct a variable using rainfall data from the state of Punjab over the time period 1990-2009. The data is available at the website of Indian Institute of Tropical Meteorology.[11] For each of the years I construct a metric for above average rainfall by subtracting the average rainfall over two decades i.e. 1990-2009, from the current year's rainfall.

Two assumptions are made in this argument. First, I am assuming that rain has some effect on the agricultural output in Punjab. This may be safely assumed for most areas in India since Indian agriculture is notoriously susceptible to the vagaries of the monsoon. Yet, Punjab is one of the states where irrigation through canals and pumps is used a lot, hence there might be some suspicion that the rain dependence of Punjabi agriculture may have lessened somewhat in recent years. To test this I looked at the total value of rice and wheat production in Punjab from 2004 to 2010. The correlation coefficient between these figures

[11] The rainfall data may be downloaded free from the website of Indian Institute of Tropical Meteorology at: http://www.tropmet.res.in/

and my rainfall metric is 0.16 and 0.17 respectively. So although it is true that agriculture is not as rain-dependent as it used to be earlier, there is still positive relation between the two.[12]

Another link to be examined is whether an increase in agricultural production in Punjab also causes larger uptake of grains from Punjab by the FCI. Here as well there may be some subtle reasons to question this very innocuous looking assumption. For example: in a year when rains are good in the entire country Punjab would have high output, but there would be extra grains to be brought up from other states as well. In such a scenario it is possible that in good years less grain may be picked up from Punjab and more from other states which are more dependent on rain. In years of low rainfall the bulk of FCI purchases are brought from Punjab which is less rain dependent and more mechanized in its farming techniques. But once again I find that the correlation between the uptake from Punjab by the FCI and value of total production is 0.43 and 0.28 for rice and wheat respectively for the years between 2004 and 2010 (Source Ministry of Agriculture and Cooperation website, Government of India). So the assumptions involved in the argument for the instrument seem to be valid.

The Punjab rainfall instrument has a major disadvantage, however, which is that it varies only by year. This means that, with this instrument, year fixed effects and state-year fixed effects cannot be used. Also, in India rainfall is often determined by the quality of the monsoon,[13] which is liable to affect rainfall all over the country. Thus rain in Punjab may be correlated with rain in other states, which in turn may have a bearing on consumption of nutrients in those other areas. So it is essential that state-year fixed effects be used.

[12] Due to the rampant use of pumps for irrigation, some of the areas in Punjab are facing salinity and water table depletion.
[13] The seasonal winds from the sea which bring rain after the summer are known as the monsoons.

One solution to this problem would be to interact the basic rainfall metric with some other variable which varies at the region, district, or household level which could enhance the effect of the original variable. A similar strategy was used by Nunn and Qian (2012), where they try to estimate the impact of U.S. food aid on conflict in Africa. Here they instrumented for US food aid by an interaction between US agricultural production and the propensity for a country to partake of US aid as represented by their average receipts of aid. In the current setting, a similar strategy would be to use the differential impact of Punjab's rainfall on the different zones that the PDS apparatus is divided into.

Zonal variation in PDS grain supply

One of the main functions of the Food Corporation of India is to move food-grains from the surplus areas to the deficit areas. It is perhaps due to the good work of the FCI that the threat of famine has largely disappeared from the country. For this purpose, FCI divides the country into five zones which are North, South, East, West and the North-East. The North zone includes the states of Punjab, Haryana, Uttar Pradesh which happen to be the major grain surplus states both for wheat and rice. The South has states like Andhra Pradesh which is a big surplus state for rice, but the others like Tamil Nadu, Karnataka and Kerala are more or less neutral. In the East, West Bengal and Orissa do have surpluses from time to time but would be best described as self sufficient. Most of the grain deficit areas fall in the West and North-East zones. As such there has to be a lot of movement of grains out of the North zone into the West and the North-East.[14]

[33]North East zone has Assam, Manipur, Meghalaya, Arunachal Pradesh, Mizoram and Nagaland.

This structure and the distribution of the surplus and deficit areas leads us to expect that any rain shock to the Punjab would lead to differential impact on PDS supplies in different zones. We would expect the biggest improvements to happen in the grain deficit areas and only marginal or no improvements for the East or South.

The patterns in inter-zone grain transfers by the FCI become more apparent when we look at the figures representing planned and actual despatches of grain into and from various zones. These figures for the year 2012-13 are presented in Tables 3a and 3b. Table 3a shows amounts of inter-state grain transfers by the FCI into states belonging to the five zones. In terms of total volume of transfers the North-East definitely receives less than the other zones, but this is not surprising considering that only about 3 percent of the total population of the country lives in this zone. The size of the population in the other zones is clearly reflected in the amounts of the grain transfers they get. However it should be noted that for all zones except the North-East these figures are liable to include intra-zone transfers as well, that is transfers from other states belonging to the same zone. Also the fact that most of the states belonging to the North are surplus grain producers is reflected in the relatively low inter-state transfers into these states.

Table 3b on the other hand, shows where the grain dispatches are coming from. While there exists at least one state in each of the four big zones which contributes a non-zero amount to the PDS stock in other states, there is no contribution of this kind from any state in the North-East. This is hardly surprising if one takes into account the very low amounts that are procured by the FCI from the North-East. Procurement of rice by zones is shown in Figure 5

for the years 2000 to 2010.[15] The procurement of rice from North-East is almost negligible when compared to the other zones. So it is perhaps safe to assume that the North-East would be totally dependent on other states for its PDS supplies. In particular it should be dependent on the North which is not only the biggest supplier of grains but also sends out a lot of grains to other states (Table 3b). At the same time the North receives very few inter-state grain transfers (as evident from Table 3a) indicating that most of the grains sent out from the northern states (like Punjab) end up in states outside the North zone.

The North-East zone is of special interest to this exercise for a number of reasons. First, it happens to be a low producer of food grains and hence is largely dependent on the surplus zones for its supplies. On top of that the North-Eastern states are quite remotely located and as such provide ample opportunities for illegal diversion of food grains into the black market while the grain is being transported. This conjecture is consistent with the findings of Khera (2011a) who reports that over 80% of the grains allocated to the state of Assam never reach the intended target. Table 4 reports some descriptive statistics of key variables in the NE zone along with the change from 2004 to 2009. The first thing that is striking in Table 4 is that the 2009 sample is more than double the 2004 sample. This indicates that the probability of finding a PDS user in the 2009 North-East sample is much higher than the corresponding 2004 sample. This could be due to various reasons both year specific (high agricultural produce in the year) or state specific (drastic reforms in the PDS in the North-East states). However, the larger 2009 sample has a lower consumption expenditure. Although poorer, the 2009 sample has about the same calorie and protein consumption. In 2009 people also have

[15] The corresponding figure for wheat is not shown since the North and the states of Punjab and Haryana always make up more than the 90% of the procurement while the South and North-East do not contribute at all.

significantly lower PDS rice consumption and derive a lower proportion of their calories from the PDS.

3.3 Exclusion Restriction

This interaction between zones and the Punjab rain metric is to be used in a two stage least square estimation as an instrument for quota-uptake difference. The main identifying assumption here is that the differential impact of Punjab rainfall on the PDS supply in the different zones is the only way it can affect calorie consumption in households. In order that this assumption is not violated a number of precautions have been taken. Here the main concerns about the validity of the instrument are discussed.

The first concern is that rainfall in Punjab could affect calorie consumption independent of its effect on PDS efficiency. It is possible that higher rainfall in Punjab causes a nationwide shock to the markets which affects agricultural output, agricultural prices and economic activity all over the country. This might be another channel affecting calorie/protein consumption in other states apart from its effect on the efficiency of the PDS. However these concerns are taken care of through the state-year fixed effects which control for state specific shocks for each year. Also prices of PDS and open market food grains (rice and wheat) and sugar are controlled for to ameliorate the effect of unobservables on the grain market.

Also, rain in Punjab may be correlated with rain in other states which may cause a boom in these states as well. From Figure 1 we know that a negative relationship exists between income and PDS consumption, hence we may expect a boom year to drive down PDS uptake in that year. This may lead to confounded results from the 2SLS estimation. In order to

address this concern the first step is to exclude Punjab and some other states which are close to it (like Haryana and Himachal Pradesh etc.) from the sample since in these states we would most likely be picking up the effects of rainfall on local conditions rather than PDS efficiency. For the rest of the states it is unlikely that rain in Punjab would directly affect local conditions. However, rainfall in Punjab may be correlated with rain in these other states through the quality of the monsoons in that year. This year specific effect would be taken care of using the year fixed effect and the state-year fixed effects.

There is still another possible scenario where the identifying assumption may be violated, which is when rainfall in Punjab causes supply spillover effects which are zone specific (apart from the PDS generated effects). However, this is unlikely since the zonal partitioning is, to the best of my knowledge, particular to the PDS only. No other government programme uses this partitioning system to either distribute resources or to fix target groups. As such it is difficult to imagine reasons why any spillover effect would be zone-specific. If there are spillovers dependent on geographical features or nearness to Punjab then the year state effects should absorb that as well. A zone specific spillover effect, if any, would most likely be caused by the resultant surge in PDS supply itself. Although with the current approach this effect cannot be disentangled from the main effect, it may be argued that any attempt to measure the effect of rise in PDS supply on calorie consumption should include any spillover effects of a rise in PDS supply to that region anyway.

3.4 Two Stage Least Squares

So now, the first stage of the 2SLS is given as follows:

$$QUD_{idstj} = \alpha_0 + \alpha_{1j}\left(PunRF_t \times \sum_j ZN_j\right) + \alpha_2 X_{idstj} + \delta_d + \tau_t + \theta_{st} + \sum_j ZN_j + \varepsilon_{idstj}$$

Here $PunRF_t$ is Punjab's rainfall, measured as described above, in the current year. Variables are now also indexed with the PDS zones which is represented by j. $\sum_j ZN_j$ is a set of dummies that indicate which zone the household belongs to (j takes five values indicating the five PDS zones). Two separate specifications are run, differentiated by the set of dummies used for the instrument. In the first specification only the NE dummy is used, which makes it a comparison between households in the NE zone to the rest of India. In the second specification all dummies except North are used, which implies a comparison of the different zones with North as the reference group. Also, the dummy for the respective PDS zones is also controlled for directly in each of the regressions. Standard errors are clustered at the year-zone level.

The first stage results are reported in the first column of Table 5. All the coefficients of the interaction of the zone dummy and the Punjab rainfall metric are negative and significant indicating that rain in Punjab increases efficiency of PDS delivery in all the zones. For example, the coefficient of the North-East dummy and the rainfall metric indicates that for every 1 centimeter of rainfall in Punjab in a year, quota-uptake gap in the North-East zone reduces by .24 KG. Apart from the significance of these interaction terms and the joint significance of the first stage the magnitude of the coefficients are also of interest. We can

tell from the size of the different coefficients that the rainfall metric influences PDS efficiency in the North-East the most. This interaction has the highest coefficient in terms of magnitude and this finding is consistent with our expectations given the details about this zone presented earlier.

The second stage results are reported in the last two columns of Table 5. The coefficients of quota-uptake are negative and significant providing evidence to support the claim that PDS supplies or efficiency is positively related to calorie consumption at the household. These results imply that a fall of one kilogram in the quota-uptake gap leads to a 0.45 percent point rise in calorie consumption (about 9 Kcal at the average). The magnitude of the coefficient is smaller than those obtained by OLS in Table 2 which is perhaps because the OLS results were upward biased due to the self selection of households with better access to PDS and other public resources. As discussed earlier, this may have been due to their better knowledge about these availability facilities or their better connectivity in the circles of political power .

On the basis of the evidence presented here it is still difficult make an unambiguous statement on the effectiveness of the PDS. The strongest and most robust specification estimated here tells us that PDS efficiency does have a positive impact on calorie consumption. Using these estimates it is possible to make rough evaluations of the impact of the PDS on the current sample of PDS users. For example, in the event that the PDS is scrapped the quota-uptake gap would go up in this sample from 9.81 Kilograms per month to about 30. This is because PDS consumption would become 0 and the average uptake of wheat and rice from the PDS in this sample is about 19 KG. This would lead to a fall in calorie consumption by more than 8.5 percent or by an absolute amount of 175 kilocalories

per day. The average calorie consumption which was just more than 2000 Kcal/day would now go down to just over 1825 Kcal/day.

However the above figure is liable to be an overestimate because funds that were previously used to buy from the PDS could now potentially be used to buy its substitutes from the open market. One crude way to take this into account would be to calculate the average amount of money freed by the absence of the PDS and calculate the impact of this amount on calorie consumption using our coefficient on consumption expenditure. We can also compute the actual subsidy provided by the government to BPL households by subtracting the central issue prices of the BPL from the APL. So we can add to the income effect from above the impact of giving the households a cash transfer equal to the amount of the subsidy. Even after controlling for all this the loss in per day calorie consumption using the estimates and averages from this sample is still about 145 KCals, which is 7 percent of the average calorie consumption in the sample.

Discussion

Although the findings from this paper are not enough to make a categorical statement about the viability of the PDS, it is still interesting that reducing inefficiencies in PDS delivery does have some impact on the consumption of nutrients. The finding prompts further enquiry into the possible mechanisms through which this gain in nutrient consumption is being achieved. One of the consequences of more subsidized grain being available at the PDS fair price shops is that open market purchase of cereals will come down. This is confirmed in the first column of Table 6 which runs the same IV estimation with total open market grain purchase as the dependent variable. The coefficient indicates that for every kilogram fall in

the quota-uptake gap about half a kilogram of open market grain purchase gets whittled away. The magnitude of the effect is consistent with the fact that open market grain is in general more expensive than PDS grain. However, the savings derived from the reduction in open market cereals purchases do not seem to be flowing into consumption of any commodity other than PDS cereals. This can be surmised from columns 2 and 3 from Figure 6 which runs the IV specification with food share of expenditure and food expenditure as dependent variables. There is no discernible effect on either of the two variables. This same specification was also run with expenditure on pulses, egg, meat, fish and oil as dependent variable. In either case no significant effect was found.

4. Conclusion

The paper sets out to characterize the relationship between efficiency of delivery of the PDS and consumption of nutrients in households. Although a simple pooled OLS analysis does not yield any significant results the instrumental variable analysis clearly shows that there is a significant negative correlation between PDS inefficiency and both protein and calorie consumption. This instrument is based on the random variation in PDS supply introduced into the system by rainfall shocks in the largest supplier state Punjab. This is then interacted with zonal dummies. The zones are a part of the organization of the Food Corporation of India which divides the country into five zones to facilitate the flow of grains from surplus to deficit areas.

The other thing that this paper sheds light on is the nature of inter-regional relationship in the PDS. While the North zone is the biggest supplier of excess grains, NE and West are the most significant beneficiaries. While the South and East are quite self-sufficient and also

efficient in terms of their PDS, they are not major users of excess bounty from the North. As such, outcomes in certain regions respond more than others if PDS is changed or modified. Since NE and West are more food insecure than the rest, it would be useful for policy makers to keep this in mind.

From this evidence it does seem that the PDS is having significant impact against malnutrition . However it is yet to be seen whether the price the government is paying for this benefit is worth it or not. Counterfactuals where the PDS is replaced by direct cash transfers may also be estimated in future research by actually estimating demand functions for PDS grain.

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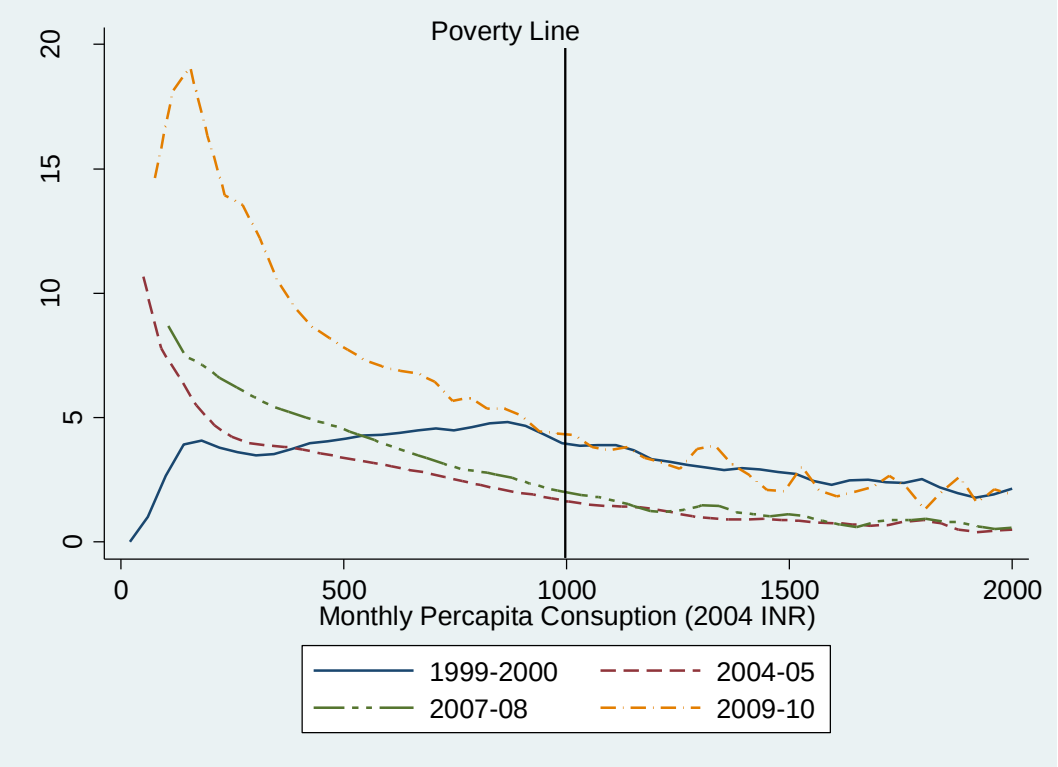
Tables and Figures

Figure 1: Kernel estimation of PDS uptake as a function of income.



Notes: These lines depict the relationship between PDS grain consumption (wheat and rice) and Monthly Percapita Consumption Expenditure. The relationship is estimated by local polynomial smoothing. The kernel function used is Epanechnikov and the degree of polynomial used is 1. This estimation was done only on households with MPCE less than or equal to two thousand rupees. The vertical line at the ten thousand rupees mark indicates the official poverty line for India according to the Planning Commission.

Source: NSS rounds 55, 61, 64 and 66

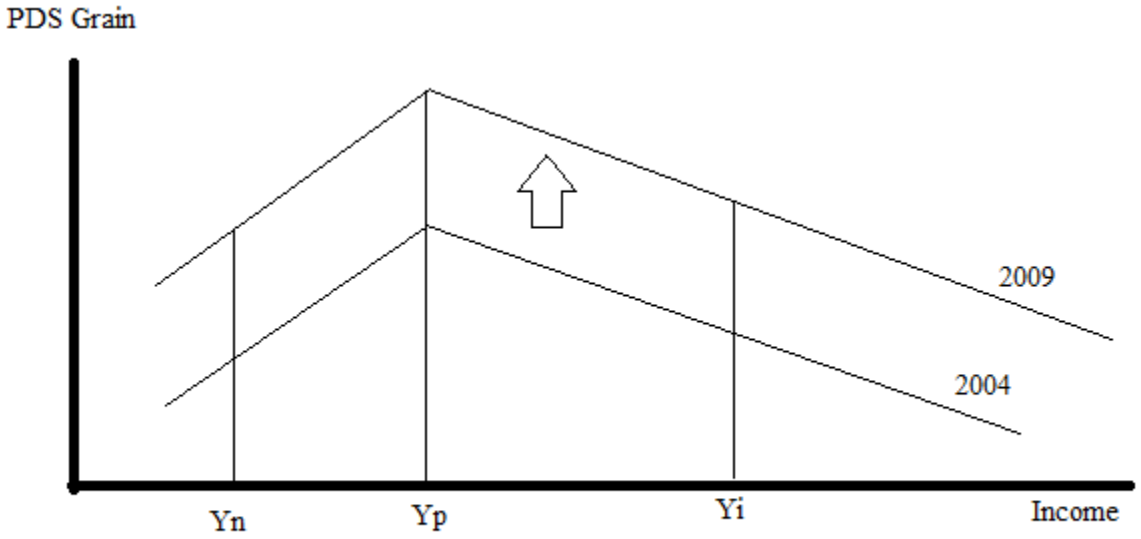


Figure 2: Schematic diagram of the relationship between income and PDS grain

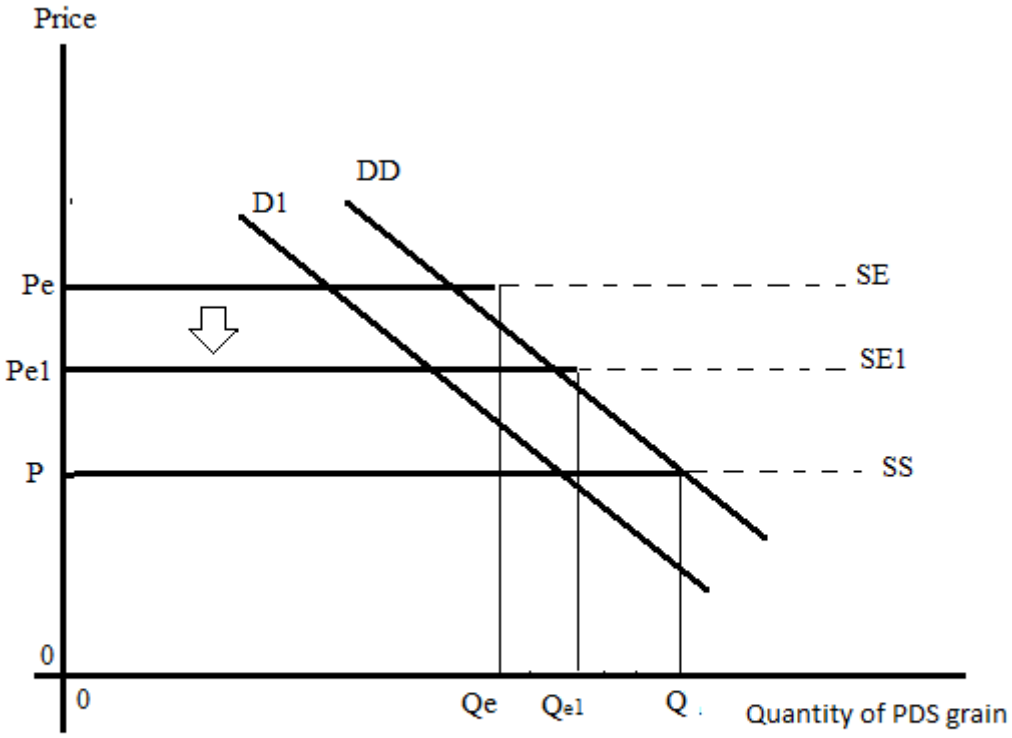
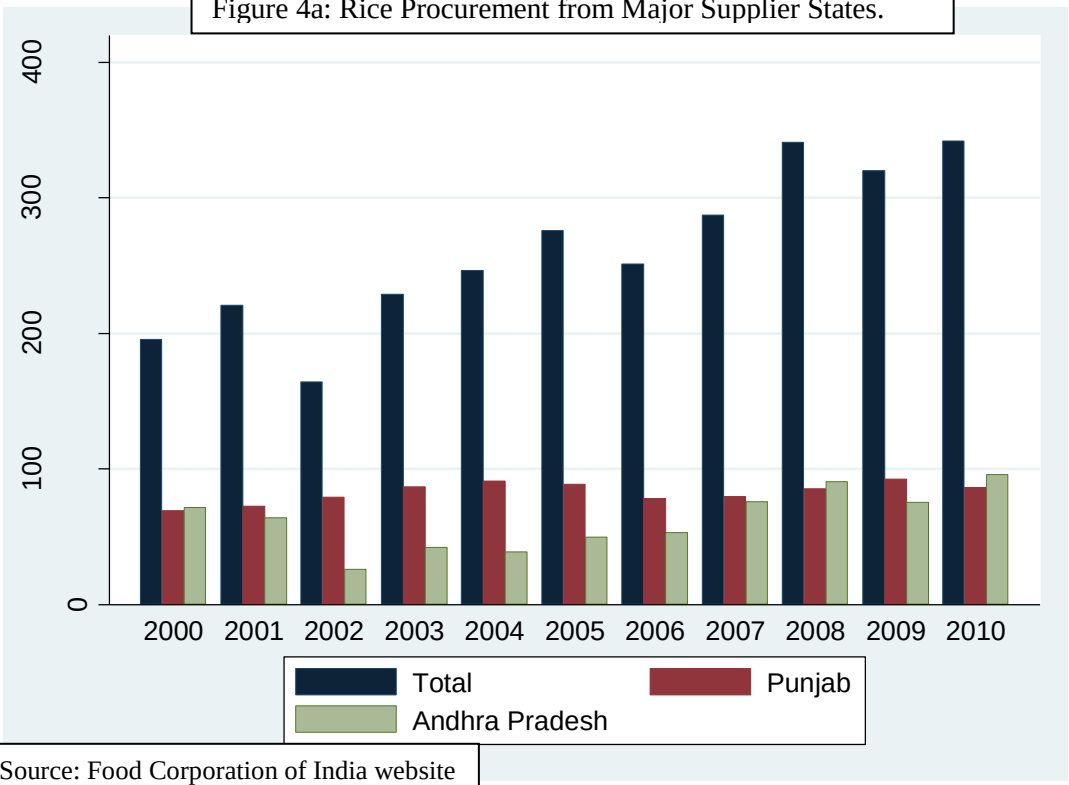


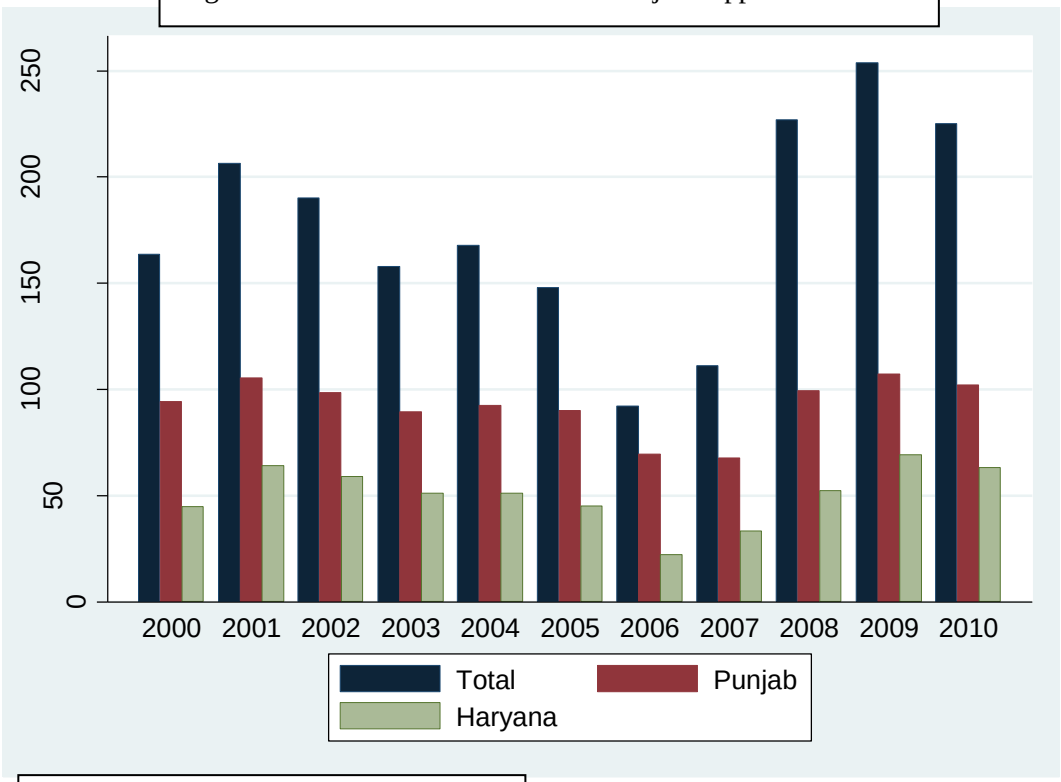
Figure 3 : The figure represents demand and supply for PDS grain for a representative consumer who has been alloted quota Q at price P

Figure 4a: Rice Procurement from Major Supplier States.



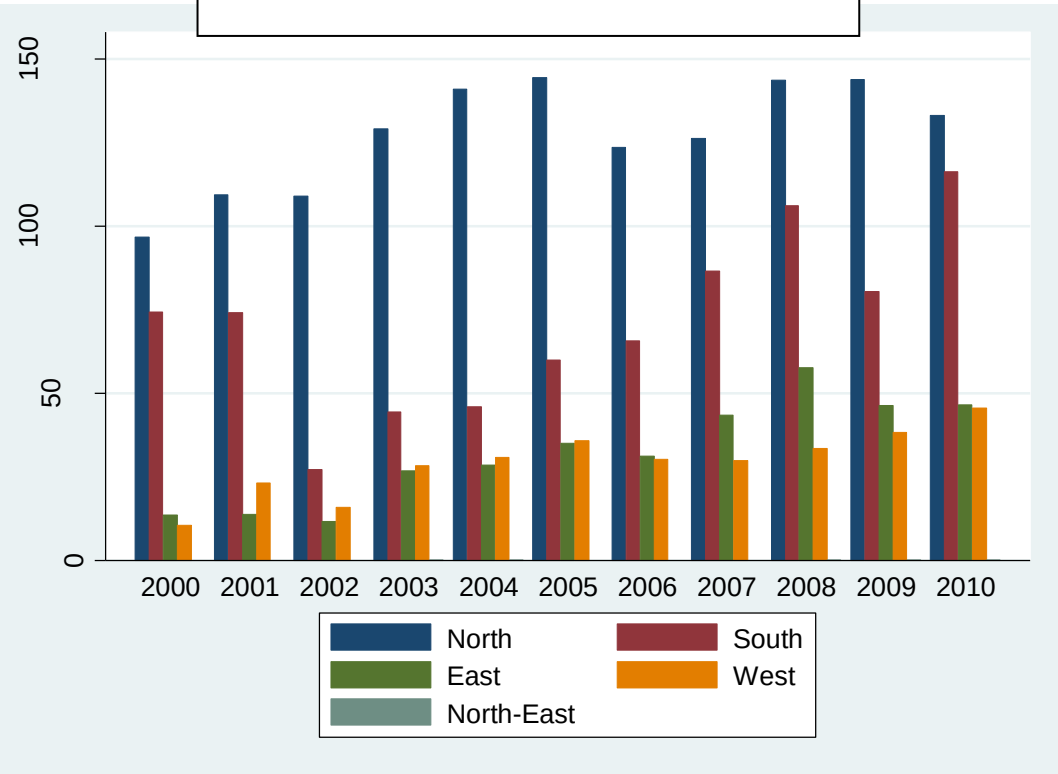
Source: Food Corporation of India website

Figure 4b: Wheat Procurement from Major Supplier States.



Source: Food Corporation of India website

Figure 5: Rice Procurement by Zones



Source: Food Corporation of India website

Table 1a: Summary Statistics Main Variables.

	Combined	2009	2007	2004	1999
Per Capita Daily Calorie Consumption	2059.23 (739.58)	1883.82 (530.85)	1931.49 (555.93)	1849.82 (526.64)	2459.29 (948.68)
Per Capita Daily Protein	61.7 (30.76)	57.97 (25.20)	62.85 (29.70)	53.99 (23.48)	71.27 (38.37)
Monthly Per Capita Consumption Exp.	696.47 (961.96)	666.14 (600.93)	668.16 (521.37)	671.72 (485.33)	759.71 (1513.33)
Quota - Uptake gap (KG)	9.81 (9.58)	13.21 (10.08)	8.34 (8.31)	7.85 (7.97)	1.25 (2.15)
PDS Rice (KG)	14.64 (13.39)	14.28 (9.78)	14.05 (8.98)	14.8 (8.97)	15.18 (19.51)
PDS Wheat (KG)	4.43 (7.83)	5.53 (7.83)	3.46 (5.95)	2.74 (5.84)	4.5 (9.16)
Proportion of PDS Calories	0.28 (0.19)	0.31 (0.16)	0.29 (0.16)	0.3 (0.16)	0.23 (0.19)
Observations	89099	34475	8253	18758	26564

Notes: This is descriptive statistics from the sample of households who have made purchases from PDS shops. Calorie (measured in Kilocalories) and protein (in gms) are daily intake averaged amongst members of each household. Mean percapita consumption expenditure is in 2004 prices.

Table 1b: Summary statistics (Control Variables , household characteristics)

	Combined	2009	2007	2004	1999
Landowner (0 or 1)	0.69	0.9	0.99	0.86	0.24
	(.45)	(0.29)	(0.02)	(0.34)	(0.42)
Electricity (0 or 1)	0.61	0.83	0.81	0.01	0.69
	(0.48)	(0.36)	(0.13)	(0.13)	(0.13)
Rural (0 or 1)	0.67	0.67	0.71	0.72	0.63
	(0.46)	(0.48)	(0.45)	(0.44)	(0.48)
Home Agricultural	0.46	0.42	0.5	0.41	0.52
Producer (0 or 1)	(0.49)	(0.49)	(0.50)	(0.50)	(0.50)
Number of Adults	3.24	2.93	2.92	2.85	4
	(1.46)	(1.36)	(1.36)	(1.34)	(2.21)
Number of Females	1.56	1.48	1.48	1.46	1.77
	(0.98)	(0.76)	(0.76)	(0.75)	(1.34)
Observations	89099	34475	8253	18758	26564

Source: NSS consumption data from rounds 55, 61, 64 and 66

Table 2: Shows OLS estimates of the effect of foodgrain uptake from PDS shops and the shortfall of uptake from alloted quota of food grains on the household consumption of Calories and Protiens

Dependant Varible	HHld Percap Calorie			Protein
PDS Rice Uptake (KG)	-0.0240			
	(0.0165)			
PDS Wheat Uptake (KG)		0.0864		
		(0.0560)		
Quota - Uptake (KG)			0.130	0.258
			(4.222)	(8.075)
N	72064	72064	72064	72064

Notes: Dependent variable is log household percapita consumption of calories/protiens. The data comprises of the NSS rounds 55, 61, 64 and 66. Each specification has demographic controls (caste religion etc.), household characteristics (number of adults, females, cooking method etc.) as well as year-state, state and year fixed effects. Standard errors are clustered at the district level. NSS weights have been used.

*** Significant at 1%
** Significant at 5%
* Significant at 10%

Table 3a: Despatches of PDS grain from other states, by zones. (2012-13 only) in thousand Tonnes

	WHEAT		RICE		TOTAL	
	Plan	Despatch	Plan	Despatch	Plan	Despatch
NE Zone	915	716	3758	2894	4673	3610
East Zone	5981	4474	3151	2551	9132	7025
West Zone	7438	6978	2563	2176	10001	9154
South Zone	4277	3867	6816	6300	11093	10167
North Zone	4116	3032	2769	1921	6885	4953
Total	22727	19067	19057	15842	41784	34909

Notes: Figures indicate amount of grains transfered to a state in the zone from any other state (could be from the same zone).

Source: Statement Showing Yearly Planning and Despatches of Wheat/Rice on Inter-State account by Rail and Road W.E.F April, 2012 to March 2013. http://fciweb.nic.in/movements

Table 3b: PDS grain amounts dispatched from donor states in 2012-13 ('000 tonnes)

	WHEAT		RICE		TOTAL	
STATE	Plan	Despatch	Plan	Despatch	Plan	Despatch
North Zone						
Punjab	11096	8899	9459	7478	20555	16377
Rajasthan	50	57	0	0	50	57
Haryana	7116	6154	2181	1874	9297	8028
Uttranchal	0	0	155	162	155	162
South Zone						
Andhra Pradesh	0	0	4095	3812	4095	3812
West Zone						
Chhattisgarh	0	0	2499	1860	2499	1860
Maharashtra	0	0	3	3	3	3
Madhya Pradesh	4465	3957	0	0	4465	3957
East Zone						
West Bengal	0	0	95	91	95	91
Orissa	0	0	570	562	570	562
Total:	22727	19067	19057	15842	41784	34909

Source: Statement Showing Yearly Planning and Despatches of Wheat/Rice on Inter-State account by Rail and Road W.E.F April, 2012 to March 2013. http://fciweb.nic.in/movements

Table 4: Changes in key variables over time in the North-East zone

	Combined	2009	2004	Diff
Quota - Uptake gap (KG)	11.06	12.59	7.82	4.77***
	(9.50)	(9.32)	(9.05)	(0.24)
Calories Percapita	1923.64	1920.99	1929.27	-8.28
	(505.21)	(473.17)	(567.22)	(13.56)
Protein Percapita	55.84	56.07	55.34	0.72
	(26.31)	(25.57)	(27.81)	(0.71)
PDS Rice (KG)	23.26	22.02	25.88	-3.85***
	(9.90)	(9.62)	(9.99)	(0.26)
PDS Wheat (KG)	0.35	0.37	0.29	0.07**
	(1.54)	(1.42)	(1.77)	(0.04)
Proportion of Calories	0.36	0.33	0.44	-0.103***
from PDS	(0.19)	(0.17)	(0.19)	(0.004)
Mean Per Capita Consn.	701.26	676.47	753.78	-77.31***
Expenditure	(5.67)	(6.51)	(10.98)	(12.11)
Observations	6364	4323	2041	

Notes: Compares the sample of PDS users from the North-East zone in the years 2004 and 2009. These are the states of Assam, Manipur, Meghalaya, Arunachal Pradesh, Mizoram and Nagaland. Calories are measured in Koilocalories, protein in grams percapita per day. Rest of the consumption statistic are monthly. Mean percapita consumption expenditure is also monthly and measured in 2004 rupees. Standard deviation in parenthesis for the first three columns and standard error for the last column.

*** Significant at 1%
** Significant at 5%
* Significant at 10%

Source: NSS 61st and 66th rounds

Table 5 : IV estimates of quota-uptake difference on nutrient consumption

	First stage:	Second Stage	
Dependent Var:	Quota - Uptake	Log Calorie Consn.	Protein
East Zone × PRF	-0.142***		
	(0.00735)		
South Zone × PRF	-0.117***		
	(0.00566)		
West Zone × PRF	-0.121***		
	(0.00488)		
North-East Zone × PRF	-0.241***		
	(0.00732)		
Quota - Uptake		-0.00457***	-0.00539***
		(0.00103)	(0.00104)
MPCE	0.847*	0.386***	0.483***
	(0.426)	(0.00825)	(0.0130)
N	72064	72064	72064
R- squared	0.579	0.382	0.343
F - Stat	9429.6	-	-

Notes: The first column represents the first stage with dependent variable quota-uptake gap. The instrument consists of a particular zone dummy interacted with rain fall in Punjab (PRF) in that year.The corresponding second stage coefficients are in the last two columns. Here the dependent variable is log percapita calorie consumption or protein consumption. All controls are used in each specification including a dummy controlling for the zones which are being used in the instrument. Year and state-year fixed effects have been included. Household level controls for caste, religion, household size, occupation, prices, landownership etc have been included. Standard errors are clustered at the year-zone level.

*** Significant at 1%
** Significant at 5%
* Significant at 10%

Source: NSS rounds 55, 61, 64 and 66.

Table 6: Impact of PDS efficiency on food exp. and market grain purchase

Dependent Var:	Open-market grains purchased	Food-share of expenditure	Food expenditure in rupees
Quota - Uptake	0.591***	0.00252	19.67
	(0.0654)	(0.0488)	(125.8)
MPCE	-2.893***	-2.046**	5306.2*
	(0.977)	(0.968)	(2722.6)
N	72064	72064	72064
R- squared	0.448	0.0732	0.0892

Notes: The IV estimation described for Table 5 is repeated here for a different set of dependent variables. Only the second stage is reported as the first stage is identical. The first column reports results for total open market cereal purchse (rice and wheat) in KGs. The second and third column report results for food share (proportion between 0 and 1) and the total value of food expenditure in 2004 rupees.

*** Significant at 1%
** Significant at 5%
* Significant at 10%

Source: NSS rounds 55, 61, 64 and 66.