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ABSTRACT

We study the effect on nutrition of an exogenous increase in food grain subsidy in rural India resulting from a program targeting the poor. Our analysis suggests that increase in income resulting from the food price subsidy changed consumption patterns in favor of the subsidized grains and certain more expensive sources of calorie, and lowered consumption of coarse grains that are cheaper, yet taste-wise, inferior sources of nutrition, but had no effect on calorie, protein and fat intake in poor households. Further, our analysis shows that households allocated some of the increase in income from food price subsidy to expenditures on non-food items. Estimates of the price effect of food price subsidy on the three measures of nutrition are also negligible. We find evidence that the decline in the price of wheat and rice, changed consumption patterns toward increased consumption of wheat and rice and lower consumption of coarse grains, the unsubsidized staple food. Our analysis thus suggests that food price subsidies are likely to affect agriculture markets without impacting nutrition.

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Introduction

There is a longstanding debate on the extent to which nutrition among the poor in developing countries improves with income. Conventional wisdom is that higher income would solve the problem of undernourishment. Empirical studies, however, provide mixed evidence with calorie-income elasticities ranging from 0.01 to 0.56.[1] The evidence is also mixed from research on the effect of food price subsidy programs on nutrition.[2] A key concern with many of these studies is that income and price variation are not exogenous. In a randomized experiment conducted in two Chinese provinces, Jensen and Miller (2011) find no evidence that subsidies improved nutrition, and some evidence of a substitution away from the subsidized staple food towards foods that are expensive sources of nutrition.[3] The subsidy recipients, in that study, were aware that the subsidy would last only six months. The impact of a longer-term food price subsidy program may differ from that of a short-term experiment where the recipients know that the benefit is temporary.

In this paper, we study the effect of an exogenous increase in food price subsidy to poor families resulting from the introduction in 1997 and expansion in 2002 of a targeted food price subsidy program in India called the Targeted Public Distribution System (TPDS). The Indian government issued ration cards, called BPL cards, to households with incomes below the official poverty threshold, which could be used to purchase at approximately a third of the market price

[1] Studies that have estimated high elasticities of calorie consumption to income include: Ravallion (1990); Strauss and Thomas (1989); Subramanian and Deaton (1996) ; and studies that have estimated close to zero elasticities include: Behrman and Deolalikar (1987); Bouis and Haddad (1992); Bouis (1994); also see Ogundari and Abdulai (2013) for more recent studies.

[2] There is a large literature on the nutritional impact of food prices in developing countries with mixed results (Ecker and Qaim, 2011, Behrman et al., 1988, Guo et al., 1999, Shimokawa, 2010).

[3] Shimokawa (2010), on the other hand, finds that response to food price subsidies in China is asymmetric: introduction of subsidies improves nutrition, but their disruption has an insignificant effect.

10 kg of rice or wheat per household per month - an amount that was raised to 35 kg in 2002.[4] We use the probability of BPL card ownership as an instrumental variable to predict the food price subsidy of households and study how the increase in predicted food price subsidy and the overall subsidy amount resulting from the expansion of TPDS affected the nutritional intake and consumption patterns of poor families in rural India. The latter allows us to study changes in consumption patterns underlying the changes in nutritional outcomes.

We take advantage of divergent consumption patterns across districts to stratify the sample covered by our study into two groups: districts where wheat and rice are the staple food and districts where coarse grains are the staple food. In districts where wheat and rice are the staple food, the average monthly household consumption of wheat and rice in the pre-TPDS period is 35 kg, the PDS purchase limit, or higher. In these districts, TPDS will have a purely income effect on households receiving the subsidy. In 15 districts, however, the average consumption of wheat and rice in the pre-TPDS period is 20 kg or less. These are districts where coarse grains are the staple food, but the price subsidy is provided for wheat and rice. As we illustrate below, the marginal price of wheat and rice for most households receiving the subsidy in these districts would be the subsidized price. In the empirical analysis, we first estimate the effect of total subsidy amount in 66 districts where the average household consumption is 35 kg or higher in the pre-TPDS period, followed by an analysis of the effect of price subsidy on poor households in the 15 districts where average combined consumption of wheat and rice is 20 kg or less in the pre-TPDS period. In the latter analysis, we specifically estimate the effect of the price

[4] The government provides rice and wheat at about 50% of the government's cost of procurement, which is somewhat higher than the market price. In our data, the price subsidy is on average 36% of the market price.

subsidy on nutrition and consumption patterns, while the former provides an estimate of the effect of an increase in income resulting from TPDS on nutrition and consumption patterns.

Our analysis follows Kochar (2005), who applies the initial changes in the Targeted Public Distribution System and finds that food price subsidy had a modestly positive effect on calorie intake. A criticism of her research is low take up rate as her empirical analysis is restricted to 9 states in India where the PDS off-take is modest and leakages high (Jensen and Miller 2011; Planning Commission 2005; Khera 2011).[5] More importantly, Kochar's study covers the initial period of the TPDS (July 1999- June 2000) during which most states/union territories had not completed identification of the poor who would be eligible for TPDS (Umali-Deininger, Sur, and Deininger 2005).[6]

We focus on states often described as PDS "functioning or reviving" states, with relatively high take up and cover a post-expansion period when BPL cards had been issued and the TPDS was fully implemented. Further, our study excludes states that had a targeted PDS prior to 1999. We use data from three rounds of the National Sample Survey for 1993-1994 (50th round), 1999-2000 (55th round) and 2004-2005 (61st round) that allow us to control for long-term trends in nutrition and estimate the effect of food price subsidy and total subsidy amount on consumption patterns and nutrition.

Our study has policy relevance for developing countries that spend large sums on food price subsidies to address undernourishment, which continues to be critical in many countries of South Asia and sub-Saharan Africa. In 2012, according to the UN Food and Agriculture Organization, there were 780 million chronically undernourished persons in the world. Food

[5] Studies find large scale grain divergence with ration shop owners selling PDS grains in the open market.
[6] Further, Kochar focuses on wheat subsidy. Detailed evaluations show that the PDS has been less effective in wheat consuming states than in rice consuming states (Khera, 2011).

price subsidy programs have high political and public support compared to unconditional cash transfer programs even though subsidy programs are often afflicted with corruption and poor targeting. To eradicate undernourishment, the Indian National Food Security Act promises to provide highly subsidized food to 75% of rural households and 50% of urban households (National Advisory Council 2011). Also known as the Right to Food program, India's National Food Security Program is expected to cost 3% of the nation's GDP in the first year of its implementation, which is three times the current expenditure on food price subsidies in India (Bhalla 2013). If food price subsidies do not influence nutrition, such a policy would increase allocation of resources to a program that is widely documented to be inflicted with poor targeting, inefficiency, and corruption (Comptroller and Auditor General of India 2000; Chaudhuri and Somanathan 2011).

A Simple Theoretical Model

Figure 1 presents a simple model to illustrate how a food price subsidy affects consumers. Let the utility function depend on two goods: x and y. Assume that both goods have positive income elasticities. The price of y is fixed at $1 and income at I. In period t, the price of x is p and the budget constraint is depicted by AB, specified as: $I=y+px$, along which the consumer allocates income between the two goods. In period t+1, the government allows a food price subsidy: the consumer can buy up to a maximum amount x_0 at price cp (where $c<1$). ACD is the new budget constraint, specified as

$I=y+cpx_0 + p(x - x_0)$, or

$I + p\,(1-c)x_0 = y + p\,x.$

At point C on AC, $x=x_0$ and $y=I-cpx_0$ and at point F on AB, $y=I-cpx_0$ and $x= cx_0$.

Figure 1 presents the indifference curves of three individuals in period t. Consumer 1 is located to the right of x_0, consuming more than x_0 in the initial period. With the subsidy program, consumer 1 will be on the CD portion of the budget constraint and the subsidy program will have a pure income effect on consumer 1. Consumer 2, who is on segment FE of the budget constraint in the initial period, could have a new equilibrium at either the AC or CD segment of the new constraint. If the new equilibrium falls on segment AC, the marginal price for consumer 2 will be the subsidized price. If, on the other hand, the new equilibrium is on the CD segment of the budget constraint, consumer 2's marginal price will be the market price. Consumer 3, who is on segment AF of the budget constraint before the price subsidy is introduced, must end up at a point on AC. Thus, the marginal price for individuals who consumed less than cx_0 in the initial period will be the subsidized price.[7]

Two inferences can be drawn from this simple illustration. One, assuming that rice and wheat are normal goods, price subsidy on wheat and rice will increase the combined consumption of wheat and rice for all 3 consumers. Two, in districts where wheat/rice are the staple food and their combined average household consumption is 35 kg or more in the pre-TPDS period (i.e. consumer 1 in the above example), price subsidy on wheat and rice will have a purely income effect. In districts where coarse grains are the staple food and the average household consumption is less than 20 kg in the pre-TPDS period (consumer 3 in the above example), most households will face the subsidized price of wheat and rice in the TPDS period.

What would be the effect of TPDS on nutrition? Consider the case of high wheat and rice consuming districts where food price subsidy will have a purely income effect. By lowering the

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[7] For a detailed illustration, see Moffitt (1989). The authors thank Michael Grossman for his insightful comments and for sharing his teaching notes.

price of subsidized food items, wheat and rice subsidies will release funds that families can use, depending on their tastes and preferences, for buying: (i) higher quantities of subsidized food items, (ii) higher quantities of non-subsidized costlier sources of nutrition (e.g. eggs, meat, milk), and (iii) non-food items. Increase in income may also lower consumption of coarse grains that are cheaper, but generally considered inferior (taste-wise) substitutes for wheat and rice. Overall, it is unclear whether TPDS in these districts would raise or lower nutrition; indeed, income increase resulting from wheat and rice subsidies may have a negligible or even negative effect on nutrition if substitution from cheap coarse grains to expensive sources of nutrition or non-food items is large.

Now consider districts where the staple food is coarse grains and the average monthly household consumption of wheat and rice is relatively low (20 kg or less). Coarse grains are cheaper sources of nutrition, but are not subsidized. In these districts, wheat and rice price subsidy will have a largely substitution effect. The subsidy will lower the relative price of wheat and rice (compared to coarse grains) raising their consumption and lowering the consumption of coarse grains. Households may also increase consumption of other food items that are expensive sources of calories, but have non-nutritional attributes (e.g. taste). Here too, it is not certain whether the price subsidy will increase or lower nutrition.

Targeted Public Distribution System

Jointly operated by the federal and state governments, India's Public Distribution System provides subsidized wheat and rice via a network of around 477,000 fair price shops across the country. To address criticism relating to high operational costs, poor-targeting, and corruption, in 1997, the government replaced the PDS, a universal program, with the Targeted PDS that

restricted sale of subsidized food grains to families with incomes below the 1993-1994 poverty threshold fixed by the Federal government (henceforth referred to as BPL households). But the implementation of TPDS could not begin in most states till 2000 due to delays in identification of BPL households and distribution of BPL ration cards (Umali-Deininger, Sur, and Deininger 2005).

The initial monthly allocation under TPDS was a modest 10 kg per household, at roughly half the price at which the government could procure the grains, and was raised to 20 kg in April 2000 and to 35 kg in April 2002. In December 2000, a third tier was introduced, under the Antyodaya Anna Yojana (AAY) program that involved a higher subsidy to the poorest of the poor. Three types of cards were issued under the new system: AAY cards to the poorest of the poor, BPL cards to the other poor with incomes below the poverty line, and APL cards to the non-poor. In the initial period of the TPDS, APL families could buy food grains from ration shops at market prices; since April 2002, a modest subsidy is given to certain purchases by APL card holders as well, but allocation to APL families is contingent on availability after meeting the needs of BPL households (Ministry of Consumer Affairs, Food and Public Distribution 2011).

State and private evaluations of the TPDS have been mixed. A detailed evaluation report by the government documents that the TPDS remains afflicted with large-scale diversion of grains in many states (Planning Commission 2005).[8] Umali-Deininger et al. (2005) and Khera (2011), however, document increased grain allocation and off-take in most states after the TPDS

[8] A detailed evaluation of the program showed that nationally only about 57% of the poor households were covered by it and only about 42% of the subsidized grains issued by the central pool reached the poor: about a third of the budgetary subsidy was siphoned off the supply chain and 21% reached the non-poor households (APL) (Planning Commission, 2005).

expansion.[9] Khera (2011) documents that there are seven large states where the PDS has been functioning well, and in another five states it has 'revived' since TPDS implementation. The focus of our study is six "well-functioning or reviving" states that have implemented the TPDS system, namely: Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Maharashtra, Uttaranchal, and Chhattisgarh. States that had dual pricing prior to TPDS, namely Orissa, and four major southern states- Andhra Pradesh, Tamil Nadu, Kerala and Karnataka (all well-functioning states) are excluded from the analysis.[10] Further, we do not include Uttar Pradesh, classified a "reviving' state by Khera, because in 2004-2005, the post policy period covered by our study, the per capita off-take of PDS was less than 500 grams per month in this state.

Data

The study is primarily based on data from three rounds of the National Sample Surveys (NSS): the 50th round conducted in 1993-1994 (Schedule 1.0), the 55th round conducted in 1999-2000 (Schedule 1.0), and the 61st round conducted during 2004-2005 (Schedule 1.0). These are nationally representative surveys covering between 120,000 to 125,000 households in each round. The last two rounds were conducted about two years before and two years after the expansion of the TPDS, therefore, are appropriate to study its effect on nutrition. In recent decades, there has been a steady decline in calorie intake across income quintiles in India (Deaton and Drèze 2009, 42-65). These trends are likely to confound the effect of the TPDS on

[9] Swaminathan and Misra (2001) found that shifting from universal to targeted coverage increased errors of exclusion (excluding poor people) but lowered the errors of inclusion in Maharashtra. But they used 1995-2000 data, thus their study did not cover the post TPDS expansion period.

[10] These states either opted to not follow the dual pricing scheme of the federal government (e.g. Tamil Nadu adopted a universal PDS with the AAY covering the entire population) or had a targeted program prior to 1997 (e.g Andhra Pradesh, Orissa, Karnataka), or are states where TPDS reduced subsidized food grain allocation (e.g. Kerala).

nutrition. We combine the 1993-1994 NSS data with the two later rounds and include district specific trends to control for the long-term trends in nutrition.

The NSS collects detailed data on expenditures over the past 30 days. Specifically, for the purpose of this analysis, the surveys provide information on the quantities of wheat and rice purchased and the value of their purchases from ration shops as well as in the open market. Following Kochar (2005) and Deaton (1997), district level open market prices of wheat and rice are computed from the NSS household data by dividing the value with the quantity of each item (wheat or rice) purchased from the open market. To minimize measurement error, districts with fewer than 80 observations (households) in any year are dropped from the analysis. Further, we stratify districts in our sample states into three groups based on their average household wheat and rice consumption in the pre-TPDS period: high-wheat/rice consuming districts (with the combined wheat and rice consumption of 35 kg per month or higher), moderate wheat/rice consuming districts (average combined rice and wheat consumption of 20 kg per month or less); and the rest (average monthly wheat and rice consumption per household between 20kg and 35 kg). The focus of our study is the first two groups. Overall, our study covers 66 districts where average monthly household consumption is 35 kg or higher and 15 districts where the average monthly household consumption is 20 kg or less.[11] The 1993-1994 NSS does not provide district identifiers for urban areas.[12] Therefore, all analysis is restricted to rural areas.

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[11] There are only 11 districts (2,285 households) in our sample with an average monthly consumption of 20-35kg. Theoretically, the effect of TPDS on these districts could be either purely an income effect or both an income and a substitution effect. This sample is not included in the analysis we present. In a supplementary analysis, we studied the effect of subsidy discount on districts with an average monthly household wheat and rice consumption of 20 kg or higher and the results were similar to those reported for high-wheat/rice consuming districts.

[12] We are grateful to Anjini Kochar for providing us with documentation on district identifiers for rural households in the 1993-1994 NSS data.

In the NSS surveys, expenditures on education, durables, and institutional medical care are for the past 365 days and on other items for the past 30 days. For the analysis we convert all items to expenditures in the past 30 days. Detailed data on food consumption are converted into three nutrient intakes: calories, protein, and fat, using conversion factors from the NSS (National Sample Survey Organization 1996; National Sample Survey Organization 2001; National Sample Survey Organization 2007). The amount of each food item consumed is multiplied by its per unit nutrient content and converted to average daily nutrient intake.

We study the effects of TPDS on per capita calorie intake from the following food items: wheat and rice; pulses and pulse products; edible oil; milk, milk products, eggs, fish and meat; sugar and sugar substitutes; and all other foods. To examine if TPDS influenced purchases of relatively cheaper or expensive sources of calories, we study two other outcomes. The first outcome is per capita calorie intake from coarse cereals namely, maize, jowar, ragi, and bajara. It captures cheaper sources of calorie and protein. In our data, in the pre-TPDS expansion period, the cost per calorie from the consumption of these coarse cereals is roughly 40% lower than the cost per calorie of non-PDS wheat and rice and 17% less than the cost per calorie of PDS wheat and rice. The second outcome is per capita expenditure on expensive sources of calories and these items are: pulses and pulse products, milk and milk products, edible oil, sugar, eggs, fish and meat. In our data, these items are 155% more expensive sources of calorie than non-PDS wheat and rice.

All expenditures are adjusted for inflation using the Agricultural Laborers Consumer Price Index. To ensure that the analysis is not driven by extreme values, households reporting per capita monthly consumption of more than 30 kilograms of any specific cereal (e.g. wheat, rice, bajara, maize etc.) or more than 30 kilograms of edible oil are dropped from the analysis.

Further, households reporting a per capita daily calorie[13] consumption of more than 10,000 and a per capita daily protein consumption of more than 300 grams are dropped from the analysis. Overall, as a result of these exclusions, 160 households are dropped from our sample. We also exclude, from the combined sample, 819 households (2.6% of the sample) that report purchasing PDS wheat and rice at prices greater than their districts' average open market price. Additionally, two districts (with a combined sample of 287 observations) are excluded because a third of their samples reported purchasing PDS wheat and rice at prices that exceeded the districts' mean open market price.

Additional adjustments are made in models using outcomes specified in logarithm: we assign a monthly per capita food price subsidy of Rs 0.01 to households that had a subsidy of 0; in models with logarithm of calories consumed (per food item) as outcome, households that consumed 0 calories from coarse cereals; sugar and sugar substitutes; and milk, egg, fish and meat are assigned 0.001 per capita daily calories for each of these food items; and in models with logarithm of per capita quantity of coarse grains as the outcome, households that did not consume coarse cereals are assigned 1 gram in monthly per capita consumption.

All three rounds of the NSS provide detailed data on individual household members, including their age, educational attainment, sex, marital status, current employment status, and relationship with the household head. The NSS also provides information on household characteristics namely: household size, caste, religion, occupation of household head, land ownership, amount of land irrigated, detailed data on ownership of durables, urban-rural residence, district of residence, and state or union territory (UT) of residence. We compute

[13] A calorie in this paper refers to one kilocalorie (kcal), as called a large calorie (Cal).

district-level monthly per capita expenditure, open market price of rice, and open market price of wheat by averaging the respective household values in each district.

The 2004-2005 NSS provides data on type of ration card that a household owns: AAY (extremely poor), BPL (poor), APL (non-poor) and no card. Because the new ration cards were not issued in 1993-94 or 1999-2000, we do not have this information for households in these years. We use the 2004-2005 data on card ownership to predict the probability of BPL/AAY card ownership using a rich set of household characteristics that are exogenous to the Targeted Public Distribution System. In our data only 2.4% of the households had an AAY card in 2004-2005. To minimize prediction error, we combine the AAY category with the BPL category. Specifically, we regress whether the household has a BPL/AAY card (binary variable – for convenience, henceforth we call this variable BPL card) on the household head's age (a set of dummy variables indicating age categories: 0-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, and 70 or older), education (categorical variables indicating illiterate; literate with less than primary education; primary education; more than primary but less than secondary; and secondary or higher education), gender, marital status, and occupation, education of other household members (all illiterate; at least one, but not all, literate; all literate), household caste (categorical variables indicating scheduled caste, scheduled tribe, and other castes) and religion (categorical variables indicating Hinduism, Islam, Christianity, Sikhism, Jainism, Buddhism, Zoroastrianism, and other religions), land ownership, household size (categorical variables indicating 1, 2, 3-5, 6-8, and 9 or more household members), whether land is irrigated, ownership of durables, namely radio, TV, bicycles, electric fan, sewing machine, fridge, motor cycle, or car; and district of residence fixed effects. The coefficients from this regression are used to predict the probability of BPL ration card ownership of households in all years.

Estimation Strategy: Food Price Subsidy and TPDS

We begin the analysis by studying the effect of the TPDS on the subsidy received by BPL cardholders, the target of the program. The per capita food price subsidy amount (S_{ijt}) that household i in district j receives in year t, is computed as the difference in the open market price (P^m_{fjt}) of the food grains (wheat, rice) minus the PDS price reported by the household (P^s_{fijt}) multiplied by the quantity purchased from the PDS (q_{fijt}). The total household subsidy amount if divided by N (household size) to arrive at the per capita subsidy amount:

$$(1) \qquad S_{ijt} = \frac{1}{N_{ijt}} \sum_f q_{fijt} (P^m_{fjt} - P^s_{fijt}) \qquad f = wheat, rice$$

Equation (2) describes the model used to study the effect of TPDS on the food grains subsidy amount received by BPL households:

$$(2)\ S_{ijt} = X_{it}\beta + \beta_c (\Pr Card_i * Post_t) + \delta_0 * \Pr Card_i + \delta_1 * D_{jt} + \pi_j + \pi_t + u_{ijt},$$

The per capita food price subsidy amount (S_{ijt}) is defined as a function of household characteristics, X_{it}, namely age (a set of dummy variables indicating age categories: 0-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, and 70 or older) and marital status of household head, their educational attainment (categorical variables indicating illiterate; literate with less than primary education; primary education; more than primary but less than secondary; and secondary or higher education), gender, occupation, education level of other household members (all illiterate; at least one, but not all, literate; all literate), household size (categorical variables indicating 1, 2, 3-5, 6-8, and 9 or more household members), caste (categorical variables indicating scheduled caste, scheduled tribe, and other castes) and religion (categorical variables indicating Hinduism, Islam, Christianity, Sikhism, Jainism, Buddhism,

Zoroastrianism, and other religions), land ownership, whether land is irrigated, and ownership of durables, namely radio, TV, bicycles, electric fan, sewing machine, fridge, motor cycle, or car. π_j and π_t are district and year fixed effects. D_{jt} denotes district-level time-varying factors namely mean district level monthly per capita expenditure, and district-specific trends. We begin the analysis without any district level time-varying controls and sequentially add these controls. In our final specification, we replace district-level trends with interactions of the district dummy variables with $Post_t$.

$\Pr Card_i$ is the predicted probability that the household has a BPL card. The variable $Post_t$ is equal to 1 if the observation is taken from the post-2002 period, after the TPDS expansion. The coefficient, β_c, estimates the effect of the TPDS on the average food price subsidy as the probability of BPL card ownership increases from 0 to 1.

The identifying assumption in equation (2) is that in the absence of TPDS, the change in food price subsidy in the pre- to post-policy period of households with a low probability of having a BPL card would be the same as that of households with a high probability of having a BPL card. This is a restrictive assumption. In general families with a low probability of owning a BPL card are likely to be richer than families with a high probability of owning a BPL card and the effect of economic factors on these two groups of families is likely to be very different. To allow more a reasonable comparison, we estimate equation (2) restricting samples to households with a monthly real per capita expenditure below the median.[14]

[14] The median monthly per capita expenditure for our sample of states is Rs 485.55 at 2004-2005 prices, which is equal to $1.04 per day at the ppp exchange rate of $1=Rs 15.54.

Equations similar to (2) are applied to study two other outcomes: price discount, defined as the subsidy amount divided by the quantity of wheat and rice consumed by the household and % discount defined as price discount divided by the market price of the subsidized food items.

Results: Effect of TPDS on Food Price Subsidy

Table 1 presents estimated coefficients from equation (2). Robust standard errors clustered around district of residence are in parenthesis. Model 1 includes controls for a rich set of individual characteristics, and district and year fixed effects. Model 2 includes an additional control of household monthly per capita expenditure,[15] model 3 further adds two more controls: mean district per capita expenditure and district-specific trends, and model 4 replaces district specific trends with interactions of district dummy variables and $Post_t$ variable (an indicator that the observation is from the TPDS expansion period). All samples are restricted to low-income rural households with per capita monthly expenditure below the median.

Estimates in panel 1, based on the sample of households in high wheat and rice consuming districts, suggest that an increase in the predicted probability of BLP card ownership (from 0 to 1) resulting from TPDS expansion raised per capita food price subsidy by Rs 1.4 per kg of the subsidized grain. Estimates remain robust in models that control for district specific linear trends (model 3) and models that include district-post interactions. The increase in price discount is of the order of 16 to 19 percentage points and the overall subsidy amount increased by Rs 15 to Rs 18 per capita. This is 8 to 10 times the average subsidy amount that households received in the period prior to the TPDS expansion. The effect size is about five percent of the per capita average household expenditure in the pre-TPDS expansion period. The F-ratio is much

[15] We also estimated models 2-4 without the control for monthly per capita expenditure. The results were similar to those reported in table 1 from models inclusive of this control.

larger than the critical F-ratio of 10 used to assess whether instruments are weak (see for example, Staiger and Stock 1997; Cameron and Trivedi 2005).

Estimates in panel 2 are for districts where coarse grains are the staple food. In these districts, the average wheat + rice consumed by households is 16 kg, which is less than half the maximum quantity that can be purchased at subsidized price under the TPDS. Further, in each district the average combined consumption of wheat and rice is less than 20 kg per household. Therefore, the marginal price that most households in these districts would face is the subsidized price. Estimates suggest that an increase in the predicted probability of BLP card ownership (from 0 to 1) raised per capita food price subsidy by Rs 1.8 to Rs 2.4 per kg of the subsidized grain after the TPDS expansion. The % price discount increased by 19-21 percentage points and the overall discount increased Rs 11 to Rs 14, a rise of about three percent over the pre-TPDS per capita expenditure. Here too the F-statistic for the interaction term- predicted probability of BPL card ownership and Post-TDPS period - is above 10.

Our analysis thus suggests that TPDS raised the food price subsidy of households with a BPL card and the effect sizes are non-trivial. In high-wheat and rice consuming districts, the price subsidy increased by 16 to 19 percentage points and the subsidy amount is about 5% of the per capita total food expenditure in the pre-TPDS expansion period. In moderate wheat and rice consuming districts, the price discount increased by 19 to 21 percentage points and subsidy discount amount was about 3% of the per capita expenditure in the pre-expansion period.

Estimation Strategy: Effect of Food Price Subsidy on Nutrition

Our next objective is to study the effect of food price subsidy on nutrition in the poor households. We first study the effect of the subsidy amount on nutrition in high wheat and rice consuming districts. Equation (3) describes the empirical model:

(3) $N_{ijt} = X_{it}\phi + \varphi * Subsidy_{ijt} + \varphi_0 \Pr Card_i + \phi_0 * D_{jt} + \eta_j + \eta_t + e_{ijt}$,

N_{ijt} , the per capita nutrition in-take of household i in district j in year t, is defined as a function of household characteristics (X_{it}), per capita food grains subsidy amount ($Subsidy_{ijt}$), the predicted probability that the household has a BPL or AAY card ($\Pr Card_i$), time-varying district level variables that may influence nutrition (D_{jt}), and district (η_j) and year (η_t) fixed effects. We study three measures of nutrition: per capita daily calorie intake, per capita daily protein intake and per capita daily fat consumption.

Unobserved factors that determine food subsidy amount may also affect nutrition levels. For instance, a demand shock that increases nutrition will also increase food prices, and in turn the amount of the subsidy. Thus, $Subsidy_{ijt}$ is likely to be endogenous to household nutrition (N_{ijt}). We use an instrumental variables methodology to address this issue. Specifically, we use the predicted probability of BPL card ownership interacted with $Post_t$ to instrument for $Subsidy_{ijt}$. The first stage regression for this methodology is described in equation (2). In the second stage, the predicted $\hat{S}ubsidy_{ijt}$ from equation (2) replaces $Subsidy_{ijt}$ in equation (3). Note that the first stage estimate includes all the covariates that are in the second stage, so the identification of the coefficient φ in the second stage depends entirely on the exclusion of interaction term ($\Pr Card_i * Post_t$) from the second stage regression. In the empirical analysis, we use the IVREGRESS command of STATA to compute the first and second stage estimates in a single step. Standard errors correct for errors in the first stage prediction and cluster on district of residence (Murphy and Topel 1985; Hardin 2002; Hardin, Schmiediche, and Carroll 2003).

An equation similar to (3), with one modification, is applied to estimate the effect of price subsidy on nutrition: the subsidy amount is replaced by % price subsidy. The sample for

this analysis is districts with combined monthly household wheat and rice consumption of less than 20 kg.

Similar IV and reduced form models are used to estimate the effect of food price subsidy and TPDS on calorie intake from specific food items, quantity/expenditure on food items, and total food and non-food expenditures.

Results: Descriptive

Table 2 presents the cost per 1,000 calories, per capita daily calories, and share in total calorie consumption of various food items in the pre- to post-PDS expansion periods in rural households with less than the median per capita monthly consumption – the sample of our analysis. There are several points to note: one, in high wheat and rice consuming districts, these two staple grains accounted for 65% of the calorie in-take in the pre-TPDS period and a somewhat higher 67.5% in the post-TPDS period. Only nine percent of the calorie-intake in these households came from coarse grains in the pre-expansion period, and the proportion further fell to 5% in the post-expansion period. In the moderate wheat and rice consuming districts, households derived almost 50% of their calorie intake from coarse grains and another 19% from wheat and rice. In the post-TPDS period, the share of wheat and rice increased to 26% and of coarse grains fell to 41%.

Two, coarse grains were the cheapest source of calorie in the pre-TPDS period and remained so in the moderate wheat and rice consuming districts after TPDS implementation. In high wheat and rice consuming districts, however, PDS wheat and rice became the cheapest sources of nutrition after TPDS implementation. Three, prices of food items rose during the period of the study, but the increase was relatively low for the staple food items - wheat and rice – both PDS and open market -and coarse grains.

Four, as found in previous research there is a decline in per capita daily calorie intake during the period of this study (Deaton and Drèze 2009). Further, in the pre-TPDS period, households in high-wheat/rice consuming districts had a calorie consumption that was 7 percent higher than the per capita calorie in-take in moderate wheat/rice consuming districts. In the post-expansion period the gap is reduced to two percent. Five, in the pre-TPDS expansion period, the share of PDS wheat and rice as a source of calorie is about five percent in both sets of districts. In the post-expansion period this share increased to 15% in high-wheat/rice consuming districts and to 10% in moderate wheat/rice consuming districts. Six, households increased their total share of calories from the more expensive sources, namely pulses, milk and milk products, edible oils, sugar and its substitutes, egg, fish, and meat by about 1 percentage point.

Were these changes in sources of nutrition and consumption patterns caused by the increase in food price subsidy from the targeted Public Distribution System? We investigate this next. We first present the effect of the exogenous increase in income resulting from the food price subsidy on nutrition and consumption pattern of poor households in high wheat/rice consuming districts. This analysis is followed by the effect of the price subsidy on poor households in moderate wheat and rice consuming districts.

Results: Effect of Food Price Subsidy on Nutrition

Table 3 has the estimates of the effect of food price subsidy amount on calorie intake. Results are presented from four models: an OLS model and three different specifications of instrumental variable models: a levels model where both the nutrition variable and predicted subsidy amount are specified as levels, a log-linear specification where the nutrition variable is specified in log and the subsidy variable is in levels, and a log-log models where both nutrition and subsidy are specified in log to compute elasticity. Regressions in the left panel control for

district-specific linear trends; regressions in the right panel include district-post-TPDS interactions. Previous research suggests that calorie and protein consumption across income quintiles has been declining in India. Regressions in the right panel are our preferred specification as they control for these trends in a parsimonious manner. In Appendix Table A1 we also present models that do not include controls for district-trends or district-post interactions.

The OLS results show that increase in income from food price subsidy is associated with an increase in per capita calorie intake. As previously argued, subsidy amount is endogenous to nutrition and the instrumental variable estimates that address the endogeneity are modestly negative and statistically insignificant. The reduced form estimates are also modest and insignificant.

To understand what lies behind these estimates, we investigate the effect of food subsidy amount on sources of calorie and consumption patterns. We study calorie intakes from seven different food categories: wheat and rice; coarse cereals; pulses; edible oil; milk, eggs, fish and meat; sugar and sugar substitutes; and all other foods.[16] The OLS results show that an increase in income resulting from the subsidy increased calorie intake from wheat and rice, pulses, and sugar and sugar substitutes, but lowered calorie intake from coarse cereals and other food items and the estimates are roughly the same across models (with district-level linear trends and with district*post interactions). The IV models (the log–log model) suggest that a 10% increase in subsidy amount increased calorie intake from wheat and rice by a modest 0.3-0.6%, and the coefficient is statistically insignificant in models that control for district specific trends, but is statistically significant in models that do not control for district level trends (Appendix Table 1)

[16] We did additional analyses with quantity of wheat and rice, coarse grains, pulses, and edible oil, and expenditures on milk, eggs, fish, and meat; expenditure on sugar and sugar substitutes, and other foods as dependent variables. Results were similar to those reported, and can be provided upon request. For brevity, we do not present them here.

and in models that include district- post-TPDS interactions. Further a 10% increase in subsidy amount increased calorie intake from sugar and sugar products by 2%-3%, and lowered calorie intake from coarse grains by 4%-8%, and from other foods by 0.2%-0.5%, leaving the overall calorie intake unchanged. The reduced form estimates lead to the same conclusion. There is also some evidence that increase in income from food price subsidy increased consumption of edible oil, but the estimates are statistically significant only in models that include district-post-TPDS interactions.

Table 4 presents the effect of subsidy amount on total food expenditure, expenditure on high-cost (per calorie) food, and non-food expenditure. The OLS estimates show that in response to a Re. 1 increase in income due to the food price subsidy, households lowered total expenditure on food by Rs. 0.61, suggesting that households absorb 39% of the increase in income from food subsidy in expenditures on food. OLS estimates also suggest that increase in income is positively associated with an increase in expenditure on high-cost food and non-food expenditures. The IV estimates (model 4) suggest that a 10% increase in subsidy lowered total food expenditure by 0.2% to 0.4% and raised expenditure on non-food items by 0.2-0.3% and the latter estimates are statistically insignificant in models that control for district specific linear trends, but remain significant in models that allow district-post interactions. These estimates thus suggest that households divide the increase in income from food price subsidy to expenditures on food and non-food items, but there is little evidence that increased expenditure on food results in higher calorie intake.

We also study the effect of subsidy amount on protein and fat intake in high-rice and wheat consuming districts (Panel 1 table 5). Estimated effects are modest and mostly statistically insignificant.

Next, we investigate the effect of the wheat and rice price subsidy on nutrition and consumption patterns. The sample of analysis is districts where coarse grains are the staple food. Specifically, these are districts where monthly wheat and rice consumption was less than 20 kg per household in the pre-TPDS period, much less than 35 kg, the maximum allowed under TPDS. The OLS estimates in table 6 show that wheat and rice price subsidy raised calorie intake from rice and wheat. The coefficient on coarse grains is negative, but insignificant. Overall, the price subsidy appears to have a modest and statistically insignificant effect on calorie intake. Estimated effects from the IV models are similar: most estimates suggest that wheat and rice price subsidy raised calorie intake from wheat and rice and there is some evidence of substitution away from coarse grains, resulting in an overall negligible effect on total calorie intake.

Table 7 presents the effect of wheat/rice price subsidy on per capita total food expenditure, expenditure on high-cost (per calorie) food, and non-food expenditure. The OLS estimates show that an increase in wheat/rice price subsidy lowered expenditure on food and raised expenditure on non-food items. Estimated effects are modest and statistically insignificant in IV models. In models that do not include district specific trends or district*post interactions, our estimates suggest that food price subsidy lowered expenditure on food items and increased expenditure on non-food items (Appendix Table A2), however, these effects disappear in models that control for district-time effects (Table 7). We also study the effect of wheat and rice price subsidy on protein and fat intake in moderate-rice and wheat consuming districts (Panel 2 table 5). Estimated effects are modest and mostly statistically insignificant.

Conclusion and Discussion

In this paper, we study the effect of an exogenous increase in food price subsidy to poor families resulting from a targeted food price subsidy program in India called the Targeted Public

Distribution System (TPDS). The Indian government issued ration cards (BPL cards) to households with incomes below the official poverty threshold. The BPL cards enabled households to buy a maximum of 35 kg of wheat and rice per month at approximately a third of the market price. We use the probability of BPL card ownership as an instrumental variable to predict the food price subsidy of households and study how the increase in predicted food price subsidy amount and price subsidy (% price discount) resulting from the expansion of TPDS affected the nutritional intake and consumption patterns of poor families in rural India in states that have a well-functioning Public Distribution System.

We take advantage of diverse consumption practices across districts to stratify the sample covered by our study into two groups: districts where wheat and rice are the staple food and districts where coarse grains are the staple food. In the former set of districts, the average monthly wheat and rice expenditure is 35 kg or more and the food price subsidy is likely to have a purely income effect and we estimate the effect of the increase in income resulting for TPDS on the nutrition and consumption patterns of poor households in these districts. In the latter set of districts, the average monthly household consumption of wheat and rice is 16 kg and for most households the subsidized price is the marginal price in the post-TPDS period. For this latter set of districts, we study the effect of food price subsidy on nutrition and consumption patterns.

Our analysis suggests that increase in income resulting from the food price subsidy changed consumption patterns but had no effect on nutrition measured by per capita calorie intake, per capita protein intake, and per capita fat intake. The instrumental variables results show that a 100% increase in subsidy amount (over the pre-TPDS subsidy), which represents a 0.54% increase in income, increased calorie intake from wheat and rice by 3-6%; increased calorie intake from sugar and sugar products by 22%-30%, and lowered calorie intake from

coarse grains by 43%-82%, and from other foods by 2%-5%, leaving the overall calorie intake unchanged. Further, our analysis shows that households allocate some of the increase in income from the food price subsidy to expenditures on non-food items.

Estimates of the effect of food price on the three measures of nutrition – calorie, protein and fat intakes – are all negligible and statistically insignificant. We find evidence that the decline in the price of wheat and rice, due to the subsidy, changed consumption patterns toward increased consumption of wheat and rice and lowered consumption of coarse grains, the unsubsidized staple food. There is also some evidence of an increase in consumption of sugar and sugar substitutes – that are more expensive sources of calorie than wheat, rice or coarse grains. Finally, there is no evidence that food price subsidy raised consumption of non-food items.

Our findings are similar to the findings of previous research that documents low or zero income and price elasticities of nutrition. In addition, we find that income transfer (resulting from the increase in food price subsidy) alters consumption patterns towards the subsidized wheat and rice, more expensive sources of nutrition and non-food items, and away from non-subsidized, but cheap coarse grains. One implication of this finding is that while the food price subsidy program fails to improve nutrition among the poor, it changes consumption patterns that may in turn have substantial impact on agriculture markets – which is an unintended and perhaps undesirable effect of the policy. The results from this study also imply that the massive allocation of resources planned under the Right to Food Program in India, estimated to be three percent of GDP in the first year of its implementation, is not likely to reduce undernourishment.

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Table 1 Estimates of the Effect of Targeted Public Distribution on Food Price Subsidy and Subsidy Amount

	Price Discount (in Rupees)				% Price Discount				Subsidy Amount (in Rupees)			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Panel 1: High Rice/Wheat Consuming Districts												
Predicted probability of BPL	1.38***	1.37***	1.44***	1.70***	16.25***	16.21***	16.67***	19.28***	15.18***	15.15***	15.69***	17.77***
card ownership*Post TPDS	(0.18)	(0.18)	(0.19)	(0.19)	(1.94)	(1.94)	(2.02)	(2.12)	(1.94)	(1.94)	(1.86)	(1.91)
F-Statistic	59.91	58.52	59.91	82.26	70.56	69.56	68.06	82.45	61.47	60.68	70.90	86.86
Mean of the dependent variable before TPDS	0.197	0.197	0.197	0.197	2.592	2.592	2.592	2.592	1.841	1.841	1.841	1.841
N	13,101	13,101	13,101	13,101	13,101	13,101	13,101	13,101	13,101	13,101	13,101	13,101
Panel 2: Moderate Rice/Wheat Consuming Districts												
Predicted probability of BPL	2.34***	2.35***	1.76***	1.94***	21.00***	21.10***	18.73***	18.77***	14.42***	14.44***	11.23***	12.08***
card ownership*Post TPDS	(0.33)	(0.33)	(0.36)	(0.48)	(4.37)	(4.39)	(3.64)	(5.24)	(2.35)	(2.38)	(2.09)	(2.33)
F-Statistic	51.70	50.98	24.30	16.40	23.14	23.04	26.52	12.82	37.70	36.97	28.73	26.94
Mean of the dependent variable before TPDS	0.738	0.738	0.738	0.738	9.918	9.918	9.918	9.918	2.331	2.331	2.331	2.331
N	3,748	3,748	3,748	3,748	3,748	3,748	3,748	3,748	3,748	3,748	3,748	3,748
Model controls for:												
Household monthly per capita expenditure	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Mean district monthly per capita expenditure, District specific trend	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
Mean district monthly per capita expenditure, district-Post TPDS interactions	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each figure in the top row of each panel is based on a separate regression that controls for household head's age, education, gender, marital status, and occupation, education of other household members, household caste and religion, land ownership, household size, whether land is irrigated, ownership of durables, predicted probability of BPL card ownership, year and district fixed effects, in addition to the factors listed in the Table. The sample of analysis is rural households with less than the median monthly per capita expenditure. Further, the sample of analysis in panel 1 is restricted to districts where the average monthly household consumption of wheat and rice is 35kg or higher in the pre-TPDS period; the sample of analysis in panel 2 is restricted to districts where the average monthly household consumption of wheat and rice is less than 20 kg in the pre-TPDS period. Standard errors are clustered around the district of residence. Post-TPDS is equal to 1 if the observation is from 2004-2005.
*** p<0.01, ** p<0.05, * p<0.1

Table 2: Consumption Pattern in Households before and after the Expansion of the Targeted Public Distribution System

	High rice/wheat consuming districts						Moderate Rice/wheat consuming Districts					
	Cost per 1,000 calories		Per capita daily calories		Share of total per capita daily calories		Cost per 1,000 calories		Per capita daily calories		Share of total per capita daily calories	
	Pre-TPDS Expansion	Post-TPDS Expansion	Pre-TPDS Expansion	Post-TPDS Expansion	Pre-TPDS Expansion	Post-TPDS Expansion	Pre-TPDS Expansion	Post-TPDS Expansion	Pre-TPDS Expansion	Post-TPDS Expansion	Pre-TPDS Expansion	Post-TPDS Expansion
Wheat & rice	1.91	2.38	1178	953	0.598	0.528	1.96	2.59	264	273	0.142	0.157
Open market	(0.01)	(0.01)	(6.75)	(8.32)	(0.003)	(0.004)	(0.01)	(0.02)	(6.52)	(8.23)	(0.003)	(0.005)
Wheat & rice,	1.42	1.65	95	261	0.050	0.147	1.35	1.55	80	182	0.045	0.105
PDS	(0.01)	(0.01)	(2.79)	(6.53)	(0.001)	(0.004)	(0.02)	(0.02)	(2.93)	(8.33)	(0.002)	(0.005)
Coarse	1.17	1.63	175	95	0.087	0.053	1.13	1.74	915	727	0.494	0.410
Cereals	(0.01)	(0.01)	(4.23)	(3.52)	(0.002)	(0.002)	(0.01)	(0.02)	(9.62)	(12.21)	(0.004)	(0.006)
Pulses	4.63	6.46	100	82	0.052	0.046	5.31	7.41	103	87	0.057	0.050
	(0.02)	(0.02)	(0.95)	(0.58)	(0.000)	(0.000)	(0.03)	(0.02)	(1.04)	(1.12)	(0.001)	(0.001)
Milk & milk	8.41	11.78	79	73	0.037	0.039	8.21	12.01	62	60	0.034	0.034
Products	(0.06)	(0.12)	(3.71)	(2.72)	(0.001)	(0.001)	(0.09)	(0.12)	(1.38)	(1.62)	(0.001)	(0.001)
Edible oils	3.82	5.71	110	121	0.058	0.069	3.94	5.55	120	157	0.066	0.090
	(0.01)	(0.02)	(0.87)	(0.74)	(0.000)	(0.000)	(0.01)	(0.01)	(2.55)	(1.89)	(0.001)	(0.001)
Sugar and its	3.03	4.37	87	85	0.046	0.048	3.17	4.62	125	118	0.071	0.068
Substitutes	(0.01)	(0.01)	(0.60)	(0.73)	(0.000)	(0.000)	(0.02)	(0.04)	(1.23)	(1.42)	(0.001)	(0.001)
Egg, fish &	32.40	45.76	5	5	0.003	0.003	37.36	60.28	7	5	0.004	0.003
Meat	(0.31)	(0.47)	(0.11)	(0.11)	(0.000)	(0.000)	(0.54)	(1.14)	(0.67)	(0.23)	(0.000)	(0.000)
All other	11.53	17.76	133	118	0.070	0.067	11.20	16.74	150	139	0.087	0.082
foods	(0.05)	(0.07)	(1.86)	(2.21)	(0.001)	(0.001)	(0.09)	(0.12)	(4.18)	(2.88)	(0.002)	(0.002)
Total	2.94	4.11	1955	1789	1.000	1.000	2.85	4.32	1829	1752	1.000	1.000
	(0.01)	(0.03)	(5.31)	(5.64)	(0.000)	(0.000)	(0.02)	(0.08)	(10.19)	(10.66)	(0.000)	(0.000)

Note: Wheat and rice = wheat, atta (flour), and rice. Coarse cereals are jowar (sorghum), bajara (pearl millet), maize, and ragi (finger millet). Pulses are arhar/tur (pigeon pea), whole and split gram, moong, masur (red lentil), urd (black gram), peas, soyabean, khesari (grass pea), besan (gram flour), and other pulses and gram products. Milk products include baby food, milk powder, curd, ghee, butter, and ice cream. Edible oils are vanaspati (hydrogenated oil), margarine, mustard oil, groundnut oil, and coconut oil. Sugar substitutes are gur, candy, misri, honey, and khandsari. Costs are in current prices. Standard errors are in parenthesis. The average monthly household consumption of wheat and rice is 35kg or higher in the pre-TPDS period in high wheat/rice consuming districts and less than 20 kg in the pre-TPDS period in moderate wheat/rice consuming districts. Pre-TPDS expansion=1993-1994 and 1999-2000; PostTPDS expansion=2004-2005.

Table 3 Estimates of the Effect of Subsidy Amount on Total Per Capita Daily Calorie Intake and Calorie Intake from Specific Food Items

High rice/wheat consuming districts: average monthly wheat+rice consumption≥35 kg/household

	Mean	OLS	IV Linear	IV Log-Linear	IV Log-log	OLS	IV Linear	IV Log-Linear	IV Log-log	Reduced Form Estimates Prob(BPLCard)*Post-TPDS	
		Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Total Calorie	1897	2.974***	-8.641	-0.004	-0.018	2.955***	-1.479	-0.000	-0.002	-132.444	-19.574
(per capita per day)		(0.477)	(5.775)	(0.003)	(0.015)	(0.476)	(3.335)	(0.002)	(0.009)	(89.698)	(60.767)
Calorie from food items:											
Wheat and rice	1253	4.366***	1.844	0.007	0.030	4.375***	6.395	0.012**	0.055**	37.849	126.642*
		(0.734)	(5.897)	(0.006)	(0.031)	(0.769)	(4.054)	(0.005)	(0.024)	(95.624)	(74.527)
Coarse cereals	146.0	-1.522***	-8.472***	-0.178**	-0.818**	-1.497***	-10.33***	-0.094*	-0.427*	-134.48***	-185.11***
		(0.464)	(3.220)	(0.071)	(0.327)	(0.469)	(2.780)	(0.049)	(0.231)	(50.116)	(47.779)
Pulses	93.81	0.055	0.501	-0.007	-0.029	0.048	1.340***	0.002	0.011	7.828	23.869***
		(0.041)	(0.651)	(0.008)	(0.035)	(0.044)	(0.398)	(0.004)	(0.020)	(10.583)	(7.764)
Edible oils	113.8	0.034	0.064	0.003	0.013	0.033	0.762	0.010***	0.046***	0.841	13.251
		(0.060)	(0.709)	(0.005)	(0.025)	(0.062)	(0.471)	(0.004)	(0.018)	(11.266)	(8.708)
Milk, eggs, fish & meat	80.05	0.079	-1.323	-0.028	-0.129	0.100	-0.312	-0.005	-0.022	-20.556	-5.157
		(0.102)	(1.146)	(0.040)	(0.184)	(0.104)	(0.822)	(0.032)	(0.147)	(18.068)	(14.807)
Sugar and sugar substitutes	86.40	0.229***	0.896*	0.049*	0.223*	0.200***	1.612***	0.066***	0.303***	13.875*	28.527***
		(0.064)	(0.465)	(0.026)	(0.118)	(0.063)	(0.416)	(0.022)	(0.104)	(7.538)	(7.512)
All other foods	125.2	-0.281**	-2.237*	-0.011*	-0.053*	-0.339**	-1.200	-0.003	-0.016	-35.768*	-21.932
		(0.133)	(1.325)	(0.006)	(0.029)	(0.128)	(0.966)	(0.004)	(0.021)	(20.714)	(18.171)
District level trends		Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
District*Post-TPDS interactions		No	No	No	No	Yes	Yes	Yes	Yes	No	Yes
N		13,090	13,090	13,088	13,088	13,090	13,090	13,088	13,088	13,127	13,127

Note: Figures in each cell are based on a separate regression that controls for household head's age, education, gender, marital status, and occupation, education of other household members, household caste and religion, land ownership, household size, whether land irrigated, ownership of durables, the predicted probability of BPL card ownership, household monthly expenditure, year and district fixed effects. The dependent variable is per capita daily calorie from the food item listed in the row heading. The reported figures for Models 1-4 are the coefficients on food price subsidy. OLS=ordinary least squares. IV=two-stage instrumental variable regression. The sample of analysis is households with less than the median monthly per capita expenditure in districts where the average monthly household consumption of wheat and rice is 35kg or higher in the pre-TPDS period. See notes to Table 2 for definitions of food items. Standard errors clustered on district of residence, and corrected for two-stage estimation in IV models, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Estimates of the Effect of Subsidy Amount on Consumption Pattern

High rice/wheat consuming districts: average monthly wheat+rice consumption≥35 kg/household

				IV				IV		Reduced Form Estimate	
			IV	Log-	IV		IV	Log-	IV	Prob(BPLCard)*Post-	
	Mean	OLS	Linear	Linear	Log-log	OLS	Linear	Linear	Log-log	TPDS	
		Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Total food expenditure	223.0	-0.61***	-1.528**	-0.009**	-0.04***	-0.62***	-0.820*	-0.005*	-0.023*	-23.85**	-14.357*
(in Rs.at 2004-05 prices)		(0.057)	(0.608)	(0.003)	(0.015)	(0.057)	(0.478)	(0.003)	(0.012)	(9.673)	(8.565)
Expenditure on high-cost	75.44	0.080**	0.112	0.002	0.010	0.068*	0.260	0.005	0.024	1.687	4.626
(per calorie) food		(0.034)	(0.350)	(0.005)	(0.024)	(0.035)	(0.273)	(0.004)	(0.020)	(5.589)	(4.924)
Total non-food	120.1	0.238***	0.166	0.004	0.018	0.266***	0.308	0.007**	0.034**	2.388	5.223
expenditure		(0.063)	(0.398)	(0.004)	(0.016)	(0.063)	(0.327)	(0.003)	(0.014)	(6.484)	(6.151)
District specific trend	--	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
District*Post-TPDS interactions	--	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes
N		13,099	13,099	13,097	13,097	13,099	13,099	13,097	13,097	13,136	13,136

Note: Figures in each cell are based on a separate regression that controls for household head's age, education, gender, marital status, and occupation, education of other household members, household caste and religion, land ownership, household size, whether land irrigated, ownership of durables, the predicted probability of BPL card ownership, household monthly expenditure, year and district fixed effects. The dependent variable is listed as row heading. The reported figures for Models 1-4 are the coefficients on food price subsidy amount. OLS=ordinary least squares. IV=two-stage instrumental variable regression. The sample of analysis is households with less than the median monthly per capita expenditure in districts where the average monthly household consumption of wheat and rice is 35kg or higher in the pre-TPDS period. Standard errors clustered on district of residence, and corrected for two-stage estimation in IV models, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Estimates of the Effect of Food Subsidy Amount and Food price subsidy on Per capita Protein and Fat Intake

	OLS	IV Linear	IV Log-Linear	IV Log-log	OLS	IV Linear	IV Log-Linear	IV Log-log
Panel 1: Effect of Subsidy Amount								
Sample: High rice/wheat consuming districts								
Per capita Protein intake								
Subsidy Amount	0.088***	-0.351*	-0.005	-0.025	0.089***	-0.139	-0.002	-0.008
	(0.015)	(0.197)	(0.004)	(0.016)	(0.015)	(0.109)	(0.002)	(0.010)
Mean of the dependent variable	53.03	53.03	53.04	53.04	53.03	53.03	53.04	53.04
N	13,083	13,083	13,081	13,081	13,083	13,083	13,081	13,081
Per capita Fat intake								
Subsidy Amount	0.011	-0.177	-0.004	-0.021	0.011	-0.009	0.003	0.015
	(0.012)	(0.122)	(0.004)	(0.019)	(0.012)	(0.102)	(0.004)	(0.017)
Mean of the dependent variable	25.50	25.50	25.51	25.51	25.50	25.50	25.51	25.51
N	13,100	13,100	13,098	13,098	13,100	13,100	13,098	13,098
Panel 2: Effect of Price subsidy (% price discount)								
Moderate Rice/wheat consuming Districts								
Per capita Protein intake								
Price Discount	0.028	-0.007	0.002	0.017	0.030	-0.068	0.003	-0.002
	(0.025)	(0.243)	(0.006)	(0.021)	(0.025)	(0.111)	(0.003)	(0.009)
Mean of the dependent variable	53.15	53.15	53.17	53.35	53.15	53.15	53.17	53.35
N	3,740	3,740	3,739	3,371	3,740	3,740	3,739	3,371
Per capita Fat intake								
Price Discount	-0.017	0.111	0.005	0.011	-0.014	0.200	0.007	-0.003
	(0.019)	(0.181)	(0.005)	(0.015)	(0.018)	(0.198)	(0.005)	(0.021)
Mean of the dependent variable	31.90	31.90	31.91	31.94	31.90	31.90	31.91	31.94
N	3,746	3,746	3,745	3,376	3,746	3,746	3,745	3,376
Model controls for:								
District specific trend	Yes	Yes	Yes	Yes	No	No	No	No
District*Post-TPDS interactions	No	No	No	No	Yes	Yes	Yes	Yes

Note: OLS=ordinary least squares. IV=two-stage instrumental variable regression. Each figure in rows 1 and 4 of each panel is based on a separate regression that controls for household head's age, education, gender, marital status, and occupation, education of other household members, household caste and religion, land ownership, household size, whether land irrigated, ownership of durables, the predicted probability of BPL card ownership, household monthly expenditure, year and district fixed effects, in addition to the controls specified in the Table. Standard errors clustered on district of residence, and corrected for two-stage estimation in IV models, are in parentheses. The sample of analysis is households with less than the median monthly per capita expenditure. Further, the sample of analysis in panel 1 is restricted to districts where the average monthly household consumption of wheat and rice is 35kg or higher in the pre-TPDS period; the sample of analysis in panel 2 is restricted to districts where the average monthly household consumption of wheat and rice is less than 20 kg.

*** p<0.01, ** p<0.05, * p<0.1

Table 6 Estimates of the Effect of Food Price Subsidy (% price discount) on Per Capita Daily Calorie Intake from Specific Food Items
Moderate rice/wheat consuming districts (average monthly wheat+rice consumption≤20 kg/Household)

										Reduced Form Estimates	
	Mean	OLS	IV Linear	IV Log-Linear	IV Log-log	OLS	IV Linear	IV Log-Linear	IV Log-log	Prob(BPLCard)*Post-TPDS	
		Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Total calorie	1803	0.989	1.505	0.004	0.020	1.049	-0.618	0.004	-0.001	28.381	-10.526
(per capita/day)		(0.725)	(7.220)	(0.005)	(0.020)	(0.717)	(3.781)	(0.003)	(0.010)	(138.099)	(77.088)
Calorie by food items:											
Wheat and rice	384.7	1.486*	12.980**	0.028*	0.134	1.548*	13.57***	0.033**	0.164**	241.421**	249.55***
		(0.733)	(5.339)	(0.016)	(0.085)	(0.738)	(4.618)	(0.014)	(0.080)	(90.507)	(61.541)
Coarse cereals	852.2	-0.649	-13.965**	-0.061*	-0.247	-0.634	-16.88***	-0.052*	-0.308**	-265.683*	-318.092***
		(0.723)	(6.940)	(0.032)	(0.156)	(0.719)	(5.349)	(0.026)	(0.144)	(135.000)	(63.356)
Pulses	98.10	0.059	0.662	0.004	0.009	0.058	0.391	-0.003	-0.015	12.684	7.649
		(0.066)	(0.498)	(0.006)	(0.026)	(0.065)	(0.493)	(0.006)	(0.026)	(8.620)	(9.149)
Edible oils	133.3	-0.020	0.990	0.011**	0.034	-0.018	0.748	0.009	0.018	20.550	16.238
		(0.095)	(0.752)	(0.005)	(0.025)	(0.094)	(1.017)	(0.008)	(0.042)	(15.885)	(20.633)
Milk, eggs, fish	68.09	0.067	-0.428	-0.026	-0.097	0.063	0.202	-0.005	-0.072	-7.567	4.268
& meat		(0.055)	(0.569)	(0.043)	(0.152)	(0.062)	(0.450)	(0.042)	(0.183)	(10.560)	(8.591)
Sugar and sugar	123.4	0.091*	1.480*	-0.003	0.014	0.098*	1.708*	-0.006	-0.048	29.117*	33.994**
Substitutes		(0.051)	(0.827)	(0.021)	(0.069)	(0.049)	(0.931)	(0.019)	(0.082)	(15.173)	(15.759)
All other foods	142.8	-0.031	0.080	0.005	0.005	-0.049	0.082	0.005	-0.002	3.239	3.733
		(0.100)	(1.481)	(0.006)	(0.027)	(0.102)	(1.297)	(0.007)	(0.029)	(28.901)	(25.274)
District-trends		Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
District-post TPDS interaction		No	No	No	No	Yes	Yes	Yes	Yes	No	Yes
N		3,744	3,744	3,743	3,375	3,744	3,744	3,743	3,375	3,763	3,763

Note: Figures in each cell are based on a separate regression that controls for household head's age, education, gender, marital status, and occupation, education of other household members, household caste and religion, land ownership, household size, whether land irrigated, ownership of durables, the predicted probability of BPL card ownership, household monthly expenditure, year and district fixed effects. The dependent variable is per capita daily calorie from the food item listed in the row heading. The reported figures for Models 1-4 are the coefficients on food price subsidy (% price discount). OLS=ordinary least squares. IV=two-stage instrumental variable regression. The sample of analysis is households with less than the median monthly per capita expenditure in districts where the average monthly household consumption of wheat and rice is 20kg or less in the pre-TPDS period. See notes to Table 2 for definitions of food items. Standard errors clustered on district of residence, and corrected for two-stage estimation in IV models, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Estimates of the Effect of Food Price Discount (% price discount) on Consumption Pattern
Moderate rice/wheat consuming districts (average monthly wheat+rice consumption≤20 kg/Household)

										Reduced Form Estimates	
	Mean	OLS	IV Linear	IV Log-Linear	IV Log-log	OLS	IV Linear	IV Log-Linear	IV Log-log	Prob(BPLCard)*Post-TPDS	
		Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Total food expenditure (in Rs.at 2004-05 prices)	210.1	-0.16**	0.270	0.003	0.013	-0.16***	0.245	0.002	-0.005	6.631	6.716
		(0.055)	(0.564)	(0.004)	(0.014)	(0.054)	(0.690)	(0.004)	(0.015)	(11.149)	(13.321)
Expenditure on high-cost (per calorie) food	87.35	0.082*	0.488	0.004	0.010	0.077*	0.527	0.002	-0.000	10.035	10.990
		(0.040)	(0.329)	(0.004)	(0.018)	(0.042)	(0.426)	(0.005)	(0.026)	(6.220)	(7.823)
Total non-Food Expenditure	125.8	0.106***	0.014	-0.000	0.013	0.105**	-0.112	-0.000	0.011	0.314	-2.203
		(0.035)	(0.540)	(0.005)	(0.022)	(0.036)	(0.499)	(0.005)	(0.021)	(10.819)	(9.870)
District-trends		Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
District-post TPDS interaction		No	No	No	No	Yes	Yes	Yes	Yes	No	Yes
N		3,748	3,748	3,376	3,376	3,748	3,748	3,376	3,376	3,765	3,765

Note: Figures in each cell are based on a separate regression that controls for household head's age, education, gender, marital status, and occupation, education of other household members, household caste and religion, land ownership, household size, whether land irrigated, ownership of durables, the predicted probability of BPL card ownership, household monthly expenditure, year and district fixed effects. The dependent variable is listed as row heading. The reported figures for Models 1-4 are the coefficients on food price subsidy (% price discount). OLS=ordinary least squares. IV=two-stage instrumental variable regression. The sample of analysis is households with less than the median monthly per capita expenditure in districts where the average monthly household consumption of wheat and rice is 20kg or less in the pre-TPDS period. Standard errors clustered on district of residence, and corrected for two-stage estimation in IV models, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

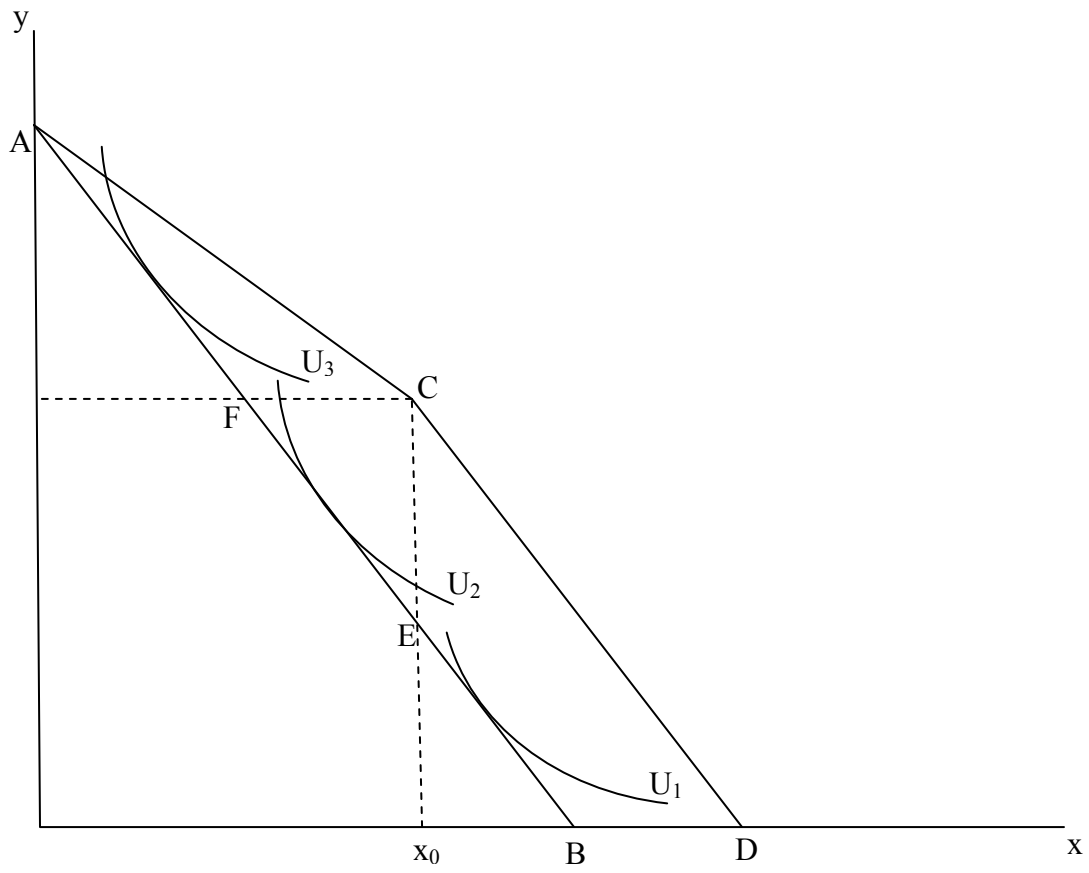

Figure 1. Food price subsidy

Table A1 Estimates of the Effect of Subsidy Amount on Nutrition and Consumption pattern
High rice/wheat consuming districts (average monthly wheat+rice consumption≥35 kg/Household)

	Mean	OLS	IV Linear	IV Log-Linear	IV Log-log	Reduced Form Prob(BPLCard)* Post-TPDS
Nutrition:		Model 1	Model 2	Model 3	Model 4	Model 5
Total Calorie	1897	3.158***	-0.692	-0.001	-0.004	-5.670
(per capita per day)		(0.506)	(4.318)	(0.003)	(0.010)	(65.525)
Total Protein	53.03	0.097***	0.006	-0.002	-0.007	0.187
(per capita per day)		(0.017)	(0.163)	(0.003)	(0.013)	(2.496)
Total Fat	25.50	0.015	0.003	-0.001	-0.002	0.017
(per capita per day)		(0.012)	(0.078)	(0.004)	(0.014)	(1.194)
Calorie from food items:						
Wheat and rice	1253	4.529***	6.907	0.011*	0.043*	111.126
		(0.786)	(5.742)	(0.006)	(0.024)	(87.751)
Coarse cereals	146.0	-1.582***	-6.962*	-0.192**	-0.723**	-105.706*
		(0.472)	(3.713)	(0.081)	(0.307)	(56.729)
Pulses	93.81	0.103**	0.861	0.001	0.005	12.964
		(0.051)	(0.648)	(0.008)	(0.029)	(9.986)
Edible oils	113.8	0.043	-0.419	-0.002	-0.007	-6.602
		(0.058)	(0.614)	(0.005)	(0.019)	(9.433)
Milk, eggs, fish	80.05	0.107	0.397	-0.008	-0.029	5.855
& meat		(0.119)	(0.584)	(0.039)	(0.148)	(9.024)
Sugar and sugar	86.40	0.252***	1.106*	0.079**	0.298**	16.478*
substitutes		(0.065)	(0.605)	(0.039)	(0.143)	(9.620)
All other foods	125.2	-0.317**	-2.489**	-0.003	-0.010	-38.021**
		(0.123)	(1.229)	(0.007)	(0.025)	(16.923)
Consumption Pattern:						
Total food expenditure	223.0	-0.585***	-1.549**	-0.008**	-0.031**	-23.477**
(in Rs.at 2004-05 prices)		(0.063)	(0.671)	(0.004)	(0.013)	(9.677)
Expenditure on high-	75.44	0.103**	0.237	0.003	0.013	3.394
Cost (per calorie) food		(0.045)	(0.471)	(0.006)	(0.022)	(7.310)
Total non-Food	120.1	0.269***	0.801	0.010**	0.038**	12.030
Expenditure		(0.067)	(0.524)	(0.005)	(0.017)	(7.766)
District level trends		No	No	No	No	No
N		13,090	13,090	13,088	13,088	13,127

See note to Table 3.

Table A2 Estimates of the Effect of Food Price Subsidy (% Price Discount) on Nutrition and Consumption pattern
Moderate rice/wheat consuming districts (average monthly wheat+rice consumption≤20 kg/Household)

	Mean	OLS	IV Linear	IV Log-Linear	IV Log-log	Reduced Form Prob(BPLCard)* Post-TPDS
Nutrition:						
Total Calorie (per capita per day)	1803	0.805 (0.686)	-2.061 (5.188)	-0.001 (0.003)	0.000 (0.014)	-41.985 (120.586)
Total Protein (per capita per day)	53.12	0.023 (0.024)	-0.078 (0.152)	-0.001 (0.003)	-0.003 (0.013)	-1.673 (3.578)
Total Fat (per capita per day)	31.91	-0.019 (0.018)	-0.158 (0.157)	-0.008 (0.005)	-0.047** (0.023)	-3.092 (3.444)
Calorie from food items:						
Wheat and rice	384.7	1.701** (0.686)	9.757*** (3.363)	0.010 (0.009)	0.053 (0.049)	210.097** (83.527)
Coarse cereals	852.2	-0.989 (0.745)	-9.582 (6.035)	-0.047** (0.022)	-0.235 (0.148)	-208.904 (160.620)
Pulses	98.10	0.063 (0.066)	-0.100 (0.460)	-0.001 (0.005)	-0.016 (0.030)	-1.519 (9.930)
Edible oils	133.3	-0.029 (0.101)	-0.777 (1.113)	-0.013 (0.011)	-0.078 (0.051)	-14.251 (24.250)
Milk, eggs, fish & meat	68.09	0.054 (0.061)	-0.305 (0.528)	-0.032 (0.032)	-0.183 (0.122)	-6.466 (11.524)
Sugar and sugar substitutes	123.4	0.077 (0.054)	0.599 (0.453)	-0.013 (0.011)	-0.031 (0.044)	13.209 (9.671)
All other foods	142.8	-0.057 (0.110)	-1.591 (1.163)	-0.010 (0.007)	-0.075** (0.036)	-32.803 (23.642)
Consumption Pattern:						
Total food expenditure (in Rs.at 2004-05 prices)	210.1	-0.185*** (0.050)	-1.030 (0.671)	-0.008** (0.004)	-0.045** (0.018)	-20.891 (15.721)
Expenditure on high-Cost (per calorie) food	87.35	0.069 (0.041)	-0.200 (0.442)	-0.005 (0.006)	-0.037 (0.024)	-3.636 (9.757)
Total non-Food Expenditure	125.8	0.139*** (0.046)	1.283** (0.567)	0.010* (0.005)	0.058** (0.023)	27.638* (14.616)
District level trends		No	No	No	No	No
N		3,744	3,744	3,743	3,375	3,763

See Note to Table 6.