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Welfare implications of fiscal reform: The case of food subsidies in India

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Discussion Paper No. 2002/32

Welfare Implications of Fiscal Reform

The Case of Food Subsidies in India

Sonia Bhalotra*

March 2002

Abstract

This paper investigates the effect of a food subsidy programme in India on child malnutrition by addressing the following linked questions using household survey data that includes information on usage of the public distribution system. *First*, does the food subsidy induce higher expenditures on food? *Second*, are there gender inequalities in the distribution of food within the household, and in the gains from the food subsidy? *Third*, does food spending impact on child health? Is this effect similar for boys and girls and in the short and the medium term? These questions are of interest with respect to the unusually high incidence of malnutrition in India, and they are topical in the context of current and controversial reform of the public distribution system through which the food subsidy operates.

Keywords: child malnutrition, food subsidies, poverty, welfare, health, gender, India

JEL classification: I1, I3, O1, H4, D1, C2

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Figure 1 appears at the end of the paper.

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1 Questions addressed

The main purpose of the proposed research is to investigate the effects of the food subsidy offered through the public distribution system (PDS) on childhood malnutrition in India. This has not been done before. It is of immediate policy interest both with respect to the unusually high incidence of malnutrition in India, and with respect to the current re-shaping of the PDS. For this, we use a recent household survey that contains information on grain bought on the PDS and on the open market, anthropometric indicators for child health and a rich set of socio-economic and demographic variables pertaining to rural households in India in the mid-1990s.

In the course of addressing the main question, our research will illuminate the following questions. *First*, there is the interesting and difficult question of estimating the counterfactual: Do users of the PDS buy more food than they would if they did not face a subsidy? How much more? *Second*, there is the often neglected question of inequalities in the within-household distribution of food. This paper investigates whether there are gender inequalities in the gains accruing to a household on account of a food subsidy. *Third*, there is the question of how health is produced. Does food matter? Does income matter at a given level of food expenditure? Or do factors like maternal health largely pre-determine nutritional status and morbidity risk? The paper quantifies the role of food expenditure in producing changes in child health indicators such as height and weight for age.

2 Motivation

There is a very high incidence of child malnutrition in India, estimated at 66 per cent in 1998 for children under 5 (World Development Indicators, World Bank 1998a). The all-India figures on malnutrition conceal enormous variation across the regions of India, a fact that the proposed analysis will exploit, given that there are also remarkable variations in access to and usage of the public distribution system through which food subsidies are made available to households in India. The incidence of malnutrition has been declining but not as rapidly as recent economic growth in India may lead us to expect. Malnutrition is *concentrated* amongst the poor and the fact that it can impair productive activity and educational achievement creates a poverty trap that can perpetuate itself across generations An intriguing fact about malnutrition is that it is not *limited* to the poor. Indeed, about 70 per cent of individuals are estimated to be malnourished in India as compared with the 30 per cent that have incomes below the poverty line (e.g. Suryanarayana 2001, Swaminathan 2000).[1]

The Human Poverty Index introduced in the Human Development Report (UNDP 1997) includes the percentage of malnourished children under five. As a result, the regular ranking of countries in terms of human development now partly reflects the extent of

[1] The most likely explanation of this is that the poverty-line is calorie-based and adequate nutrition requires more than calories. Since the relative prices of foods rich in proteins and in vitamins and minerals are relatively high, it may not be so surprising that a large fraction of households with incomes above the poverty line cannot afford to balance their diets.

child malnutrition. Malnutrition is an intrinsic component of well-being and an important index of human welfare, known to predispose a child towards morbidity and mortality (e.g. Gómez et al. 2000, Rice et al. 2000) and low levels of educational attainment (Glewwe and Jacoby 1995) and productivity (see Dasgupta 1993).

What can be done to address this problem? To the extent that the problem reflects inadequate access to food, a government distribution network that incorporates a food subsidy would appear to be an appropriate intervention. India's public distribution system (PDS), which has been around since the Bengal Famine of 1943 is precisely such an intervention. Until recently, it offered a universal entitlement to a food subsidy to all citizens of the country. In the last decade, fiscal constraints have precipitated path-breaking changes in the system. It is now targeted at the poor. Some argue that it should be phased out as it is not only unaffordable but also inefficient, whilst others argue that it is crucial for food security in India. This paper offers new insights relevant to this ongoing debate on the public distribution system. It also contributes to the literature on child health in India.

3 The fiscal context of the food subsidy

Following some tentative steps towards economic liberalisation in the 1980s, India embarked on a programme of economic reform in 1991 with the objective of achieving macroeconomic stabilization and structural adjustment, the latter being closely tied to getting prices right. Both processes encourage government expenditure reduction and the removal of subsidies. In this context, the PDS has commanded considerable attention. It has been argued that it is an obsolescent and fiscally unsustainable institution (e.g. Umali-Deiringer and Deiringer 2001, World Bank 1998b, Radhakrishnan and Subbarao 1997). These authors have typically also argued that the PDS has a poor record of reaching the poor. Hence the move towards slimming the system and targeting the subsidy at the poor. This done, there is still a view that the PDS should be phased out and replaced with more effective instruments for reaching the poor. Others (e.g. Mooij 1994, Swaminathan 2000) see these changes of content and tone as indicators of the general weakening of welfare systems in the context of economic liberalisation. They argue that it is an important safety net for the poor, most likely to be useful in the current context of deregulation and inflation.

How large a fiscal burden does the PDS impose? What is the current situation? The cost of the food subsidy in the Central Government budget is argued to have increased substantially since the mid-1980s. For example, it increased from Rs. 6.5 billion (0.5 per cent of GDP) in 1980–81 to Rs. 18 billion (0.7 per cent of GDP) in 1993–94 (see Table 1). Table 2 shows Central Plan budgetary expenditures on the PDS relative to other welfare expenditures. The central food subsidy is augmented by further subsidies offered by some state governments such as those of Kerala, Andhra Pradesh and Karnataka (Radhakrishna and Subbarao 1997, p.1). For comparison, it is interesting to note that public expenditures on health and education as a percentage of GDP and GNP respectively were 0.7 per cent and 3.8 per cent in 1990–96 (World Bank 1998b). The increasing fiscal cost of the PDS has been reflected in higher procurement and issue prices of rice and wheat in the 1990s. With the consequent shrinking of the difference between PDS and open market prices, consumers have begun to shift from the PDS to

the open market. At the same time, farmers have been keen to supply grain to the Food Corporation of India (FCI),[2] given the generous minimum support price offered to producers. As a result, the FCI has bought more foodgrain than it can manage, resulting in a huge increase in the cost of holding buffer stocks (which is counted as part of the cost of the food subsidy). The recommended stock of foodgrain on 1 July of every year is 22.3m tonnes of which 12.3m tonnes is the PDS requirement and 10m tonnes is retained as insurance against fluctuations in food production. In July 1995, the FCI had a foodgrain stock of 35.6m tonnes, which implied an increase in carrying cost of 78 per cent!

Table 1

Central Government expenditure on the food subsidy

	Expenditure at 1980 prices (Rs million)	Expenditure/GNP (%)	Expenditure/total government expend.(%)
1974	4238	0.44	3.01
1975	3688	0.35	2.08
1976	7029	0.66	3.85
1977	6276	0.55	3.20
1978	7316	0.61	3.22
1979	6689	0.58	3.24
1980	6500	0.53	2.89
1981	6349	0.49	2.76
1982	5961	0.45	2.33
1983	6466	0.45	2.32
1984	7927	0.53	2.51
1985	11032	0.71	3.11
1986	12511	0.77	3.12
1987	11506	0.68	2.84
1988	11703	0.63	2.70
1989	12172	0.61	2.60
1990	10863	0.52	2.33
1991	11018	0.53	2.53
1992	9903	0.45	2.22
1993	17871	0.78	3.80
1994	14920	0.61	3.01

Source: FCI Performance Budget documents & Economic Survey, GOI, several years.

2 The FCI is the central body responsible for procuring and distributing grain under the Public Distribution System.

Table 2

Anti-poverty programmes: central plan budgetary expenditure

Figures are percentages of total expenditure

	1	2	3	4	5	6	7	8
	Food subsidy	Rural empl.	IRDP & related	Welf. & nutrition	NRY	SC/ST welfare	ΣCentre APP	+ basic needs
1990	2.3	1.9	0.4	0.3	0.1	0.3	5.3	6.4
1991	2.6	1.6	0.3	0.4	0.1	0.4	5.3	6.6
1992	2.3	2.1	0.3	0.4	0.1	0.4	5.6	6.7
1993	3.9	2.8	0.5	0.4	0.1	0.4	8.0	9.4
1994	3.2	2.9	0.4	0.9	0.0	0.5	7.9	9.3
1995	3.0	2.7	0.4	0.8	0.0	0.4	7.3	8.9
1996	3.0	2.5	0.3	0.7	0.0	0.4	7.0	8.9
1997	3.2	2.3	0.2	0.7	0.0	0.3	6.7	8.9

Source: World Bank (1997, Table 4.1), based on GOI data. Rural employment programmes include JRY, EAS, IAY and MWS. Basic needs programmes include outlays for elementary and adult education, accelerated rural and urban water supply and sanitation, child welfare (including the midday meals programme) and backward area development programmes (drought prone, desert, wastelands). APP is anti-poverty programmes.

4 The public distribution system in India

The rural Indian population spends about 64 per cent of its budget on food. Foodshare is an (inverse) indicator of welfare (e.g. Deaton 1997): it follows that food security should be a major focus of policies concerned with wellbeing in this society. In terms of both coverage and public expenditure, the most important instrument of the Indian state in the area of health and nutrition policy is the Public Distribution System (PDS). Of the 200 million tonnes of foodgrain produced in 1999–2000, about 29 million tonnes were procured by the government under the PDS, which now supports the largest network of 'fair price shops' in the world (4.5 lakh outlets in 1999). These provide rice, wheat, sugar, edible oil, soft cake and kerosene oil at subsidised prices. The PDS is managed by state governments which, to varying degrees, also supply other commodities such as pulses, salt and coarse clothing. The central government determines the total procurement of foodgrains and their allocation across states. The state government then determines the off-take, public distribution, the list of commodities provided, and retail prices (Bapna 1990). Food security falls under the Directive Principles of State Policy in India's federal structure. Locations of the fair price shops through which the subsidised items are sold are determined by officials at the district level, taking account of village size and 'suitability' (Suryanarayana 1996). There is enormous variation in the density of fair price shops as also in the regularity of supplies both across and within states.

It has a long history. Quantity rationing of essential commodities was introduced in India in the inter-war period and the PDS took shape soon after the Bengal Famine in 1943. It evolved in the 1950s and 1960s as a mechanism for providing price support to producers at the same time as providing a food subsidy to consumers. This was a time when the country was threatened by national-level food shortages and there was rapid food price inflation, especially in urban areas. By the 1980s, India had generated a surplus of foodgrains and the incidence of poverty had declined progressively from about 50 per cent in the 1960s to about 30 per cent in the 1990s. As a result, the welfare component of the PDS gained strength in the 1980s, when it was considerably extended to rural areas and tribal blocks, with an explicit view to reaching areas of high poverty incidence. In the context of currency devaluation and economic reform in the 1990s, procurement and issue prices of PDS commodities were increased and the government sought to mitigate adverse welfare consequences by better targeting of PDS supplies at the poor. Until 1992, there was universal entitlement to the PDS but it has since been restructured. In 1992, the subsidy on foodgrains was increased for people in tribal, drought-prone and desert areas (spread over 1775 blocks). This was called the Revamped PDS or RPDS. In 1997, it was replaced by the Targeted PDS or the TPDS in which targeting was shifted from poor regions to poor households and the subsidy differential between the poor and the non-poor was widened. More specifically, 10 kg of foodgrain were available at a highly subsidised price per family per month for families below the poverty line. This tendency was pushed further in the year 2000, since when families below the poverty line were are offered 20 kg per month at half the economic cost while all other families are required to pay the economic cost (see Government of India 2000). So the subsidy to the poor is indexed to costs. And those classified as non-poor now get no subsidy (unless they live in drought-prone areas, in which case they get the 50 per cent subsidy that the poor get) though they are served by fair price shops, which can play a useful distributional function in areas where private shops have not emerged.

5 A preliminary assessment of the debate

It is not the main purpose of this paper to assess the overall viability or relative effectiveness of the PDS. However, in order to motivate this paper, we present in this section an overview of the recent debate that recent reforms (indicated in the preceding section) have generated. This will set the question we ask in a policy context.

Arguments in favour of a severe trimming down of the PDS are of *two sorts*, and it is important to distinguish between them. One is that it is too great a fiscal strain. This argument often rests on indications of how the PDS is inefficiently run, which means that it imposes an *unjustifiable* fiscal strain (see Dev and Suryanarayana 1991, Swaminathan 2000). For example, there is evidence of leakages- of subsidised grain being diverted to the open market for profit. It has also been argued that meeting the cereal needs of the poor in India requires a budgetary commitment that is simply too large (Geetha and Suryanaryana 1993). The estimates themselves deserve closer consideration, especially as other research has estimated that the cost of achieving calorie adequacy is a trivial fraction of the household budget (see Deaton and Subramaniam 1996). Also, such a claim needs to be investigated in relation to the entire programme of public spending. The discussion should clearly indicate whether the argument is about cutting the share of social spending or about allocating a given or

greater share amongst alternative programmes. This is beyond the scope of the current paper. Some discussion of alternative programmes is in Radhakrishna and Subbarao (1997) and Chatterjee and Measham (1997), both World Bank publications.[3] There remains considerable scope for tightening the analysis.

The second argument adduced to support a narrowing of the scope of the PDS is that it is not progressive: it is argued to have failed in many states to provide nutritional support to the poor. This argument is made, for example, in Parikh (1994) where aggregate data are tabulated to show that the participation rate in the PDS is similar across income groups. This sort of analysis has influenced opinion against support for the PDS and it has been argued that other schemes such as food-for-work programmes are more progressive because the non-poor will tend to select themselves out of participation in a programme that offers a low wage and requires work (e.g. World Bank 1998b). However, this argument seems flawed unless it can be shown that the PDS is non-progressive *after controlling for access*. Suppose that within a given region where programme access is similar across households, the poor utilise the PDS more than the non-poor. It seems plausible that the non-poor will select themselves out of the scheme on account of the poor quality of grain that is supplied through it or else on account of having to queue for supplies. Within regions, then, we may conclude that the programme is progressive. Suppose, however, that the location of fair price shops or the delivery of regular supplies favours relatively rich regions, say, on account of political lobbying or because transport costs are lower (poorer regions tend to be more remote). Then taking aggregate data and failing to control for programme access, the programme may appear to be non-progressive when in fact it is not. So access is key and analysis of micro-data, controlling for access, is warranted. The regional distribution of the PDS has in fact been very uneven, there being a greater density of fair price shops in urban than in rural areas (e.g. Howes and Jha 1992) and, this aside, a much better developed distribution network in some states than in others (see Table 3).[4] As the states with a weak PDS are relatively poor states and as the poor are disproportionately located in rural areas, access has disfavoured the poor[5]. In summary, if the programme is pro-poor conditional on access then the role for policy is to expand access. This is distinct from searching for alternative pro-poor programmes on the grounds that the PDS is inherently unprogressive.

In defence of the PDS and, especially, its role in supporting food security for the poor, the following four arguments can be distinguished. First, even if entitlement were universal as was the case until 1992, some degree of progressivity is likely to have been introduced by (a) self-selection, as discussed above, and (b) by virtue of the fact that the

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3 Radhakrishnan and Subbarao (1997) estimate the cost per unit of income or nutritional gain under the PDS, and compare this with other anti-poverty programmes in India, concluding that the PDS is considerably less cost-effective than the JRY, MEDS or ICDS.

4 Diversity in the experience of states is valuable in illustrating the *potential* of the PDS. In Kerala, for example, delivery functions without too much malpractice and utilization is nearly universal.

5 In the sample of rural households analysed in this paper, about 34 per cent of all households report buying grain on the PDS in the preceding month and this percentage is similar among the non-poor and the poor. Since access is regionally differentiated, it may be the case (for example) that most non-poor households have access and 66 per cent self-select themselves out of the scheme whereas only about 34 per cent of poor households have access and most of them use the PDS. No previous research has attempted to distinguish between self-selection and programme selection.

poor spend a larger fraction of their budget on food than the rich. Second, the (centralised) PDS plays a critical distributional function that ongoing reforms in India need to be careful to protect. The grain distributed under the PDS is regularly procured by the government from farmers at a supported price and a certain (large) fraction is held as a buffer stock. This is available to smooth supply and stabilise prices in response to fluctuations in production. For example, in 1979 and 1987, years of low production, PDS supplies were considerably higher than usual. In both these years, the government increased supply through employment programmes located in distressed areas (see Radhakrishnan and Subbarao 1997). In the extreme, PDS reserves are available for the central government to react to regional crises created by drought or flood, for example (see Besley and Burgess 2001) for evidence that it does react in this way). A third problem with cutting back the PDS or narrowing its reach to the income-poor is that of physical access to food. By virtue of building fair price shops, the PDS has, at least in some states, significantly improved access in some of the more remote and economically underdeveloped regions where the market has yet to penetrate. Indeed, in the 1980s, the rural network of PDS supplies expanded considerably (be there much scope for improvement). As Sen (1981, for example) has emphasized, aggregate availability is not enough to avoid food deprivation when distribution is uneven. And distribution does not just involve purchasing power but also an effective delivery system (see Venugopal 1992).[6] These arguments militate against narrowing the scope of the PDS down to those classified as income poor. Fourth, the proportion of people below the poverty line is considerably smaller than the proportion malnourished. In 1999/2000, poverty incidence is estimated to have been 26 per cent (e.g. Sundaram 2001), while malnutrition is estimated to have been about 70 per cent around 1998 (World Bank 1998a). This is not implausible since the non-poor may, for example, be calorie-adequate but not able to afford balanced nutrition and build disease resistance. In this context, it is relevant that the income distribution in India is highly skewed, so that a large slice of society above the poverty line is not very well off. In any case, it implies that a programme that offers food subsidies to a larger proportion of the population than that classified as income-poor may be justified as addressing the problem of malnutrition. This particular question has not been established, and investigation of it is the objective of this paper.

Overall, it is clear that, in the context of this debate over the whittling down of one of the oldest, most far-reaching food subsidy programmes in the world, it is important to see if the new methods and new data used in this study can throw any light on the actual effects of the PDS on child malnutrition and, thereby, contribute to reconsideration of its benefits.

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6 Research has established that the distribution of cereal consumption and calorie intake across the Indian states is not correlated with foodgrain production (*except in drought years)* but with the distribution of purchasing power and physical access to food (Suryanarayana 1996). This differs remarkably across states with Kerala having a very dense network of fair price shops in rural and urban regions and less well-governed states like Bihar having no shop in most villages.

Table 3

Participation in PDS: by state & income group

	# households	% PDS users	% subsidy	pov.rank	% poor
Andhra	2100	64.0	13.0	15	21.9
Assam	1233 (NE)*	21.6 (NE)*	4.3	5	41.1
Bihar	2155	5.6	4.5	1	55.2
Gujarat	1606	47.5	3.6	14	24.2
Haryana	1722	9.4	2.7	12	25.2
Himachal	1225	75.2		10	28.6
Karnataka	2523	69.9	5.7	9	32.9
Kerala	1474	76.1	9.5	13	25.1
Madhya	4162	33.9	3.9	3	42.5
Maharashtra	2765	2.3	7.6	6	36.8
Orissa	1971	5.2	3.1	2	48.6
Punjab	1303	6.4	2.0	16	11.5
Rajasthan	1984	24.3	4.8	11	27.5
Tamil	1456	81.0	6.2	8	35.4
Uttar	4036	4.3	7.7	4	41.2
West Bengal	1515	9.4	7.1	7	36.9
All India	33230	34.6	100	-	36.1

Sources: Columns 1 and 2: Human Development Report, India and author's own calculations based on NCAER, 1994. Column 3: Performance Budgets of FCI (reported in Radhakrishnan and Subbarao 1997, Table 3.4). Column 5 has the head count index for rural and urban areas combined, from World Bank (1997, Annex 1, Table 1) and column 4 is based on column 5.

6 Previous research

6.1. On the Indian PDS

There is no existing research that attempts to analyse the impact of the Indian Public Distribution System on childhood malnutrition. Previous research on the PDS in India has been concerned with its inflationary consequences, its administration, and its correlation with poverty. Particular questions investigated include regional variations in the supply of foodgrains through the PDS (Tyagi 1990), urban bias (Howes and Jha 1990), targeting (Jha 1991, Dev and Suryanarayana 1992), and the growing cost of the food subsidy (e.g. World Bank 1998b).

The only studies that appear to investigate welfare effects of the PDS are Parikh (1994: described in Section 5) and Radhakrishnan and Subbarao (1997). As the latter makes a relatively careful attempt, it is considered in some detail. Both use the 1986–87 National

Sample Survey data which provide information on open market and PDS prices and expenditures for a range of commodities. These are microdata but both studies use these data aggregated up to deciles of monthly per capita expenditure. Radhakrishna and Subbarao (1997) compute the income gain for users of the PDS as the product of the quantity purchased from the PDS and the price differential between the open market and the PDS. In per capita terms, this is estimated to be Rs. 2.01 per month or 2.7 per cent of per capita expenditure for the rural poor, and Rs. 3.4 or 3.2 per cent of p.c. expenditure for the urban poor. In absolute (rupee) terms, the income gain was marginally larger for the rich. They use income elasticities of calories estimated by decile in Radhakrishna and Ravi (1990) to translate the income gains into increases in calorie intake associated with the PDS. Given that the poor have higher calorie-income elasticities, these gains are larger for the poor than the non-poor. Moreover, these averages hide enormous variations across states as well as significant variations across commodities sold on the PDS. About 84 per cent of the income gain for the rural poor was on account of rice, sugar and clothing, the per unit subsidy on wheat being about 10 per cent as compared with a per unit subsidy on rice, for example, of about 35 per cent. Amongst states, average income and calorie gains were considerably greater in Kerala, Andhra, Karnataka and Gujarat than in the poorer states of Bihar, Orissa and UP. So, for instance, the income gain associated with PDS rice purchases in Kerala is Rs. 5.4 per capita per month for the poor and Rs. 4.7 for the non-poor, which is not inconsiderable. The calorie gain for the very poor in Kerala (bottom 25 per cent of those under the poverty line) associated with PDS use is 12 per cent (the corresponding all-India average is 3 per cent).

6.2 On childhood malnutrition

Research on malnutrition has advanced in the last decade, with the appearance of micro-data for developing countries that contain information on child height and weight, thought to be robust indicators of health and longevity (see Strauss and Thomas 1995, 1998). A brief survey of this research is contained in Bhalotra (2002). For our current purposes, what is relevant is that much of this research attempts to explain individual variation in heights and weights of children in terms of household income and a range of community variables. There is no consensus on whether income or food expenditure improves health or not, contrary to the common presumption that they do (see Behrman and Deolalikar 1987). This may reflect variations across regions in its effect, or statistical problems of model specification. This question is investigated here for Indian data.

7 Contributions of this study

Although the question of whether the PDS is any good for the poor is at the very heart of fairly radical changes in progress in India today, the analyses done so far are not rigorous and therefore not conclusive. Since questions of distribution are key to this debate, the use of regional data in existing research on the PDS is a limitation. This is redressed in this paper, which uses a household survey conducted in 1994. This will permit us to allow for differences in household behaviour within regions, including differences between rich and poor households in a region. The paper attempts to control for the possible endogeneity of programme placement. In contrast to previous research

which has only tabulated participation rates by income group or computed income gains from observed prices and quantities, the current analysis is more behavioural. It uses a wealth of socio-economic data available for both participating and non-participating households in a multivariate analysis that permits estimation of conditional effects of policy interest. It allows for and estimates the rise in food expenditures (encompassing quantity and quality increases) in response to the food subsidy: there are no estimates of this in the literature. The paper departs from any other work in this area in modelling the within-household distribution of food and any PDS-related food gains. It is now well-documented that there are systematic differences in poverty in India between men and women, adults and children, and 'high' and 'low' castes. The third step of the analysis investigates how the increase in food purchases stimulated by the food subsidy translates into health status for children of both genders. Some of the advantages of studying programme effects on a sensitive index of human development such as child malnutrition are highlighted in Section 9.1. A linked analysis of this sort is useful in identifying where in the chain policy fails if it does fail.

8 The data and description

The relevant previous research on the PDS referred to in Section 6 has used National Sample Survey data for 1986–87. While this and a more recent NSS survey contain valuable micro-data on the PDS and deserve further analysis, the NSS is not suitable for this study as it does not have information on child malnutrition. I propose to investigate these questions using the data collected in 1994 by the National Council of Applied Economic Research (NCAER) that covered 34000 rural households. This survey formed the basis of the India Human Development Report (Shariff 1999). It asked respondents whether the household had bought any cereal on the PDS in the month before the survey. It then asked what quantities of a few basic foods were bought on the PDS and what problems, if any, households faced in using the PDS. There are also detailed data on heights and weights of children under twelve, which permit construction of anthropometric measures of malnutrition. Other relevant variables in the data include household income, household demographics, parental characteristics and indicators of community infrastructure.

Table 3 presents information on the percentage of (rural) households in the NCAER survey that report having bought some grain on the PDS. The average is only 35 per cent and there is considerable inter-state variation. It also reports the subsidy cost to the government by state, and shows that the state dispersion of participation rates is not closely related to poverty incidence (see the discussion in Section 5). Overall participation rates, including urban areas, are in Table 4, where it is clear that average participation is much higher in the PDS than in some of the other major welfare programmes in India. The *marginal* odds of participation (defined in Table 4) in the PDS are, however, similar across programmes (see Lanjouw and Ravallion 1998). State-wise data on three anthropometric indicators of malnutrition (defined in Section 9.1) are presented in Table 5. Using the commonly-used reference population of healthy children in the US, our data suggest that 63 per cent are stunted, 29 per cent have low weight for age and 10 per cent are wasted (definitions in Section 9.1). As with PDS-usage, there is enormous inter-state variation. An interesting fact about these malnutrition data for rural India is that they do not exhibit an income gradient: the incidence of malnutrition was computed by income quintile and there was no significant tendency for it to decline with income (data not shown).

Table 4
Participation rates in India's main anti-poverty programmes
Rural India, 1993–94

	PDS		Public works		IRDP	
Quintile	Partic rate	MOP	Partic rate	MOP	Partic rate	MOP
Poorest	69.5	1.06	5.0	1.16	6.5	1.11
2nd	76.7	0.99	4.6	0.93	7.1	1.28
3rd	77.9	0.91	4.2	0.80	6.4	1.21
4th	78.1	0.86	3.5	0.92	6.0	0.96
5th	76.1	0.81	3.4	0.55	5.6	0.39

Source: World Bank (1997, Tables 4.2 and 4.3). The data are based upon the 1993–94 NSS. The three anti-poverty programmes compared are the PDS, Public Works Programmes and the Integrated Rural Development Programme (IRDP). Column 1 refers to quintiles of the distribution of total expenditure per capita. The participation rate is in percentages. MOP is the marginal odds of participation. Let p_{qr} denote the participation rate in the programme in quintile q and NSS-region r and let p_s denote the participation rate in the corresponding state, averaging over all quintiles and regions. Then the MOP is estimated as dp_{qr}/dp_s by running a simple regression. Since p_s includes or depends upon p_{qr}, it is instrumented by a state average arrived at after excluding region r and quintile q (see Lanjouw and Ravallion 1998).

Table 5

Incidence of malnutrition by state

State	Number of children	Wasting (Intl.std.)	Stunting		Low weight for age	
			Intl. std.	Indian std.	Intl. std.	Indian std.
Andhra	3151	13.0	55.6	5.8	24.6	1.3
Bihar	4780	8.1	68.7	1.9	30.8	1.4
Gujarat	2766	13.0	69.2	7.6	39.3	3.2
Haryana	3835	8.4	64.8	1.5	28.1	0.4
Himachal	2056	4.4	66.3	2.1	20.6	0.2
Karnataka	4553	12.2	73.4	9.4	29.3	2.7
Kerala	2062	11.8	44.5	1.3	18.4	0.3
Maharashtra	4858	10.9	56.7	1.5	31.6	1.0
Madhya	8462	9.0	68.2	5.6	29.6	0.9
Orissa	3534	8.5	48.1	1.3	21.6	1.3
Punjab	2449	6.4	53.9	1.9	18.6	0.6
Rajasthan.	4706	8.7	61.0	3.1	29.8	1.8
Tamil	1999	7.1	58.6	1.9	26.3	0.8
Uttar	9016	13.9	63.5	1.8	32.9	1.7
Wbengal	3050	11.1	62.7	2.8	33.9	1.0
N-East	2575	6.8	71.9	10.2	25.5	1.3
All India	63852	10.0	63.1	3.7	28.9	1.3

9 Estimation

9.1 Anthropometric measures of malnutrition

This sub-Section defines anthropometric measures and considers their costs and benefits relative to alternatives. Normalised body size has been shown to be a fairly robust indicator of nutritional status. The commonly used measures are height for age (stunting), weight for age (underweight) and weight for height (wasting). These are often translated into z-scores by subtracting the median and dividing by the standard deviation derived from a reference population of a given age and sex. We use a reference population of healthy US children, which is the NCHS/WHO standard (this choice is discussed in Section 9.2). Binary indicators of stunting, wasting and underweight are defined by setting to unity observations for which z-scores fall two standard deviations below the reference median. The choice amongst the three measures depends upon the time horizon of interest, the age of the target group (height increases most rapidly for children under two), and the form of nutritional deficiency (calorie/micronutrient) that one is investigating. This choice can be crucial to the results of the analysis since the correlation amongst the measures is often low (see Micklewright and Ismail 2001). In this analysis we therefore report results for both height-for-age which is a good measure of chronic malnutrition and weight-for-age which picks up shorter-term undernourishment. We briefly indicate results for weight-for-height but do not highlight these since research suggests that this measure is more suitable for adults than for children (Micklewright and Ismail 2001).

An advantage of anthropometrics over alternative measures of welfare is that they refer to the individual rather than the household. This is especially relevant in the current context, where we would like to allow for gender differentials in child malnutrition. A second benefit to anthropometrics is that they capture *net* nutritional status, whereas measures like income make no allowance for the fact that the efficiency with which the body converts food in to nutrition varies across individuals. Third, they seem preferable to a calorie measure of nutrition. This is because malnutrition is consistent with calorie adequacy, given inadequacy in protein or micro-nutrient intakes. For example, Radhakrishnan and Subbarao (1997) observe that calorie intake levels are *lower* in the Southern Indian states where the PDS has a better record, as compared with the Northern states where the distribution network is relatively sparse. While this seems counter-intuitive, they argue that it is most likely a reflection of dietary differences between states, with people in the poorer Northern states deriving a greater proportion of their calorie requirements from (cheaper) cereals. A fourth advantage of using anthropometrics is that, in rural economies, accurate measurement of income is very problematic whereas weighing and taking the height of a child would appear to be relatively straightforward. Against these advantages, a difficulty with anthropometrics is that they are subject to genetic and environmental influences. While averages for a population are relatively robust, analysis of individual heights and weights as attempted in this paper should attempt to control for these influences.

The survey used has data on community characteristics such as availability of safe water and presence of sanitation schemes, on the structure and cleanliness of the house and on literacy and other skills of parents. These are expected to control for environmental influences. Unfortunately we do not have data on the heights and weights of parents, which may be used to control for genetic endowments (see Thomas et al. 1990, for

example). In principle, we could control for these as household-level unobservables by using sibling fixed effects. As we are interested here in the effects of food expenditure on child health and food expenditure would be wiped out in sibling-fixed-effects estimation, this option cannot be pursued in the current context. Instead, we control for ethnicity which we expect is likely to account for a large part of the genetic variation in stature. A second potential problem with these data is that they display a non-monotonic relation with welfare. However, in our sample of rural Indian households, this concern is not substantially relevant, the problems of obesity tending to come in to play at rather higher income levels than are observed here.

9.2 Other issues

The research strategy is described in Section 10. In this section, some general points relating to estimation are discussed. The entire analysis is first conducted on the entire sample of households and then on only the poorest 40 per cent. This will allow us to observe whether the parameters of household food demand, son-preference and of health production are different for the poor, and whether the impact of PDS use on child health is any greater than amongst the non-poor. Our data show that the percentage of poor and non-poor households using the PDS is similar on average but, given a village with PDS-access, we may expect some self-selection out of the programme amongst the non-poor (see footnote 5, Section 5). This may be on account of the poor quality of food supplies available on the PDS or on account of the costs of having to queue at the shop.[7]

If the distribution of fair price shops and supplies under the PDS was systematically associated with endogenous characteristics, our estimates would not be valid without taking this into account. In principle, there was universal entitlement to the PDS until 1992 although, as indicated earlier, there were substantial differences across regions in the reach of the system. Also, the data used were collected in 1994 and, as discussed in Section 4, from 1992–94, there was an attempt to target geographically poor areas within states. It may therefore be important to allow for endogeneity of programme placement. This is done by estimating an auxiliary model that predicts access to the PDS using exogenous variables. The identifying variables in the auxiliary equation are state dummies, district-level poverty and inequality rates and village size.[8] Why these? As indicated earlier, there is considerable inter-state variation in the estimated percentage of households reporting PDS use and this is likely to be a function of access. On account of the tendency for poor districts to be remote, supplies to them may be thinner. On the other hand, poorer districts may have qualified for greater support and certainly did after 1992, so this effect could go either way. Inequality may influence the political economy of programme placement. Village size appears to be an explicit criterion for allocation of PDS resources (Suryanarayana 1996).

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7 We could distinguish between *self-selection* of this sort and *selection* arising from differential programme access by estimation of a double hurdle model. However, this is outside the scope of the present study, and there is the problem of finding a sufficiently good instrument.

8 Distance of the village to the nearest town, an indicator of remoteness of the village and transport costs associated with getting supplies there is a likely to be a good additional instrument but it is unavailable in the NCAER. Future work merging the NCAER and Census data holds the potential of exploiting this instrument as well as other useful information.

The dependent variable of the auxiliary model is defined at the village level. It is zero if less than 5 per cent of the households in the village reported using the PDS and unity otherwise.[9] Estimates of the auxiliary model are used to generate an estimate of the inverse mills ratio and this is included in estimation of the Engel curve for food (see 1 in Section 10.1). To see that this is effectively sample selection correction, refer to Section 10.1 where we describe our strategy as beginning with an estimate of an Engel curve on the sample of PDS users. If the foodshare equation is different in slope and intercept for users and non-users then we need to include a sample selection correction term in the equation for users in order to predict the demand behaviour of non-users (Heckman 1974). This is exactly what we are doing when we construct the counter-factual posed above: What would PDS users have spent on food if they had faced the same prices as non-users?[10]

An alternative way of allowing for the fact that access to the PDS subsidy differed widely across Indian regions is to produce state-specific estimates, the state being a natural unit of disaggregation because state governments are responsible for conduct of the PDS. This is done for selected states at the two ends of the distribution of poverty and of PDS-usage.

In estimation of the food demand equation (Steps 1 and 2, Sections 10.1 and 10.2) as well as in estimation of the health production function (Step 3, Section 10.3), issues of endogeneity arise. These are discussed in context in Section 10. Food expenditure in the health function is instrumented by an indicator for PDS-use. Income in both functions is instrumented by land owned, which is assumed to be exogenous to the model on the grounds that there is no very active market for land. Overidentifying restrictions associated with parents education are investigated.

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9 We define this indicator variable in terms of reported access of less than 5 per cent to allow for measurement error and also to allow for the possibility that the village in question does have access in principle but that actual access is very difficult for most (95 per cent) of households. In principle, the dependent variable we have defined will pick up not only access (selection) but also self-selection. In practice, it is unlikely that to be the case that a village has good PDS facilities (access) but that less than 5 per cent of households choose to use it. It therefore seems reasonable to define access in this way.

10 It may be useful to draw an analogy with the classical problem of estimating the effect of union-membership on wages. If one believes that there is simply an intercept effect then it is enough to include a union dummy in a pooled sample and to instrument it if it is thought that union membership is endogenous to wages. This would be equivalent in our context to estimating an Engel curve on the sample of all households with a dummy on the right hand side indicating whether the household reported using the PDS or not. Returning to the union-wage case, if one believes that union membership influences not only the intercept but all slopes in the wage model, then a sample selection model is appropriate. In this case, the sample is split into union and non-union workers and a wage equation estimated for each. To allow for the fact that each sub-sample is non-random (or that union-membership is endogenous), an auxiliary model describing the determination of union status is estimated and an inverse mills ratio based on this is included in the wage model. The parallel with our context is clear: We prefer the more general assumption that the food demand equation for PDS users may have not only a different intercept but also different slopes than that for non-users. So we split the sample. If PDS-access is non-random (or if programme placement is endogenous) then we need an auxiliary model determining PDS access. Using this, we introduce a sample selection correction factor into the Engel equation for food.

Although anthropometric data are available for children under 12, we restrict the analysis in Step 3 to children under 8, in view of WHO guidelines on the usefulness of anthropometric indicators by age. In order to allow for biological differences in the growth path by age and gender, a full set of dummies interacting age and gender of the index child is included amongst the regressors. I also estimate separate equations by gender as girls and boys may have different health production functions for biological reasons (see Duraisamy and Duraisamy 1995 for India and Hill and Upchurch 1995 for studies of gender differences in health functions in a number of developing countries). Almost all previous studies of child health use the NCHS/WHO reference population which is of healthy children in the USA. If healthy Indian children are shorter or lighter for genetic/ethnic reasons then z-scores obtained by normalization on the parameters of a US population will tend to over-estimate the incidence of malnutrition in India. In Table 5, we have computed the incidence of malnutrition using the median and standard deviation in the sample. Unsurprisingly, we get much smaller estimates. This sample of rural households is, of course, not the correct reference group since it definitely contains some malnourished children: the figures are merely illustrative. What is important for the current analysis, is to recognise that the question of which reference group is used is not such an issue. Let us write the z-score for indicator X as $(X-\mu)/\sigma$, where μ and σ are the mean and standard deviation of the reference population. These parameters are constants for a given age and sex of the child. The z-score is the dependent variable in Step 3. Rewriting the z-score as $(X/\sigma)-(\mu/\sigma)$, it is clear that (μ/σ) is a constant the size of which is irrelevant once we have put in a full set of age-gender dummies on the right hand side of the model. The term (X/σ) involves deflation of X by an age-gender-specific σ and now the population from which σ comes is not entirely irrelevant. However, if we are willing to assume that the standard deviation of the reference population actually used (the NCHS/WHO) is a constant multiple of the standard deviation of the true population (whichever that may be) at every age and sex, then again the use of the NCHS/WHO standard becomes completely innocuous. A way of freeing the estimates entirely of any relation to the choice of standard would be to allow every regressor to be interacted with age and sex dummies. We do not take this route as this level of generality seems unnecessary.

10 Research strategy

In order to conduct a systematic investigation of the effects of the PDS food subsidy on child malnutrition we address the following three questions.

10.1 Step 1: Does the food subsidy result in higher purchases of food?

This question is not straightforward to answer because we do not have market and PDS prices and quantities. We do, however, have data on household expenditure on food and on some of its components, an indicator for whether the household buys any cereal on the PDS, income, demographic, and other characteristics of households. So we estimate an Engel curve for consumers who do not use the PDS and use the estimates to construct the counter-factual: what would PDS-users have purchased if they did not face a subsidy? Comparing this with observed purchases gives us an estimate of the increase in food purchases associated with the PDS.

The main equation modelling food demand is specified as a Working-Leser Engel curve:

$$(1)\ \omega = F(y) + \alpha n + \Sigma_k \gamma_k(N_k/N) + \varphi^T z + \delta\lambda + \nu$$

where ω is household foodshare (share of food expenditures in total expenditures), y is log household income, F is a quadratic function, n is log household size, N_{ki}/N_i are a vector of k variables reflecting the age-gender composition of the household, and z are other relevant controls. λ is the inverse Mills ratio, a correction factor for (village-level) PDS access. This is obtained from probit estimates of an auxiliary model which describes village-level access as a function of a set of instruments and all exogenous variables in (1). Further discussion of this appears below.

The aim of the exercise is to estimate the increase in the quantity (and quality) of food consumed by households in rural India that is associated with the price subsidy. This is done as follows.

i) Equation (1) is estimated on the sample of non-users. Given the selection correction (or programme placement) term λ, these estimates can be used to predict consumption for the sample of PDS users. This is what PDS users would spend on food if they did not have a subsidy. Let this be $\omega_{no\text{-}subsidy}$.

ii) Given that users do enjoy a subsidy (call this β), they can buy a food basket with the same quantities and composition of foods with an expenditure of $(1-\beta)\omega_{no\text{-}subsidy}$.

iii) We observe that they spend ω_{actual}.

iv) The difference between ω_{actual} and $(1-\beta)\omega_{no\text{-}subsidy}$ denotes the increase in quantity (or quality/mix) of food that they choose upon receiving the subsidy. See Figure 1.

The intention of the subsidy is to get people who cannot afford to meet food needs to be able to do so. If we find that lowering the price of food does not result in higher food purchases, then we may infer that the households being subsidised are not very poor, that is, they are not 'hungry' households.[11] In this case, food purchases under the PDS may simply be substituting for food purchases on the open market. Alternatively, the quality of food offered on the PDS may be so low as to discourage purchase, or access of the poor to the PDS may be very limited. Overall, the estimated obtained in Step 1 indicate the impact of the PDS on food security.

10.2 Step 2. Allocation of food and the food subsidy within households

Food purchased by the household may be distributed unequally amongst its members. In particular, there is considerable evidence that women and girls are disadvantaged in India and that this disadvantage may stem from differential treatment within the

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11 To the extent that consumers buy a fraction of their grain on the PDS and the rest on the open market, the marginal price is the open market price and this is no different for users and non-users. In this case, any increase in food expenditure associated with PDS-use represents an income effect.

household (e.g. Chen et al. 1981, Harriss 1990). In this case, interventions aimed at providing food security may have to be re-designed to target individuals rather than households. For example, children could be offered free school meals.[12] In order to investigate any differences in food allocation as between boys and girls of similar ages, an Engel curve is estimated on the full sample and we allow interactions of every regressor with an indicator variable for PDS-use (denoted I).

$$(2)\ \omega_i = F(y_i) + \alpha n_i + \Sigma_k \gamma_k(N_{ki}/N_i) + z_i\varphi + \delta\lambda_i +$$

$$I^*F_0(y_i) + \alpha_0\, I^*n_i + \Sigma_k \gamma_{k0}\, I^*(N_{ki}/N_i) + (I^*z_I)\varphi_0 + \delta_0\, I^*\lambda_i + \nu_I$$

The notation in (2) is the same as that in (1). If the coefficient on the k^{th} variable is γ_k, then the change in foodshare upon replacing a person in the suppressed group (suppressed on account of collinearity) with a person from the kth group, holding constant total household size, is γ_k/N. Estimates of (2) can be used to compare the coefficients on proportions of girls and boys in the household (of specified age groups) for households that are and are not on the PDS (i.e. compare γ_k and γ_{k0} for boys and girls).

10.3 Step 3. Is food inadequacy an important determinant of child malnutrition?

Intuition would suggest that food (or income) is an important determinant of nutritional status, especially in a country in which a third of the population lives below the poverty line and two-thirds of all children under five may be classed as malnourished. However, the evidence from other studies is mixed (see Section 6.2). The finding of small or insignificant effects may be spurious if good instruments are unavailable since both income and (food) expenditure are often measured with error and this is known to generate a downward bias. Small expenditure effects may be genuine when critical food needs have been met or else when higher food expenditures do not translate into more nutritious consumption (see Behrman and Deolalikar 1989). A third possible explanation of small effects flowing from income or food expenditure is that the effectiveness of these inputs in producing health relies upon the absence of disease. For example, a child with diarrhoea may be unable to hold down nutrients. As such, complementary investments in clean water and sanitation may be necessary to generate payoffs to food subsidies. In general, malnutrition indicators compound the effects of food quantity and quality, disease, and genetic endowments. An important empirical research question is therefore to estimate the size of the effect of food expenditure on nutritional status. This will complete the investigation of the effects of the PDS food subsidy on nutritional status.

We estimate the health production function:

$$\text{z-score}(X)_{ijks} = f(\ln \text{food}_{jks}, \ln \text{p.c.income}_{jks}, C_{ijks}, H_{jks,} V_{ks}, Z_s, \varepsilon_{ijks})$$

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12 This raises the potential for parents to reduce food given to the child at home in the knowledge that the child has had a meal at school: a case of crowding-out of private by public expenditure. However, it is likely to be an improvement on a subsidy offered bluntly to the household.

where X is an anthropometric indicator for individual i in household j in village k in state s, C are child characteristics, H are household characteristics, V are village variables, Z are state dummies and ε is a random term. The key variable of interest is household-level expenditure on food (ln $food_{jks}$). We also investigate any additional effects of household income (ln $p.c.income_{jks}$) which may arise, for example, by virtue of access to sanitation and medicines increasing in income. The potential endogeneity of food expenditure is allowed for by instrumenting it with an indicator variable for PDS use. When used as a regressor, income is instrumented by land owned, which is assumed to be exogenous to the model. Overidentifying restrictions associated with parents education are investigated.

The data we use has the advantage of offering an unusually rich set of control variables. In addition to food expenditure and income, a further variable denoting household resources that is investigated is the number of adults in the household.[13] The relevant child-specific characteristics in the data include age, gender and birth-order, (and interactions thereof). We also include indicators of early feeding of the child (age till breastfeeding and age at which solid foods were introduced), of the child's health endowment (age of mother at child-birth), indicators of mother's 'ability' (educational level, whether she reads the newspaper, and whether she has knowledge of diarrhoea treatments), father's ability (his education, whether he reads the newspaper), indicators of environmental factors that might determine vulnerability to disease at the household level (whether mother and father smoke, whether kitchen and toilet in the house are clean, whether house is pucca, i.e. of robust material), and also at the village level (indicators of sanitation and health schemes and of public goods including access to clinics), village-level demographics (age-gender composition of population including 'female status' measured as the ratio of women to men in the village), and a measure of genetic endowments that may influence stature (ethnic group).

11 Results

This section discusses the results in the three steps outlined in the Methods section. It first addresses the questions central to this research. It then points to some other interesting findings that emerge from the estimated equations.

11.1 Does the PDS subsidy result in greater spending on food?

Estimates of the Engel curve for households that do not use the PDS (Equation 1) were obtained, taking into account differential access to the PDS. The selection correction term allows the parameters of food demand to be different for households that do and do not use the PDS. The instruments in the auxiliary model were jointly highly significant. The mean predicted foodshare of PDS users is 50.9 per cent ($\omega_{no\text{-}subsidy}$). It turns out that this is not significantly different from the actual mean foodshare of this group, which is 50.5 per cent (ω_{actual}). Distinguishing the sample of households with incomes in the bottom 40 per cent of the distribution does not alter this result: their actual and their

[13] The number of children is not included because fertility and child quality (including child health) are codetermined in a Beckerian framework.

predicted foodshare is 67 per cent. Distinguishing cereals and pulses from other foods also does not alter this result. The actual budget-share of cereals and pulses for PDS-users is 39 per cent and the predicted share is 41 per cent.

In terms of Figure 1, this suggests that curves a and c happen to coincide. The additional expenditure on food associated with the subsidy is given by the vertical distance between curves b and c. In our data, this is the distance between curves b and a, which is the unit subsidy, β (see the Methods section). So if PDS prices are 23 per cent lower than market prices, then our data indicate that PDS users buy 23 per cent more food. This is why their observed food expenditure (the product of a lower price and a higher quantity) is the same as the expenditure they would incur without a subsidy.[14] Thus, our estimates indicate that, on average, the subsidy translates entirely in to more (or better) food. It is important to note that we can make this inference without knowing the value of β.

What is the value of β? This is a difficult question. PDS prices vary by state and open market prices vary by centres within each state and the relevant data are not readily available for the country as a whole for every year. PDS and open market prices for the year 1986–87 are reported for rural and urban areas for every Indian state for rice and wheat separately in Radhakrishna and Subbarao (1997), based on NSS data. A simple average for all-India suggests β=0.23 or that the PDS price is 77 per cent of the open market price. The price ratios are reproduced in Table 6, where we also present predicted and actual foodshares of PDS users from our data. These predictions are from an equation in which data is pooled across the states. The purpose of Table 7 is not only to show the reader the level and variation of the PDS-subsidy (β) across the Indian states but also to show that, at any given β, the extent to which the subsidy results in higher food expenditure varies across states.[15] Consider Andhra Pradesh, a Southern rice-eating state (refer to Table 7). The foodshare predicted for users of the PDS in the absence of a subsidy is 60 per cent. Given that the cost of rice on the PDS is 64 per cent that on the open market, their foodshare with this subsidy would fall to 38 per cent (0.64*0.60). Since we observe that the actual foodshare of this group is 54 per cent, we can infer that a unit subsidy of 26 per cent stimulates a 16 per cent point increase in food purchases.[16] Looking down the rows of Table 7, it is evident that, in every state, PDS use is associated with a positive increase in food purchased.

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14 There is not a lot of variation in quality in the food items available on the PDS. However the PDS user often buys some food on the PDS and some on the open market. The subsidy accruing to the user through purchases on the PDS may result, as we suggest in more food being bought, whether on the PDS or the open market. However, it is recognized that the additional expenditure on food could also involve changes in composition and quality (e.g. a higher ratio of protein to cereal). What is interesting from our perspective is that the extra spending is on food and not on clothes, ceremonies, or something else. We can safely conclude that the food subsidy does improve food security if this is understood to mean a greater realised demand for food quantity or quality, both of which may be expected to generate health improvements.

15 In other words, curves *a* and *c* coincide for India as a whole but, for many states, the predicted food share deviates considerably from the actual foodshare.

16 This analysis assumes that if a household reports buying any cereal on the PDS then it buys all its cereal on the PDS. Suppose that this is not true but that the household buys only a fraction p of its cereal on the PDS. Then β will be replaced by pβ in this discussion. The spirit of the argument is unchanged.

Table 6
Actual and predicted foodshares by state
& price subsidy rates on rice and wheat

	Foodshares		Subsidy	
	Actual	Predicted	$(1-\beta)_{rice}$	$(1-\beta)_{wheat}$
Andhra	0.54	0.60	0.64	0.76
Assam	0.53	0.55	0.66	0.25
Bihar	0.35	0.47	0.83	0.78
Gujarat	0.55	0.62	0.60	0.71
Haryana	0.46	0.49	0.75	
Himachal	0.62	0.75		
J&Kashmir			0.77	0.95
Karnataka	0.54	0.65	0.60	0.64
Kerala	0.49	0.55	0.66	0.73
Madhya	0.48	0.52	0.77	0.97
Maharashtra	0.45	0.48	0.88	0.79
Orissa	0.54	0.59	0.89	0.97
Punjab	0.56	0.68		1.04
Rajasthan	0.54	0.68	0.66	0.80
Tamil Nadu	0.50	0.63	0.61	0.76
Uttar Pradesh	0.55	0.69	0.97	1.07
West Bengal	0.68	0.86	0.76	0.83
Simple Average			0.74	0.80

Notes: Columns 1 and 2 are the actual and the predicted foodshares estimated by the author from the 1994 NCAER survey of rural households. These are predictions from a single equation that pools data across states. Predictions from state-specific equations in which all slopes are treated as heterogeneous are discussed in the text. The figures in columns 3 and 4 are the ratios of the PDS price to the open market price for rural areas of each state in the year 1986–87. These are obtained from Radhakrishna and Subbarao (1997).

We also estimated state-specific equations for selected states that allow complete heterogeneity in the parameters of the Engel curve by state. The actual and predicted shares were as follows: 26 per cent and 28 per cent in Kerala, 41 per cent and 42 per cent in Andhra, 33 per cent and 38 per cent in Bihar and 42 per cent and 50 per cent in UP.

11.2 Is the additional spending on food distributed equally amongst boys and girls?

We also obtained estimates of an Engel curve estimated on all households in which every regressor is interacted with an indicator for whether the household participates in the PDS (Equation 2). Our estimates are consistent with the view that boys and girls

aged 0–12 have equal claims on food, irrespective of whether the household is on the PDS or not. Both boys and girls get a slightly larger share of food amongst households that use the PDS but the difference is not significant. Amongst 0–6 year olds, boys in PDS-using households claim a higher foodshare than girls but, again, the difference is not significant. In particular, amongst households that do not use the PDS, replacing an adult male with a child in the 0–6 year age range results in a decrease in foodshare of 0.024 for boys and girls. The corresponding figure for 7–12 year olds is 0.014. Amongst households on the PDS, the ratio of child to adult consumption is larger, these numbers being 0.016 for boys and 0.021 for girls, which also indicates some 'preference' for boys. However the coefficients on the terms of interaction with PDS-use are not significantly different. We therefore cannot reject the hypothesis that any additional spending on food is distributed equally amongst boys and girls. This result is unchanged when the sample is restricted to the poorest 40 per cent of households.[17]

11.3 Do higher food expenditures at the household level improve child nutritional status?

This question is addressed by estimating a health production function in which household food expenditure appears as an explanatory variable (see the Methods section and the section on anthropometrics). First consider results for the child's height for age. The main result is that, at given levels of household income, higher food expenditures are associated with significantly better child nutritional status. This effect is not very large. An increase in food expenditures of 23 per cent predicts an increase in child height of 0.09 standard deviations (at a given age and sex). The level of income itself is insignificant. As households will tend to smooth consumption and especially food consumption, food consumption will be a better descriptor of the long run welfare of the household than income. Income in rural households is very volatile and also more likely than food expenditure to be mis-measured. This may explain the insignificance of income. Alternatively, these results may simply be read as saying that income that is not spent for food has no effect on child health. There is no direct effect of gender on child height. The set of age and state dummies is very significant.

When the full set of individual, household and community characteristics indicated in Section 10.3 are included, food expenditure remains significant. Some of the control variables are interesting in themselves, and these are discussed in the following sub-Section. The same specification was estimated on a sample restricted to households in the bottom 40 per cent of the income distribution. The effect of food expenditures on health was still significant but smaller. This may reflect the fact that the translation of food consumption in to child health depends upon complementary factors such as maternal ability, information, or hygienic living conditions which are less available in poor households.[18] Although the gender dummy is insignificant in these models, gender may nevertheless have slope effects. This was investigated by separating the samples of boys and girls. There are some significant differences in slope. Food spending remains a

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[17] It may be of interest to note that the Engel curve for the poor is downward sloping and concave to the origin while that for the whole sample is downward sloping and convex to the origin.

[18] A smaller marginal effect of food expenditure on child health amongst poor as opposed to non-poor households is unlikely to be explained by the lower nutritional quality of food purchased by the poor because quality should be reflected in prices and therefore in expenditures.

significant determinant of height but the effect is (just) significantly higher for boys than for girls.

Estimates of the determinants of child weight-for-age are even more different as between boys and girls. Food expenditures have a significant positive effect at given levels of income for both boys and girls, the effect being somewhat larger and more robust for boys than for girls. Household income has no relation to girl weight but has a significant non-linear effect on boys' weight. At low income levels, an increase in income generates a reduction in weight which may reflect a diversification in diet away from cereal alone. However, at higher levels of income, increments in income are associated with weight gains. This is a plausible pattern. It should be emphasized that our measure is of current rather than permanent income and that child weight is a current or short-term measure of nutritional status.

Child weight-for-height was also investigated, although the results are not reported in any detail as this is not such a meaningful measure for children. There are no significant gender differences here. Food expenditure takes a positive sign but the effect is not robust. Income is insignficant.

We also investigated including medical expenditure as a regressor. This has a significant but small positive effect on child height for age in the pooled sample. Separating genders reveals that the positive effect of household medical expenditures is significant (with a coefficient of 0.03) only for boys, being completely insignificant for girls. This is consistent with research on gender differentials in child welfare that argues that it is in health care and expenditure that parents exercise some relative neglect of girls (e.g. Basu 1989). In the weight-for age equation, medical expenditures display a negative association with the weight of boys, which is odd and might suggest reverse causality. There is no effect for girls. In the weight-for-height equation, medical expenditures are not significant for boys but are significant for girls once the full range of control variables is included in the model.

Our main conclusions are that we find a robust effect of food expenditures on child height and weight given food expenditures, income is unrelated to height for both boys and girls. It is unrelated to the weight of girls, and has a significant and non-linear association with the weight of boys.

11.4 Other results

The discussion has focused so far on the precise questions set out in the Methods section. This section summarises other results of interest. Evaluated at sample means, the income elasticity of food expenditures is 0.38 for PDS users and an insignificantly different 0.35 for non-users. It is 0.39 for poor users (defined as the bottom 40 per cent of the income distribution) and it is 0.50 for poor non-users. The estimation was done again for the expenditure share of cereals and pulses and other foods rather than for food expenditure as a whole. These estimates produce an elasticity of 0.14 for cereals and pulses and of 0.94 for other foods. The average for all-food conceals a fairly dramatic difference in expenditure responses for 'necessities' versus more diverse elements of the food basket.

Somewhat puzzling but consistent with estimates of Engel curves for several other developing countries (see Bhalotra and Attfield 1998, Deaton and Paxson 1998), there are sizeable scale economies in food expenditure. The coefficients on the set of variables describing the age-gender composition of the household are plausible, revealing lower consumption amongst children than amongst adults and gender differentials restricted to adults.

Table 7

Quick summary of significant determinants of health outcomes by gender

	Height		Weight	
	boys	girls	boys	girls
Food expenditure	0.29	0.19	0.16	0.12[+]
Med expenditure	0.02	n.s.	n.s.	n.s.
Food exp * PDS	n.s.	0.02		
Income (quadratic)	n.s.	n.s.	-0.07	n.s.
Birth-order	0.17	0.15	0.08	0.08
Age to breastfeeding	0.07	n.s.	-0.04[+]	-0.05[+]
Age start solids	n.s.	n.s.	n.s.	-0.03
Age (ma) at birth	0.02	0.02	0.014	0.007
Ma smokes	-0.20	n.s.	-0.09	n.s.
Ma education[+]	prim	mid	n.s.	n.s.
Ma news			0.17	n.s.
Ma knows ORS			0.07	n.s.
Pa smokes	-0.15	n.s.	-0.09	n.s.
Pa education	n.s.	n.s.	n.s.	mid
Pa news	n.s.	n.s.	n.s.	0.09
Clean house	0.25	0.29		
Pucca house	n.s.	n.s.	0.09	n.s.
Water potable	sig	Sig	n.s.	n.s.
Water scheme	n.s.	0.21	n.s.	n.s.
Health scheme	0.19	0.26	n.s.	n.s.
Road	sig	Sig	sig	n.s.
Ethnic group	-(xian)	+(ST)	-(xian)	n.s.
State dum	sig	Sig	sig	sig
State dum*PDS	Sig	Sig	sig	sig
R^2	0.08		0.09	

Only significant coefficients are displayed.

Variables which are insignificant across an entire row are not shown.

We found that food expenditure has a significantly positive effect on height and weight for age for both boys and girls under the age of eight. We have also reported finding generally insignificant effects of income and unstable effects of medical expenditures on child health, holding food expenditure constant. The effects of other variables are summarized in Table 7. Birth order has a significantly positive effect on health, indicating that first-born children are stronger, possibly because resource competition disfavours younger siblings. Mother's age at birth has a positive effect on child health and there is a negative effect associated with the mother smoking. Mother's educational level has a positive effect on child height but no effect on weight. Mother's that read newspapers often and also mother's that have knowledge of the oral rehydration therapy recommended for diarrhea have healthier sons by the weight criterion but there is no significant effect on the weight of girls. The height and the weight of sons suffers if the father smokes but there is no such effect for girls. Newspaper reading on the part of the father has a positive influence on the weight of daughters but no effect on sons and no effect on height. Living in a clean house significantly increases height but has no effect on weight. The presence of water and health schemes in the village has a positive influence on height but not on weight. The ethnic dummies included to allow for possible genetic variation in stature between ethnic groups are significant. Many of the variables not explicitly mentioned here but included as potential regressors (and listed in Section 10.3) were insignificant.

12 Conclusions

This paper illuminates two very different concerns of immediate relevance to policy reform in the context of human development in India by analysing the determinants of child malnutrition and by evaluating, in this context, the benefits of the food subsidy carried by the PDS. The most striking result is that the entire food subsidy appears to be spent on increases in food quantity (or quality). We find no evidence of significant gender differences amongst children in the allocation of food or the food subsidy. Food expenditures have a significant impact on child health, whether measured as height or weight for age. Given food expenditure, income has no significant effect. The impact of food expenditure on child health tends to be larger for boys than girls and larger amongst the non-poor than amongst the poor.

The results are linked as follows. If the average subsidy for the average household on the PDS is 23 per cent (which is what the data suggest), then our findings indicate that the PDS-using household buys 23 per cent more food (step 1). The additional expenditure on food translates, on average, into statistically significant increases of 0.09 standard deviations in height and 0.05 standard deviations in weight for boys, and into smaller increases for girls (step 3). Gender differences appear not in the allocation of food expenditure but in the conversion of this into health and also in the effects of other covariates on health (steps 2 & 3). Overall, we conclude that the PDS has a significantly positive effect on childhood nutritional status, although the size of this effect is small.

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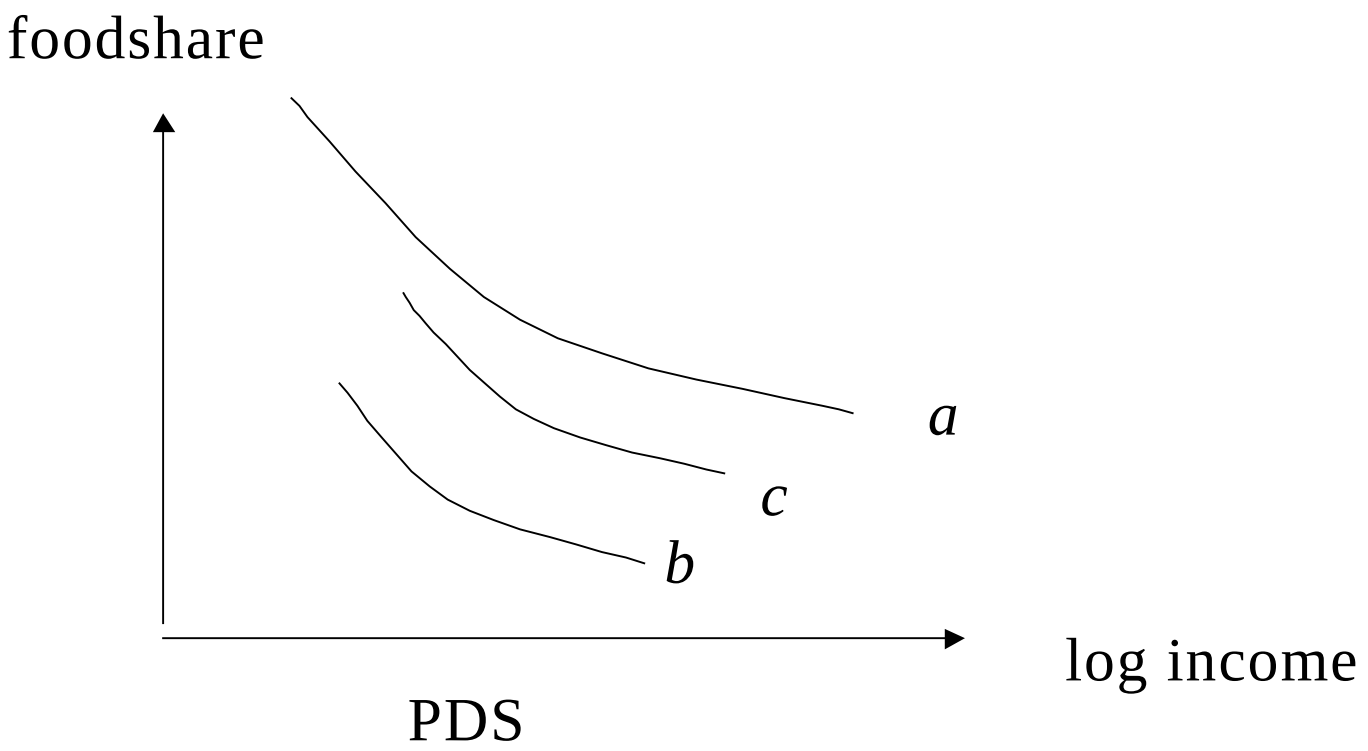
Figure 1

Engel curves: Do PDS users consume more?



Curve ***a*** denotes estimates for the non-PDS sample and predictions for the PDS sample. Curves ***b*** and ***c*** refer to the PDS sample alone. Curve ***b*** lies below a by the (%) amount of the subsidy. Curve ***c*** plots the actual data for PDS users.