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Reforming Food Subsidy Schemes: Estimating the Gains from Self-targeting in India

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Abstract

The paper uses the theoretical framework of the theory of tax reform to analyze whether a "small" change in an existing food subsidy program can be both welfare-improving and revenue-neutral. It shows how existing econometric methods can be adapted to estimate demand parameters even when household-level data exhibit little price variation because the government controls food prices. The methodology is used to estimate welfare changes from shifting a rupee of subsidy on existing commodities to coarse cereals in the Indian public distribution system.

1. Introduction

Many countries implement safety nets and anti-poverty programs whose purpose is to provide benefits specifically for the poor. However, it is not an easy task to identify the poor. This makes it very difficult to design schemes under which the nontarget groups can be excluded from deriving these benefits (Besley and Kanbur, 1993; Lipton and Ravallion, 1995; van de Walle, 1998). The failure to design properly targeted schemes whose benefits accrue only to the target group obviously inflates the overall costs of most safety-net programs.

The errors arising due to the failures of targeting make *self-targeted* programs, in which the relatively rich *voluntarily* opt out of the program, particularly valuable.[1] Self-targeting in food subsidies can work by subsidizing commodities consumed primarily by the poor. Several countries have experimented with self-targeted food subsidies. For instance, sorghum flour was substituted for wheat in the food subsidy program in Bangladesh. Self-targeting can also be achieved by quality differentiation. This experiment has been carried out in Tunisia, Egypt, and Morocco.[2]

Despite the widespread use of food subsidy programs in different countries, there have been few formal quantitative analyses of these programs. In particular, how do we determine whether the right basket of commodities is being subsidized? Or how do we determine the impact on social welfare of a change in the existing rates of subsidy?

This is the main focus of our paper. We use the theoretical framework of the theory of tax reform to analyze whether a "small" change from an existing food subsidy program can be *welfare-improving* and *revenue-neutral*. In principle, the contemplated change could be in the rates of subsidy of the existing basket of goods. Alternatively, it could be the introduction of a new commodity into the basket of subsidized goods.

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This exercise will typically involve estimation of the specific structure of demand. This is because budget share data alone cannot tell us fully about the consequences of self-targeting since the policy experiment will decrease the price of coarse cereals relative to the prices of rice and wheat. The usual substitution effect can be expected to lead to a shift in consumption in favor of coarse cereals. The *magnitude* of the shift will depend on the specific structure of demand, and must therefore be estimated.

Consider situations where the government already has in place a subsidized food delivery system. Then, there may be very little variation in food prices in the household-level cross-sectional dataset since the government controls these prices. As a result, the information is insufficient to estimate all the demand parameters (and hence the welfare change) using "standard" procedures such as those used by Deaton (1997). However, we show how Deaton's procedure can be modified by (a) reducing the number of demand parameters by considering policy experiments that do not alter the relative prices between the subsidized commodities, and (b) using the homogeneity restriction of demand theory to identify the other "troublesome" parameters.

We place our theoretical analysis in the context of an evaluation of the welfare gains from self-targeting food subsidies in India, which are provided through a state controlled marketing network known as the public distribution system (PDS). The PDS has been the most prominent element of India's safety-net system, and handles about 40% of the total quantities of rice and wheat transacted on the market. The PDS costs over 0.5% of the country's GDP and about 6% of the central government's tax revenues. The system has been criticized because of the absence of targeting and hence the inordinately high cost of delivering benefits to the target group.[3] The potential for improvement makes the empirical analysis particularly relevant and important.

Rice and wheat are the main commodities that are subsidized under the PDS. On the other hand, coarse cereals comprising sorghum, pearl millet, and maize are known to receive higher shares in the household budgets of the poor in several regions of the country. But these commodities are unsubsidized. This paper asks whether it would be welfare-improving to transfer one rupee of subsidy from rice and wheat to the coarse cereals.

Since the importance of coarse cereals varies by state and residence, our empirical analysis is disaggregated by state and region. For reasons that are discussed later, the gains from self-targeting might be expected to differ sharply between Andhra Pradesh and Maharashtra. We therefore choose these two states for a formal analysis of the gains from transferring a subsidy rupee from wheat and rice to coarse cereals.

2. Theoretical Framework

The theory of tax reform seeks to find out whether "small" departures from the status quo can be welfare improvements; that is, whether the current situation is a "local" optimum (Newbery and Stern, 1987; Deaton, 1997). The policy reform with which we are concerned falls under this theory since we are interested in estimating the welfare consequences of *marginal* changes in prices.

The first step in any tax reform exercise is a specification of a social welfare function, which provides a ranking of alternative social states. It is customary to assume that social welfare is a function of individual utilities. As our dataset collects information about households, we shall assume that each individual within a household receives the same utility, and neglect the intrahousehold distribution of utilities. So, if there are n households, then the social welfare function in its general form can be written as

$$W = V(u_1, u_2, \ldots, u_n). \tag{1}$$

While (1) is the general form of an individualistic social welfare function, we use a more specific functional form due to Atkinson (1970). When extended to households, the Atkinson social welfare function takes the form

$$W = \frac{1}{H}\sum_{h=1}^{H}\frac{n_h}{1-\varepsilon}\left(\frac{x_h}{n_h}\right)^{(1-\varepsilon)}, \quad \varepsilon \neq 1. \tag{2}$$

Here, x_h is household h's income (or expenditure), H is the number of households, n_h is the number of persons in household h, and ε measures the degree of inequality aversion in society. A higher value of ε represents a greater aversion for inequality. Note that if $\varepsilon = 0$, then society has no aversion to inequality. In other words, social welfare is a simple or unweighted average of individual utilities.

The individual utilities can be obtained as the values of indirect utility functions of different households. Thus, the utility level of household h can be represented as

$$u_h = g(x_h, p), \tag{3}$$

where p is the price vector. The derivative of social welfare with respect to a change in the price of good i is

$$\frac{\partial W}{\partial p_i} = \sum_h \frac{\partial V}{\partial u_h}\frac{\partial u_h}{\partial p_i}. \tag{4}$$

Let η_h be the social marginal utility of money in the hands of household h; i.e., $\eta_h = (\partial V/\partial u_h)(\partial u_h/\partial x_h)$. Using Roy's identity, (4) can be rewritten as

$$\frac{\partial W}{\partial p_i} = -\sum_h \eta_h q_{ih}. \tag{5}$$

We consider a model in which there are *five* commodities: rice and wheat supplied through the PDS, denoted as commodities 1 and 2, respectively; coarse cereals denoted as commodity 3; and rice and wheat sold in the open market which are commodities 4 and 5, respectively.[4] The rice and wheat supplied through the PDS are sold at prices fixed by the government while the market determines the prices of the other commodities. Suppose now that the government increases the price of commodities 1 and 2 and uses the proceeds to subsidize the market sales of commodity 3 (coarse cereals). What happens to welfare? This is our question.

Let c_i be the cost of supplying one unit of commodity i through the public distribution system. Households buy the commodity at price p_i. Denote r_i to be the rate of subsidy on good i. Hence $p_i = (1 - r_i)c_i$. Consider now a policy reform that decreases the subsidy to commodity 1 and increases the subsidy to commodity 3 such that (i) relative prices between 1 and 2 are held constant and (ii) the total subsidy bill is held constant. The second condition guarantees revenue neutrality. As far as the first condition is concerned, note that constancy of relative prices implies that the subsidy rate on commodity 2 decreases as well. Thus the policy reform is a shift of the subsidy rupee from commodities 1 and 2 to commodity 3. We impose condition (i) because it eliminates from the demand responses the effect of a change in commodity 1 price on the demand for commodity 2, and vice-versa. We discuss later why such effects are impossible to estimate from our dataset.

Using (5), the change in welfare following from the policy experiment is

$$\Delta W = -\left(\frac{dp_1}{dr_1}\right)\sum_h \eta_h q_{1h} - \left(\frac{\partial p_2}{\partial r_2}\right)\left(\frac{dr_2}{dr_1}\right)\sum_h \eta_h q_{2h} - \left(\frac{dp_3}{dr_3}\right)\left(\frac{dr_3}{dr_1}\right)\sum_h \eta_h q_{3h}. \tag{6}$$

We calculate dr_2/dr_1 from the condition that the ratio p_2/p_1 is constant. Thus $dr_2/dr_1 = (1 - r_1)^{-1}(1 - r_2)$. Also, let $w_{ih} = (p_i q_{ih}/x_h)$ denote the share of good i in the budget of household h. Then, for commodity i:

$$-\left(\frac{dp_i}{dr_i}\right)\sum \eta_h q_{ih} = \sum_h \eta_h q_{ih} c_i = \frac{1}{(1-r_i)}\sum \eta_h p_i q_{ih} = (1-r_i)^{-1}\sum \eta_h w_{ih} x_h.$$

Define

$$w_i^{\varepsilon} = \frac{\sum_h \eta_h w_{ih} x_h}{\sum_h x_h}.$$

Then, w_i^{ε} is the average of $\eta_h w_{ih}$ (weighted by household income) and would therefore depend on the distribution of welfare weights. For this reason, Deaton calls w_i^{ε} the "socially representative budget share." Denoting the per capita income as $x = \sum_h x_h \big/ H$, we have

$$-\left(\frac{dp_i}{dr_i}\right)\sum \eta_h q_{ih} = (1-r_i)^{-1}\sum \eta_h w_{ih} x_h = (1-r_i)^{-1} H w_i^{\varepsilon} x.$$

In the Atkinson welfare function, the welfare weights are $\eta_h = (x_h/n_h)^{-\varepsilon}$. The socially representative budget share therefore becomes

$$w_i^{\varepsilon} = \sum_h \left(\frac{x_h}{n_h}\right)^{-\varepsilon} w_{ih} \frac{x_h}{\sum_h x_h}.$$

Notice that when $\varepsilon = 0$, w_i^{ε} is the average budget share (weighted by household income) of the ith commodity. In the general case when $\varepsilon \neq 0$, w_i^{ε} depends on ε and the distribution of income.

Using the above expression and substituting for dr_2/dr_1, the change in welfare due to a change in subsidy rate on good 1 is

$$\Delta W = Hx\left[\frac{w_1^{\varepsilon}}{(1-r_1)} + \frac{w_2^{\varepsilon}}{(1-r_1)} + \left(\frac{dr_3}{dr_2}\right)\frac{w_3^{\varepsilon}}{(1-r_3)}\right]. \tag{7}$$

The first two terms within the square brackets represent the loss in social welfare because of the decrease in subsidy on rice and wheat. This depends on the commodity budget shares of wheat and rice and the distribution of welfare weights parameterized by ε. The greater are the proportions of PDS rice and wheat in household budgets, the greater are the welfare losses. The third term in brackets is the gain to social welfare from the subsidy to coarse cereals. For any individual household, the greater is the consumption of coarse cereals, the greater is that household's net gain from the policy reform. If, relative to the rich, poor households consume little PDS rice and wheat but more coarse cereals, the policy measure would favor the poor and be adverse for the rich. For these consumption patterns, the greater is the inequality aversion incorporated in the social welfare function, the greater is the likelihood that the policy reform leads to an increase is welfare.

Besides consumption patterns and welfare weights, there is another factor as well. The magnitude of gains also depends on the extent to which coarse cereals are subsidized (i.e., dr_3/dr_1) which in turn depends on the increase in government revenues when subsidies to PDS wheat and rice are reduced. Here demand responses matter and must therefore be estimated. Following Deaton, we choose standard demand models where budget share is a linear function of the logarithms of total expenditure and prices; i.e., for the kth commodity

$$w_k = a_k = \beta_k \ln x + \sum_i \theta_{ki} \ln p_k. \tag{8}$$

Given (8), we calculate dr_3/dr_1 from the condition that the total subsidy is constant. Denote $S_i = \sum_h (c_i - p_i) q_{ih}$, so that S_i is the total subsidy on good i. This can also be written as $S_i = \sum_h (1 - r_i)^{-1} r_i p_i q_{ih} = \sum_h (1 - r_i)^{-1} r_i w_{ih} x_h$. The total subsidy is

$$S = \sum_i \sum_h (1 - r_i)^{-1} r_i w_{ih} x_h. \tag{9}$$

The change in subsidy due to the policy reform is therefore

$$\Delta S = \sum_{i=1}^{3} \frac{\partial S_i}{\partial r_1} + \sum_{j=2}^{3} \sum_{i=1}^{3} \frac{\partial S_i}{\partial r_j} \frac{dr_j}{dr_1}. \tag{10}$$

Putting $\Delta S = 0$, we get

$$\frac{dr_3}{dr_1} = -\frac{\sum_{i=1}^{3} \left[\frac{\partial S_i}{\partial r_1} + \frac{\partial S_i}{\partial r_2} \frac{dr_2}{dr_1} \right]}{\sum_{i=1}^{3} \frac{\partial S_i}{\partial r_3}}. \tag{11}$$

Since coarse cereals are not subsidized, $r_3 = 0$. In the numerator of (11), the third term is $\partial S_3/\partial r_1 + (\partial S_3/\partial r_2)(dr_2/dr_1)$. This vanishes at $r_3 = 0$ since $\partial S_3/\partial r_1 = (1 - r_3)^{-1} r_3 \sum_h x_h (\partial w_{3h}/\partial r_1)$ and $\partial S_3/\partial r_2 = (1 - r_3)^{-1} r_3 \sum_h x_h (\partial w_{3h}/\partial r_2)$. Denote the first two terms of the numerator of (11) as ΔS_1 and ΔS_2, respectively. Then

$$\begin{aligned}
\Delta S_1 &= \frac{\partial S_1}{\partial r_1} + \frac{\partial S_1}{\partial r_2} \frac{dr_2}{dr_1} \\
&= (1 - r_1)^{-2} \sum_h w_{1h} x_h + r_1 (1 - r_1)^{-1} \sum_h x_h \left(\frac{\partial w_{1h}}{\partial r_1} \right) \\
&\quad + r_1 (1 - r_1)^{-1} \sum_h x_h \left(\frac{\partial w_{1h}}{\partial r_2} \right) \left(\frac{dr_2}{dr_1} \right).
\end{aligned}$$

From budget share equation (8) we obtain

$$\frac{\partial w_{ih}}{\partial r_j} = \frac{\partial w_{ih}}{\partial \ln p_j} \frac{\partial \ln p_j}{\partial r_j} = \frac{-\theta_{ij}}{1 - r_j}. \tag{12}$$

Using (12) and substituting for (dr_2/dr_1), we obtain

$$\Delta S_1 = (1 - r_1)^{-2} \sum_h w_{1h} x_h - r_1 (1 - r_1)^{-2} \sum_h x_h (\theta_{11} + \theta_{12}).$$

Denote $w_i = \sum_h w_{ih} x_h / \sum_h x_h$ and recall that x is the average household income. Hence we have

$$\Delta S_1 = (1-r_1)^{-2} H w_1 x[1+(r_1/w_1)(\theta_{11}+\theta_{12})]. \tag{13}$$

By similar reasoning, the second term of the numerator of (11) can be shown to be

$$\Delta S_2 = (1-r_1)^{-1}(1-r_2)^{-1} H w_2 x[1+(r_2/w_2)(\theta_{21}+\theta_{22})]. \tag{14}$$

We now turn to the denominator of (11). Call it D, so that

$$D = \sum_{i=1}^{3}\frac{\partial S_i}{\partial r_3} = \left[\sum_h w_{3h}x_h(1-r_3)^{-2} + r_3(1-r_3)^{-1}\sum_h x_h\left(\frac{\partial w_{3h}}{\partial r_3}\right)\right] + \left[r_1(1-r_1)^{-1}\sum_h x_h\left(\frac{\partial w_{1h}}{\partial r_3}\right) + r_2(1-r_2)^{-1}\sum_h x_h\left(\frac{\partial w_{2h}}{\partial r_3}\right)\right].$$

Using (12) and evaluating at $r_3 = 0$, the expression simplifies to

$$D = \left[\sum_h w_{3h}x_h - s_1(1-s_1)^{-1}\sum_h x_h\theta_{13}(1-s_3)^{-1} - s_2(1-s_2)^{-1}\sum_h x_h\theta_{23}(1-s_3)^{-1}\right] \text{or}$$

$$D = Hw_3x\left[1 - s_1(1-s_1)^{-1}(\theta_{13}/w_3) - s_2(1-s_2)^{-1}(\theta_{23}/w_3)\right]. \tag{15}$$

On substituting (13), (14), and (15), we can evaluate dr_3/dr_1 in (11) and hence the welfare gain in (7). Computation of (13), (14), and (15) requires knowledge of the parameters of the demand system.

3. The PDS in Andhra Pradesh and Maharashtra

As mentioned earlier, our empirical analysis is restricted to the two states of Andhra Pradesh and Maharashtra. The data come from national sample surveys (NSS) of consumption expenditures of households during the period June 1993 to May 1994. The NSS uses a stratified two-stage sampling design, first sampling clusters (which are villages in rural areas and urban blocks in urban areas) and then selecting 10 households within each cluster. The survey elicits consumption expenditures for the household for the month preceding the date of survey. The date of survey varies between the clusters as the survey is done at four different times (corresponding to quarters) within the 12 months from June to May.

The survey reveals differences in the operation of the public distribution system as well as the pattern of consumption between the two states. Perhaps the most crucial difference is that the PDS in Andhra Pradesh has a distinctly superior coverage compared to Maharashtra. About 63% of households in Andhra Pradesh are beneficiaries of the public distribution system; the overwhelming majority of them buy rice. The corresponding figure is 38% in Maharashtra. In Maharashtra, the PDS retails wheat and rice. Coarse cereals are not distributed through the PDS in either state and household purchases are entirely from the market.

A reason why so few households use the PDS in Maharashtra is because the geographical coverage of PDS in this state is much lower relative to Andhra Pradesh. The NSS survey does not give information on whether the household that did not buy PDS grain was because of choice or because a PDS sales outlet was not available in their area. However, this can be deduced because of the two-stage sampling design of the survey. It seems reasonable to assume that if at least one household in the cluster purchases PDS grain, then a PDS outlet is available to all households in that cluster.

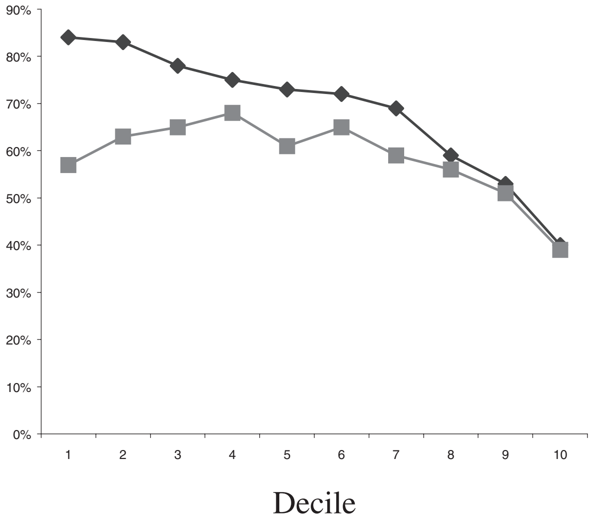

Figure 1. PDS Use by Decile Group in Rural Sectors (diamonds: Andhra Pradesh; squares: Maharashtra)

Defined this way we find that the geographical coverage of the PDS in AP is almost universal. Nearly 98% of clusters have access to PDS. In Maharashtra, the corresponding figure is 71%.

Controlling for access, 64% of households buy subsidized grain in Andhra Pradesh while 50% do so in Maharashtra. Figure 1 displays, by decile group, the proportion of rural households with access to the PDS who buy subsidized grain in the two states. Notice that rural Andhra Pradesh does much better than rural Maharashtra in terms of lower errors of exclusion while the errors of inclusion are comparable between the two states. The participation rate in AP is about 84% in the bottom decile group, which drops to 40% in the top decile. In Maharashtra, the participation rates at the two ends of the income distribution are 57% and 39%. As a result, the Andhra Pradesh usage curve starts well above that of Maharashtra but falls and approaches the Maharashtra curve at higher income levels. This also describes the usage of PDS by urban households in the two states (Figure 2). In both states, therefore, significant numbers of nonpoor receive food subsidies. Could the food subsidy system be redesigned to achieve better targeting?

As mentioned earlier, coarse cereals (consisting of pearl millet, sorghum, and maize) consumption is not subsidized. However, it is well known that the poor consume more of this commodity than the nonpoor. Table 1 shows the average consumption (per month and per capita) of coarse cereals in rural and urban sectors of the two states for the poorest 40%, middle 30%, and richest 30% of the population. A subsidy on coarse cereals could therefore be self-targeting.

Tables 2 and 3 display budget shares of the subsidized commodities and of coarse cereals by decile groups and by urban and rural residence. The figures for Andhra Pradesh exclude budget shares of wheat since they are negligible for all decile groups. We see that, except for the bottom 20% in rural areas, coarse cereals are largely unimportant in household budgets of all other decile groups in AP. On the other hand, especially for the bottom five deciles, subsidized rice accounts for anywhere between 3% and 8% of household budgets. The picture is just the opposite in Maharashtra. In the

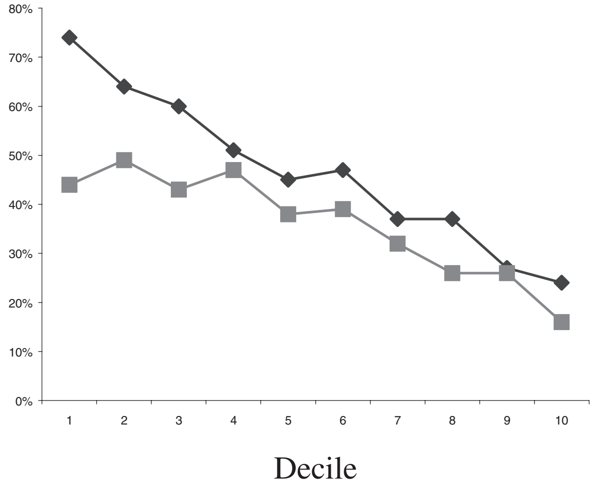

Figure 2. PDS Use by Decile Group in Urban Sectors (diamonds: Andhra Pradesh; squares: Maharashtra)

Table 1. Per Capita Consumption of Coarse Cereals (kg per month)

	Andhra Pradesh		*Maharashtra*	
	Rural	*Urban*	*Rural*	*Urban*
Poorest 40%	0.77	0.4	4.04	2.4
Middle 30%	0.53	0.24	2.85	0.77
Richest 30%	0.48	0.2	2.2	0.7

Source: Authors' calculations from the NSS survey of consumption expenditures: 1993/94.

Table 2. Average Household Budget Shares by Decile Groups in Andhra Pradesh (percentages)

	Rural		*Urban*	
Decile group	*Subsidized rice*	*Coarse cereals*	*Subsidized rice*	*Coarse cereals*
1	8	2.4	5.8	1.1
2	6.6	1.3	3.9	0.64
3	5.7	0.95	3.4	0.44
4	5.1	0.82	2.7	0.29
5	4.5	0.67	2.3	0.53
6	4.4	0.83	1.7	0.18
7	3.7	0.53	1.3	0.17
8	2.7	0.55	0.76	0.19
9	1.8	0.35	0.28	0.07
10	1.1	0.2	0.24	0.04
Overall	4.4	0.86	2.3	0.37

Source: Authors' calculations from the NSS survey of consumption expenditures: 1993/94.

Table 3. Average Household Budget Shares by Decile Groups in Maharashtra (percentages)

	Rural			*Urban*		
Decile group	*Subsidized rice*	*Subsidized wheat*	*Coarse cereals*	*Subsidized rice*	*Subsidized wheat*	*Coarse cereals*
1	1.4	1.4	10.4	1.6	1.2	7.9
2	1.7	1.4	7.2	1.7	1.2	3.3
3	1.6	1.5	6.6	1.6	1.0	3.1
4	1.3	1.2	6.3	1.4	0.7	1.6
5	1.4	1.1	4.2	1.1	0.6	1
6	1.6	1.3	4.2	0.99	0.5	0.8
7	1.1	1.1	3.4	0.86	0.36	0.42
8	1.3	0.95	2.3	0.5	0.28	0.31
9	1.2	0.8	2.1	0.45	0.22	0.37
10	0.5	0.4	1.0	0.18	0.07	0.1
Overall	1.1	1.0	4.2	1.1	0.65	2

Source: Authors' calculations from the NSS survey of consumption expenditures: 1993/94.

bottom five rural deciles and the bottom urban decile, household expenditures on coarse cereals are many times greater than on subsidized rice and wheat. In the other decile groups, expenditures are comparable between the two sets of commodities.

Recall that the policy reform consists of increasing the prices of subsidized rice and wheat, while decreasing the price of coarse cereals. As noted earlier in the interpretation of (7), households that consume more of coarse cereals relative to the subsidized commodities will gain more than households with an opposite consumption pattern. This suggests that the policy reform is more likely to result in a welfare improvement in Maharashtra than in Andhra Pradesh. Note than in Andhra Pradesh, it is not even clear that poor households will gain relative to richer households. This is because although poor households have higher budget shares of coarse cereals, they also spend higher proportions of their budget on subsidized rice.

4. Measuring Demand Responses

As mentioned earlier, we represent demand behavior for commodity k by the following budget share equation:

$$w_k = a_k^0 = \beta_k^0 \ln x + \sum_i \theta_{ki} \ln p_k. \tag{16}$$

This follows the functional form of the almost ideal demand system of Deaton and Muellbauer (1980).

There are two sources of variation in the price data. The two-stage sampling design implies some price variation between clusters. Second, because of the division of the survey into four quarters, prices also vary across time. Deaton (1997) showed that spatial and seasonal price variations can be considerable in developing countries and are therefore a useful source for estimating demand parameters. While this is generally true of market goods, it is not so for the subsidized commodities which are sold by the government at a fixed price in all regions and all through the year. On the other hand, demand responses to changes in the prices of the subsidized commodities are critical in evaluating the welfare impact of policy reform. Consider equation (13), which is the change in subsidy on rice because of lower subsidy rates on rice and wheat. To evaluate it, we need to know the sum $\theta_{11} + \theta_{12}$. This quantity cannot be identified from available data since the prices of commodity 1 and commodity 2 show very little variation across space or time. To achieve identification, we use the homogeneity restriction from demand theory. Since a doubling of prices and incomes should leave budget shares unchanged, we have for commodity k

$$\sum_{l} \theta_{kl} + \beta_k = 0. \tag{17}$$

From (17), we have $\theta_{11} + \theta_{12} = \sum_{l \neq 1,2} \theta_{1l} + \beta_1$. Similarly, to evaluate (14), the change in wheat subsidy, we need the sum $\theta_{21} + \theta_{22}$, which cannot be estimated directly. Using the homogeneity restriction, we identify this quantity by $\sum_{l \neq 1,2} \theta_{2l} + \beta_2$. In order to make the homogeneity restriction identify the parameters of interest, we considered the policy reform to be of the form where subsidies on wheat and rice are reduced such that their relative prices are constant. If the policy reform did not hold relative prices constant, the homogeneity restriction would not identify the parameters of interest. The demand parameters in equation (15) do not involve responses to price changes in commodity 1 and 2 and can therefore be estimated by the price variation in the data.

In estimating (16), we do not use ordinary least squares (OLS) because of measurement error concerns. The problem has to do with the price variables. The consumption survey does not ask households about the prices that they paid. Rather, the sampled households report both the physical amounts bought as well the expenditures on each good. The ratio of these is the *unit value*, and is used here as the *price* of the good. Therefore, any error in measuring quantity will involve an error in the corresponding unit value. For instance, if a household has imperfect recall, and underestimates the quantity of rice bought, but reports expenditure correctly, then the unit value or price will be overestimated and the measurement errors in prices and quantities will be negatively correlated.

The empirical counterpart to (16) is specified as

$$w_{khc} = a_k + \beta_k \ln x_{hc} + \gamma_k z_{hc} + \sum_{i} \theta_{ki} \ln p_{kc} + (f_{kc} + \varepsilon_{khc}), \tag{18}$$

where the subscripts index commodity k, household h, and cluster c. Here z_{hc} is household size, f_{kc} is a cluster fixed effect to account for tastes specific to the cluster, and ε_{khc} is a random error term. Even though prices are not observed, it is reasonable to assume that all households within a cluster face the same prices. Hence household does not index the price variables. We observe unit values, which are related to prices by the following:

$$\ln v_{khc} = \ln p_{kc} + \eta_{khc}, \tag{19}$$

where v is unit value and η is a random error representing the measurement error if unit values are used instead of unobserved prices. If (19) is substituted in (18), consistent estimation would call for instrument variables estimators. Instead, we follow Deaton's methodology, which involves correcting the OLS estimators for measurement errors. As the details are available in his work, we provide just a sketch of the principal ideas.

Deaton's method is best illustrated for the case when $\theta_{ki} = 0$ for all $i \neq k$. Also, suppose for the moment that β_k and γ_k are known. Then form $y_{khc} \equiv w_{khc} - \beta_k \ln x_{hc} - \gamma_k z_{hc}$. Substituting in (18), we get after using (19):

$$y_{khc} = a_k + \theta_{kk} \ln v_{khc} + (f_{kc} + \varepsilon_{khc} - \theta_{kk} \eta_{khc}).$$

Averaging across all households within a cluster, we get

$$\bar{y}_{kc} = a_k + \theta_{kk} \ln \bar{v}_{kc} + (f_{kc} + \bar{\varepsilon}_{kc} - \theta_{kk} \bar{\eta}_{kc}), \tag{20}$$

where the cluster averages have a bar on top of them and are no longer indexed by h. Equation (20) is a regression of average cluster demand (purged of income and household size effects) on average cluster unit value. Let δ be the OLS estimate of the slope coefficient in (20). From standard results about the consistency of OLS estimators, it can be shown that

$$P \lim(\delta) = \theta_{kk} - \frac{\theta_{kk} \operatorname{Var}(\bar{\eta}_{kc}) + \operatorname{Cov}(\bar{\varepsilon}_{kc}, \bar{\eta}_{kc})}{\operatorname{Var}(\ln \bar{v}_{kc})}. \tag{21}$$

A consistent estimator can therefore be constructed as

$$\hat{\theta}_{kk} = \frac{\widehat{\delta \operatorname{Var}(\ln \bar{v}_{kc})} - \widehat{\operatorname{Cov}(\bar{\varepsilon}_{kc}, \bar{\eta}_{kc})}}{\widehat{\operatorname{Var}(\ln \bar{v}_{kc})} - \widehat{\operatorname{Var}(\bar{\eta}_{kc})}} \tag{22}$$

where the parameters with circumflexes denote consistent estimators of the respective population parameters. Substituting for δ, the consistent estimator in (22) becomes

$$\hat{\theta}_{kk} = \frac{\widehat{\operatorname{Cov}(\bar{y}_{kc}, \ln \bar{v}_{kc})} - \widehat{\operatorname{Cov}(\bar{\varepsilon}_{kc}, \bar{\eta}_{kc})}}{\widehat{\operatorname{Var}(\ln \bar{v}_{kc})} - \widehat{\operatorname{Var}(\bar{\eta}_{kc})}} \tag{23}$$

Calculation of (23) is the second step in Deaton's method. In the first step, the variables that are necessary to form the consistent estimators in (23) are computed. In (18), the price variables vary by cluster but do not vary by household. Hence, even though they are unobserved, they can be merged with the cluster fixed effect f_c and (18) can be estimated by a fixed-effects formulation to obtain consistent estimates of β_k and γ_k, which are used to form $\bar{y}_{kc}$. Also, let e_{khc} be the residuals from this regression. Similarly, (19) can be estimated by a fixed-effects model to obtain residuals n_{khc}. Then $\operatorname{Var}(\bar{\eta}_{kc})$ is consistently estimated by $\sum_h e^2_{khc}/(T - l - c - 1)$ and $\operatorname{Cov}(\bar{\eta}_{kc}, \bar{\varepsilon}_{kc})$ is consistently estimated by $\sum_h e_{khc} n_{khc}/(T - l - c - 1)$, where T is the total number of observations, c is the number of clusters (or fixed effects), and l is the number of the other right-hand-side variables in the regression.

Even if unit values accurately measure prices, households may pay different prices depending on the quality of the commodity. Because of quality preference, unit values are typically higher for richer households. A change in unit value could therefore be due either to a change in price or to a change in quality. If quality preference were ignored, demand elasticities would tend to be upwardly biased. Deaton proposes a quality correction that removes the bias. However, we do not apply any quality correction because the resulting bias is likely to be small, for two reasons. First, Deaton reported small quality elasticities for cereals. We find this in our data too, especially for coarse cereals. Secondly, quality preference is absent in the case of the subsidized commodities where the government supplies one quality of grain.

5. Results

We now turn to a numerical evaluation of the welfare change due to a shift of a rupee of subsidy from rice and wheat to coarse cereals. As noted earlier, our analysis throws light on the direction rather than the magnitude of welfare change. For this reason, it is convenient to rewrite (7) as

$$\frac{\Delta W}{Hx} = \left[\frac{w_1^\varepsilon}{(1-r_1)} + \frac{w_2^\varepsilon}{(1-r_1)} + \left(\frac{\partial r_3}{\partial r_2}\right)\frac{w_3^\varepsilon}{(1-r_3)}\right]. \tag{24}$$

In order to compute (24), we must specify the current subsidy rate to different commodities; i.e., r_i. This involves specification of p_i and c_i. Since coarse cereals are not currently subsidized, $r_3 = 0$. For PDS rice and wheat, p_i is the price at which government sells grain to consumers. From the data, we calculated p_i as the *median* price paid by different households. We used two alternative specifications to approximate c_i, the cost of supplying a unit of subsidized commodity. In the first specification, we used the figures of *economic costs* incurred by the Food Corporation of India in supplying foodgrains to the PDS.[5] In the second specification, we let c_i be the average price paid by the poorest 10% of the population. The assumption here is that the quality of rice and wheat supplied through the PDS is similar to that purchased from the market by the poorest decile of households. The results of this exercise are reported in Table 4. Subsidy rate 1 is based on the economic cost of the Food Corporation of India. Subsidy rate 2 is based on prices paid by the poorest 10% of the population. As can be seen, subsidy rates are substantially higher in Andhra Pradesh than in Maharashtra.

Tables 5 and 6 report the socially representative budget shares for the two states (i.e., w_i^ε), for subsidized rice, subsidized wheat, and coarse cereals, for different values of ε. Recall that w_i^ε is the household average of the product of budget share and welfare weight. In the tables, the welfare weights have been rescaled such that w_i^ε sums to unity

Table 4. Subsidy Rates on Rice and Wheat

	p_i	c_i	c_i	*Subsidy rate 1*	*Subsidy rate 2*
Rice (Maharashtra)	6	6.65	7.4	10%	19%
Wheat (Maharashtra)	4.25	5.32	6.15	20%	31%
Rice (Andhra Pradesh)	3.5	6.65	5.93	47%	40%
Wheat (Andhra Pradesh)	3.6	5.32	8.12	32%	56%

Table 5. Socially Representative Budget Shares: Maharashtra

	Rural			*Urban*		
ε	*Subsidized rice*	*Subsidized wheat*	*Coarse cereals*	*Subsidized rice*	*Subsidized wheat*	*Coarse cereals*
0	0.21	0.18	0.61	0.33	0.19	0.47
–1	0.19	0.16	0.65	0.28	0.17	0.55
–1.5	0.18	0.15	0.67	0.25	0.16	0.59
–2	0.17	0.14	0.69	0.22	0.15	0.63

Table 6. Socially Representative Budget Shares: Andhra Pradesh

	Rural			*Urban*		
ε	*Subsidized rice*	*Subsidized wheat*	*Coarse cereals*	*Subsidized rice*	*Subsidized wheat*	*Coarse cereals*
0	0.78	0.017	0.20	0.67	0.20	0.12
–1	0.78	0.01	0.21	0.72	0.15	0.13
–1.5	0.77	0.008	0.22	0.73	0.13	0.14
–2	0.76	0.007	0.23	0.75	0.11	0.14

Table 7. Subsidy Rate Change in Coarse Cereals due to a Marginal Decrease in Subsidy Rates on Rice and Wheat

	dr_3/dr_1 *(subsidy rate 1)*	dr_3/dr_1 *(subsidy rate 2)*
Maharashtra: rural	–1.004	–1.43
	(0.08)	(0.18)
Maharashtra: urban	–2.27	–4.98
	(0.21)	(1.55)
Andhra Pradesh: rural	0.11	–2.1
	(28)	(38)
Andhra Pradesh: urban	1.32	2.99
	(11.3)	(80)

Note: Standard errors are in parantheses.

across the three goods. In both states, as the degree of inequality aversion increases, so does the socially weighted share of coarse cereals. Exactly the opposite is the case with rice and wheat in all regions except for rice in urban Andhra Pradesh. But for this exception, these patterns suggest that the greater is ε, the greater is likely to be the welfare gain from the policy reform. These tables also reveal the socially representative budget shares in Maharashtra to be much higher than in Andhra Pradesh. This suggests that policy reform is more likely to produce gains in Maharashtra than in Andhra Pradesh.

The welfare gains also depend on the extent to which policy reform subsidizes coarse cereals. This is shown in Table 7 for both states, by region and for the high- and low-subsidy regimes. Since dr_3/dr_1 is a function of demand responses, the precision with which it is estimated depends on how well the demand parameters are estimated. The table therefore also reports bootstrapped standard errors. The estimates for Andhra Pradesh are very imprecise and the data is uninformative about the magnitude of dr_3/dr_1. This is probably due to the dominance of rice in cereal budgets across households and regions (averaging 75–90%), unlike consumption patterns in Maharashtra that are more diversified and variable.

Table 8 presents the computations of welfare change for Maharashtra, for the rural and urban areas, for the different specifications of subsidy rates and for different values of the inequality aversion parameter ε. The figures in parantheses are bootstrapped standard errors. The results are remarkably robust—social welfare goes up

Table 8. Estimated Welfare Effects: Maharashtra

Sector	*ε*	*DW (subsidy rate 1)*	*DW (subsidy rate 2)*
Rural	0	–0.18	–0.4
		(0.05)	(0.11)
Rural	–1	–0.27	–0.5
		(0.05)	(0.12)
Rural	–1.5	–0.31	–0.56
		(0.05)	(0.122)
Rural	–2.0	–0.35	–0.61
		(0.06)	(0.13)
Urban	0	–0.49	–1.7
		(0.1)	(0.73)
Urban	–1	–0.76	–2.2
		(0.11)	(0.86)
Urban	–1.5	–0.9	–2.45
		(0.12)	(0.92)
Urban	–2.0	–1.04	–2.71
		(0.13)	(0.99)

Note: Standard errors are in parantheses.

Table 9. Welfare Effects in Andhra Pradesh

dr_3/dr_1	*AP urban* ($\varepsilon = 1$)	*AP urban* ($\varepsilon = 2$)	*AP rural* ($\varepsilon = 1$)	*AP rural* ($\varepsilon = 2$)
–1	1.49	1.48	1.3	1.26
–5	0.94	0.92	0.36	0.3
–10	0.26	0.22	–0.75	–0.85
–15	–0.42	–0.47	–1.85	–2

unambiguously if the PDS prices of rice and wheat are increased so as to keep the rates of subsidy constant while the price of coarse cereals is decreased so as to keep the total subsidy bill constant. This is true even when the social welfare function is simply the unweighted sum of individual utilities. Of course, the magnitude of increase in social welfare is higher if the social welfare function exhibits inequality aversion; that is, if the social welfare function attaches greater weight to the utilities of poorer households. Since coarse cereals account for a larger fraction of the budgets of the poorer households, the decrease in the price of coarse cereals has a correspondingly larger beneficial impact on the utilities of poorer households.

We also prepared a similar table for Andhra Pradesh but do not present it here because the welfare changes are so badly estimated that none of them was significantly different from zero. This happens because dr_3/dr_1 is poorly estimated. As noted earlier, in Andhra Pradesh the socially representative budget share is much higher for subsidized rice than for coarse cereals. This suggests that a policy reform that transfers subsidies from rice to coarse cereals is less likely to produce gains even for the poor. To confirm this, we computed the change in welfare due to the policy reform for various values of dr_3/dr_1. The results are shown in Table 9. As can be seen, the policy reform of the kind we are considering produces welfare gains only if it results in large decreases in the price of coarse cereals. This is especially so in urban areas. For small to moderate price decreases, the gains are insufficient to overcome the losses from higher rice prices.

6. Conclusions

We have used tax reform analysis to evaluate the gains from self-targeted interventions in the design of food subsidies. For empirical analysis, we considered the Indian states of Andhra Pradesh and Maharashtra. In both these states, significant numbers of the nontargeted population received subsidies. At the same time, consumption patterns revealed coarse cereals (which are not subsidized) to be more important for the poor, in absolute and relative terms, than for the nonpoor. We asked: If we considered a social welfare function that weighted the consumption of the poor more strongly than that of the nonpoor, then would a shift of subsidy from rice and wheat to an inferior commodity such as coarse cereals improve welfare?

Our results support such a reform in Maharashtra but do not endorse it for Andhra Pradesh. Our results are divergent even though (a) the food subsidy systems are comparable between the two states in their coverage of the nonpoor, and (b) coarse cereals are an inferior commodity group in both states. Therefore, self-targeting by subsidizing an inferior commodity does not always lead to higher welfare even when the welfare function is weighted in favor of the poor. This happens because the welfare gains also depend on the shares of the subsidized commodities and of coarse cereals in the budgets of the poor. In Maharashtra, poor households consume a significant amount of coarse cereals and correspondingly smaller quantities of superior qualities of food grains. Hence, they benefit from the relative price change in favor of coarse cereals. In contrast, poor households in Andhra Pradesh lose from such "local" changes because of their considerable consumption of subsidized rice.

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Notes

1. Programs can suffer from type 1 and type 2 targeting errors (Cornia and Stewart, 1993; Hoddinot, 1999). Type 2 errors occur when members of the target group are *excluded* from the program. The focus of this paper is on type 1 errors that occur when untargeted groups are *included* in the program.
2. For a survey of issues and experiences, see Alderman and Lindert (1998).
3. For instance, see Ahluwalia (1993), Dev and Suryanarayana (1991), Howes and Jha (1992), and Parikh (1994).
4. Coarse cereals are not part of the food subsidy system and therefore not supplied through the PDS.
5. Estimates of these costs are provided in the annual *Economic Survey* published by the government of India. Our figures are from the *Economic Survey* (1999–2000).