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Food prices and the efficiency of public intervention: the case of the public distribution system in India

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Abstract

As public intervention is a pervasive influence on food prices, this paper asks whether and how the inefficiency of state institutions matters to food prices. In the context of the wheat subsidy scheme in India, the paper models the implications of quality differences between public and private grain supply. As both are procured at similar prices, the lower quality of public grain marks the inefficiency of government operations. The paper proposes and empirically validates a method to test for demand switches that occur as a result of quality preference. As a result, a reduction in food subsidies increases food prices and hurts the poor even when they are not major recipients of the subsidy. This seeming paradox is contingent on the inefficiency of public interventions. Thus, the outcome will be different if the reduction in food subsidy were to be accompanied by reforms in the associated state agencies.

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Introduction

Public intervention is a pervasive influence on food prices in many countries. A large literature has built around the study of these interventions. In developing countries, these interventions are implemented by various state agencies and parastatals buying and selling food. Although it is known that the state marketing institutions perform their duties with varying efficiency, the literature has not paid as much attention to this issue as it does to the intervention itself. Does the inefficiency of state institutions matter to food prices and to the outcome of food policies? The point of this paper is to answer this question in the context of the wheat subsidy scheme in India.

It is usual for food subsidy schemes to operate along with private food markets. Comprehensive rationing schemes, where the state is the single intermediary between consumers and producers and has the monopoly over all domestic and foreign trade, were prevalent in the erstwhile socialist states. In most countries, however, food subsidy schemes are partial (Ahmed, 1988; Yitzhaki, 1990). Not all consumers receive the subsidy (such as, for instance, when the scheme is restricted to urban consumers) and neither is the government the sole buyer from the producers. It is then the case that many consumers depend, partially or wholly, on purchases from the market. It is apparent that, in partial subsidy schemes, the welfare of agents (both producers and consumers) depends not only on the price at which the government buys and sells food but also on the market price of food. The impact of a food subsidy scheme therefore depends on how the market price of food varies with the subsidy. Modeling this relationship is the object of our study.

The income transfers to households that receive subsidies may be expected to increase the demand for all market goods including market food (Sicular, 1988). This suggests that the market price of food should increase with subsidies. The reasoning is as follows. As long as the subsidy is positive, and if the market food is an exact substitute of subsidised supplies, consumers purchase food from the market only after exhausting their ration entitlement of subsidised food. The market demand of these consumers depends on the income received as price subsidy. A small increase in subsidy produces an income effect, which raises the demand for market food and thus its price.[1]

While the literature contains theoretical analyses of partial food subsidy schemes, there has been, to the best of our knowledge, no empirical estimate of the impact of food subsidies on the market prices of food. We investigate this relationship in the context of the wheat subsidy scheme in India, and discover that the market price varies inversely with the subsidy. This is contrary to the prediction noted in the earlier paragraph. The failure to match prediction cannot be ascribed to negligible

[1] More generally, subsidies on particular commodities such as food, housing and fuel would result in higher demands for non-rationed market goods. For evidence on such spill-over effects in the consumption behaviour of Chinese households, see Gao et al. (1996) and Wang and Chern (1992).

income effects as that would, at best, lead market prices to be invariant to subsidy.[2] The explanation must therefore lie in the possibility that consumers regard grain (wheat) from different sources (the government and the market) as imperfect substitutes. We propose and empirically validate a model in which consumers perceive subsidised grain as inferior in quality to market grain. In this model, income effects are not the only consequence of food subsidies. Consumers switch demand between government and market supplies depending on the level of subsidy. Such demand switches can overwhelm income effects and explain the empirical relationship in the Indian wheat market. In our interpretation, we argue that the functioning of state institutions is responsible for producing this outcome. Since the government and private trade procure wheat at similar prices, the lower quality of government wheat at the retail level marks the inefficiency of government operations. While this is also the finding of case studies and consumer surveys, the literature has neglected to analyse the implications of quality difference for food prices and subsidy interventions (Nair and Sivanandan (1995); Indrakant (2000)).

These findings are relevant for analyzing the consequences of reducing food subsidies. For fiscal reasons, governments in poor countries are often under pressure, from international creditors, to trim subsidies. Such measures, however, encounter political resistance especially when organized interests capture subsidies. When food subsidies are badly targeted, the poor are not beneficiaries of food subsidies and a subsidy reduction might seem desirable from efficiency and equity points of view. Such reasoning is incomplete as the effect of subsidy reduction on market price must be taken into account. If the income effect dominates, reducing subsidies would allow food prices to fall and poor consumers, without access to food subsidies, would be better off. But if, as we find for wheat in India, subsidies vary inversely with food prices, then the poor are worse off because of the higher prices following subsidy reduction. This seeming paradox where the poor are worse off by subsidy reduction even when they do not receive them is contingent on the inefficiency of public interventions. Thus, the outcome will be different if the reduction in food subsidy is accompanied by reforms in the associated state agencies.

The wheat policy regime in India

As in many developing countries, the foodgrains subsidy scheme in India is held in place by a system of state procurement of grain (primarily rice and wheat) and by a state-controlled marketing network known as the Public Distribution System (PDS). Between 5 to 10 million tons of wheat are sold annually through the PDS. Since 1985, wheat sales through PDS have, on average, accounted for about 14%

[2] The evidence for India suggests that the income effects are indeed positive. From the country-wide consumption expenditure survey of 1993/94 in India, a recent study estimated the income elasticities of cereals to vary between 0.89 to 0.56 (depending on income level) in the rural sector and to vary between 0.8 and 0.58 in the urban sector (Murty, 2001). Using another data set, Bhalotra (2002) found the food subsidy to have a positive effect on household food consumption.

of output. Since less than half of the output is marketed (due to self-consumption by producers), the PDS is a significant but not the sole source of grain to consumers.

At the wholesale level, producers face two prices: a wholesale market price and the state determined procurement price. At the retail level, consumers face two prices: a retail market price and a PDS retail price called the issue price. The government fixes both the procurement price and the issue price. While the decision on the procurement price is an annual one, the issue price has, on occasion, remained unchanged for periods as long as three years. When the issue price is increased, the intention and the official justification are to obtain immediate relief from the burden of a growing budgetary subsidy.[3] Nonetheless, the political cost of such a step is usually reckoned to be sufficiently great that the government devotes much thought to the timing of such decisions. Our focus is on the consequences of higher issue price (and the consequent lower subsidy) on the market price of grain.

The relationship, in wheat, between procurement price and wholesale market price has been addressed in earlier studies (Balakrishnan and Ramaswami, 1995; Ramaswami, 2000). Essentially, the relationship is governed by the seasonality in market prices. Since the procurement price does not change during the marketing year (March to February), almost all sales to the government take place in the first couple of months of the marketing year. During this period, known as the procurement season, the procurement price is found to be equal to the price in the wholesale market. This happens because (a) the procurement price is not lower than the market price for if it were, the government would not be able to buy any grain and because (b) the procurement price is not higher than the market price because government buys all the grain offered to it (for evidence on this, see Balakrishnan and Ramaswami (1995); Dantwala (1993); Krishna and Chhibber (1983)).[4] As the marketing season proceeds, storage costs push the market price above the procurement price. At this point, all procurement ceases. The typical seasonal pattern is for the market price of wheat to keep rising till it peaks in February–March, just prior to the annual harvest.

Although, the public distribution system is intended to reach the poor, studies indicate that many of the poor are either excluded or receive small amounts of subsidies (Dev and Suryanarayana, 1991; Parikh, 1994; World Bank, 2001). In the southern states, especially Andhra Pradesh, Kerala and Tamil Nadu, the poor seem to make reasonable use of food subsidies. This is not so in the rest of the country. In the above mentioned states the average purchase of PDS grains by a household in

[3] The cost to the government consists of two components. The first component arises from the sale of subsidized foodgrains. Although the issue price is higher than the procurement price, the difference is not large enough to cover the costs of storage, transportation and distribution. The second component consists of the costs of carrying stocks across years.

[4] Wheat procurement relies on voluntary sales by farmers unlike procurement methods in rice where rice mills have to part with a proportion of their output (known as the levy) to the government at a price below the level in the market. However, during the period of study, wheat producers did not receive world prices as external trade was controlled by the government. But the tax (or subsidy) implied by this policy was negligible as the domestic price of wheat was usually between the fob export price and cif import price.

the bottom 20% exceeded 9 kg per month in 1993–94 (Table A3.1a, World Bank, 2001) accounting for 25% to 60% of total grain consumption. By contrast, these figures were negligible for Bihar, Haryana, Punjab, Rajasthan, Uttar Pradesh and West Bengal. In Assam, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Orissa, the quantities were between 1 to 4 kg.

Even where publicly subsidised grain reaches the poor, the market is just as important a supplier. Most households depend on a mix of the two. In the typical pattern, the market is the dominant supplier presumably because ration quotas are limited and not available for purchase continuously (Dev and Suryanarayana, 1991; Parikh, 1994; World Bank, 2001). This means that consumer benefits from the PDS depend not just on the scale of subsidies but also on how the subsidies impact the market price of grain.

We note here that the food subsidy scheme is only one part of a wider government intervention in the foodgrains economy. The policy regime also includes procurement. Although procurement is essential to obtain supplies for the PDS, it also contributes to other ends. In particular, it serves as a price support and is a mechanism of distributing state patronage to farmers. The policy regime is implemented by state agencies, notably the Food Corporation of India (FCI) responsible for procurement, storage and transportation to major consuming centers. Local government bodies complete the link from FCI warehouses to ration shops. Except for the running of ration shops, private agents are not involved in procurement, storage or transportation even though their costs are believed to be lower than that of state agencies (Tyagi, 1990; Gulati et al., 2000). Past work, however, has not studied the implications of inefficient state marketing institutions for the foodgrains economy and food policies.[5]

Market price and issue price: an empirical analysis

We turn to the evidence on the relationship between the market price and issue price of wheat. As retail price data are not available for the entire period, the market price refers to the wholesale price.[6] The data consists of wheat price observations (wholesale and issue) for 22 marketing years from April 1972 to March 1994. A wheat-marketing year stretches from April of a year t to March of a year $t + 1$. During the period, the issue price was changed, in all instances upwards, 14 times. There is no particular month in which such decisions are taken.[7] In the past, increases in the issue price have been announced in all months except June, July, September and October. Since these changes have occurred in different points of the marketing year, we model the relationship using monthly data rather than yearly averages. Since

[5] For instance, the issue does not find mention in Sukhatme and Abler's (1997) recent review of food price policies in India.

[6] The relation between the wholesale market price and the issue price is not likely to be qualitatively different from the relation between the retail market price and the issue price.

[7] This is unlike the decision on procurement price which is made annually before the arrival of the new crop in April.

wheat is a storable commodity, a model using monthly data must take into account the relationships between prices at successive dates. Within such a framework, we treat the issue price change as an unanticipated demand shock.[8]

Let k represent the fixed costs of storage and r be the opportunity cost of funds employed in storage. Then arbitrage by risk neutral traders ensures, in equilibrium that

$$E_{t-1}(P_t) = k + (1 + r)P_{t-1} \tag{1}$$

where $t-1$ and t are any two consecutive dates. E denotes the expectations operator and is indexed by $t-1$ to emphasize that the expected price is conditional on information at $t-1$. Eq. (1) can be rewritten as

$$P_t = k + (1 + r)P_{t-1} + \eta_t \tag{2}$$

where $E_{t-1}(\eta_t) = 0$. η consists of shocks to price due to supply and demand shifts that are not anticipated by traders at time $t-1$. A change in the issue price is a shock to market demand and is therefore one component of η. We therefore have

$$\eta_t = \alpha\Delta q_t + v_t \tag{3}$$

where q denotes the issue price and v_t consists of supply and demand shocks that are uncorrelated with the issue price. Substituting in eq. (2), we have

$$P_t = k + (1 + r)P_{t-1} + \alpha\Delta q_t + v_t \tag{4}$$

which can be approximated by

$$\Delta P_t = k + \alpha\Delta q_t + v_t \tag{5}$$

As an estimating equation, eq. (5) is preferable to eq. (4) because eq. (5) contains both variables in first differences and is therefore not subject to inferential problems due to non-stationarity. Eq. (5) assumes r to be zero; the resulting bias can, however, be minimized by working with high frequency data since r will be smaller, shorter is the gap between t and $t-1$.

The no-arbitrage condition of eq. (5) is a valid representation of the time-series behavior of wheat prices for all months in which stocks are carried. Evidence, however, points to the fact that wheat stocks are not carried across marketing years (Balakrishnan and Ramaswami, 1995; Ramaswami, 2000). Letting t index the year and i index the month, rewrite eq. (5) as

$$\Delta P_{i,t} = k + \alpha\Delta q_{i,t} + v_{i,t} \tag{6}$$

which is valid for all months except the harvest months when the new crop arrives, that is, the months of March, April and May.[9]

[8] If the issue price change is fully anticipated, then our method will fail to uncover a relationship even when it exists. On the other hand, if the regression reveals a significant relationship, we are valid in regarding the issue price change as unanticipated.

[9] From our earlier discussion of the relation between procurement and wholesale market price, it is clear that when the months of March, April and May are excluded, the left hand side of eq. (6) measures the change in market price and not the change in procurement price.

We thus have 22 years of data on each of nine months stretching from June to February. An ordinary least squares estimation procedure was not considered because analysis of OLS residuals revealed month-wise heteroscedasticity as well as correlation of error terms across months. Instead, the data set was treated as a pooled cross-section and time series data where the months i were regarded as the cross-section units and the years t as time units. Eq. (6) was then estimated allowing for cross-sectional heteroscedasticity, cross-sectional correlation and autoregression across years.

The results are presented in column (a) of Table 1. To make sure that these estimates are not because of omitted variables, column (b) of Table 1 presents estimates of an augmented version of eq. (6). First, we include shocks due to inflation and rice price changes. The inflation shock is measured by the difference between current and lagged rate while the rice price shock is similarly represented by the difference between the current and lagged change in rice price. Second, we include regressors that belong to the information set at $t-1$. The variables of this type (all included in first differences) are the one month lagged market price, the 12-month lagged market

Table 1
The market price and the issue price

Dependent Variable: Market Price, $P_{i,t}$		
Variables	Column (a)	Column (b)
Constant	2.8	2.41
	(10.03)	(8.74)
$q_{i,t}$	0.48	0.43
	(10.73)	(11.71)
$P_{i-1,t}$	–	0.006
		(2.1)
$P_{i,t-1}$	–	0.19
		(3.41)
H_t	–	−0.00035
		(-5.36)
W_t	–	0.050
		(3.86)
I_t	–	56.65
		(12.65)
$R_{i,t}$	–	0.13
		(12.65)
N	198	198

i indexes the month and t indexes the year, P is market price of wheat, q is issue price, H is wheat output, W is procurement price of wheat, I is the inflation rate; all of these variables are in first differences; R is the rice price shock and is measured as the difference between the change in rice prices and the lagged change in rice prices; N is the number of observations; t-values are in parentheses. The data is monthly from April 1972 to March 1994. The estimation technique is GLS with correction for month-wise heteroscedasticity, correlation between month-wise errors and year-wise autocorrelation.

price, current year's output and current year's procurement price.[10] The inclusion of procurement price controls for endogeneity of government behavior in the choice of issue price. If the government increases the issue price because of higher costs of procurement, then the issue price and procurement price would be correlated. Ignoring procurement price would therefore lead the issue price to be correlated with the error term and lead OLS estimates to be inconsistent.

The estimates in Table 1 provide firm evidence of a positive relationship between the issue price and the market price of wheat. This result is robust to the choice of regressors. But this contradicts the expected prediction that smaller subsidies (and higher issue price) reduces the demand and hence the price for all market goods. Why have not the income effects of wheat subsidies worked to increase the market demand for wheat? In the remaining sections of this paper, we write down and test a model that can account for the observed relation between (changes in) the subsidy and the market price of wheat in India.

A model with quality differences

According to anecdotal accounts and case studies, consumers of the PDS regard the grain supplied by the government to be of lower quality than that available in the market (Nair and Sivanandan, 1995; Indrakant, 2000).

If PDS grain is an imperfect substitute for market grain, then income effects are not the only consequence of food subsidies. We propose a model where the perception of quality difference is specific to each consumer. Consumers switch demand between the PDS and the market depending on changes in the subsidy. Such demand switches cause market demands and market prices to vary directly with the issue price (and inversely with the subsidy) and are thus capable of explaining the observed empirical relation between the market and the issue price.

There are two categories of consumers: those with access to the PDS and those without access to the PDS. The demand for wheat emanating from the latter group does not vary with the subsidy and hence plays no role in the analysis. It is sufficient therefore to consider only the consumers with entitlements to the publicly supplied wheat. Although the grain retails at the issue price q, let $c_i = q + \epsilon_i$ denote the cost of PDS purchases to consumer i. ϵ_i represents unobserved private costs to consumer i of buying an unit of wheat from the PDS. It includes a money value of intrinsic quality differences as well as the costs of transacting in the PDS. Transaction costs arise because of the location of PDS shops, uncertain supply, waiting time in queues and the use of incorrect weights and measures. As the perception of intrinsic quality differences as well as costs of transacting are individual specific, let $H(\epsilon_i)$ represent the distribution of these private costs in the population.

[10] Note that although the procurement price is equal to the market price during the initial harvest months, the market price rises above this floor in subsequent periods. Hence it is legitimate to include procurement price as a right hand side variable.

Consider now consumer i's demand for market grain. Let P denote its price. If $c_i > P$, consumer i does not buy any wheat from the PDS. If $c_i < P$, the consumer would buy wheat from the PDS subject to the limits placed on such purchases. In this case, consumer i's market demand would be positive only if this consumer has purchased her entitlement from the PDS. The demand for market grain can therefore be rewritten as

$$x_i = x_i(P,Y_i) \qquad \text{if } c_i \geq P$$

and

$$x_i = \max\{0,[x_i(P,Y_i + (P-c_i)E_i) - E_i]\} \text{ if } c_i < P$$

where x_i is i's demand for wheat as a function of price and income, Y_i is the consumer's income and E_i denotes i's entitlement from the PDS. Summing across all consumers, aggregate demand for market wheat is

$$D(P,q) = \int_{\varepsilon}^{\infty} x_i(P,Y_i)dH(\varepsilon_i) + \int_{0}^{\varepsilon} \max\{0,[x_i(P,Y_i + (P-c_i)E_i) - E_i]\}dH(\varepsilon_i) \qquad (7)$$

where $\epsilon = P-q$ is the subsidy provided by the government. As consumers with private costs greater than the level of subsidy do not buy from the PDS, the first term in eq. (7) represents the market demands of consumers outside the PDS while the second term represents the market demands of consumers inside the PDS. Using $c_i = q + \epsilon_i$, rewrite eq. (7) as

$$D(P,q) = \int_{\varepsilon}^{\infty} x_i(P,Y_i)dH(\varepsilon_i) + \int_{0}^{\varepsilon} \max\{0,[x_i(P,Y_i + (\varepsilon-\varepsilon_i)E_i) - E_i]\}dH(\varepsilon_i) \qquad (8)$$

In this formulation it is clear that although the government provides a subsidy of ϵ, consumer i receives an income transfer of $(\epsilon-\epsilon_i)$ per unit of entitlement. The first term in eq. (8) consists of consumers for whom the income transfer is negative while the second term in eq. (8) consists of consumers for whom the income transfer is positive.

Consider now a small increase in the issue price. The decrease in ϵ leads to smaller income transfers and thus to a lower demand for the market wheat. But this is not the only effect. For some consumers, $(\epsilon-\epsilon_i)$ becomes negative and they switch their entire demands to the market. Algebraically,[11]

$$\partial D(P,q)/\partial q = x_i(P,Y_i)h(\varepsilon) - (x_i(P,Y_i) - E_i)h(\varepsilon) - \int_{0}^{\varepsilon} (\partial x_i(P,Y_i + (\varepsilon - \varepsilon_i)E_i)/\partial Y_i)dH(\varepsilon_i)$$

[11] For the sake of expositional convenience, the comparative statics assume that the demand for market grain from the customers of the PDS is positive. It is straightforward, though tedious, to accommodate PDS consumers with no demand for market grain.

Canceling terms, we have

$$\partial D(P,q)/\partial q = E_i h(\varepsilon) - \int_0^{\varepsilon} (\partial x_i(P, Y_i + (\varepsilon - \varepsilon_i)E_i)/\partial Y_i) dH(\varepsilon_i)$$

where the first term is the positive effect due to demand switches (which happens when consumers abandon one source of supply in favour of another) from the PDS to the market while the second term is the negative effect on demand due to a lower income transfer. Thus, if demand switches are stronger than income effects, subsidy reductions lead to higher aggregate demand for market grain and higher market prices.[12] The empirical evidence for the Indian wheat market does suggest such that demand switches have overwhelmed income effects. But can demand switches be directly observed and estimated?

Identification of demand switches

The most straightforward way of validating our model would be to relate market sales of wheat to variations in its issue price. A positive relationship would be evidence of demand switches that are strong enough to overpower income effects. However, data on market sales are not available. Information on aggregate PDS sales is, however, available. Should it be regressed on the issue price? The answer is that such a regression will not identify demand switches. This is because an increase in issue price causes aggregate PDS sales to fall because some consumers exit the PDS and also because of income effects due to the reduction in subsidy. So how can income effects be disentangled from demand switches?

The answer lies in regressing aggregate PDS sales on the wheat market price. Such a strategy, however, raises couple of additional issues for identification, which are namely the endogeneity of government intervention and illegal grain sales by PDS retailers. We now turn to each of these issues.

Income effects

Let s_i denote the PDS purchases by consumer i. From earlier analysis, we can write this as

$$s_i = 0 \qquad \text{if } P \leq q + \varepsilon_i$$

$$s_i = \min\{x_i(P, Y_i + (\varepsilon - \varepsilon_i)E_i), E_i\} \qquad \text{if } P > q + \varepsilon_i$$

[12] Even though a higher q leads to a higher P, it can be shown that subsidy rate $\epsilon = P - q$ is declining in q.

Aggregating over all consumers, sales from the PDS are

$$s = \int_0^{\varepsilon} \min\{x_i(P, Y_i + (\varepsilon - \varepsilon_i)E_i), E_i\} dH(\varepsilon_i) \tag{9}$$

which says that sales from the PDS are the aggregate of purchases made by all consumers with private costs (of purchase from the PDS) less than the level of subsidy.

Consider now the relationship between aggregate PDS sales and the market price of wheat. Suppose issue price remaining constant, the market price increases (or decreases). Consumers receive a higher (lower) subsidy. Consumers with private costs (of purchase from PDS) smaller (greater) than the new level of subsidy but greater (smaller) than the old level of subsidy will switch demands from the market (PDS) to the PDS (market) to the extent permitted by their ration entitlements. As a result of the demand switch, aggregate sales from the PDS will increase (decrease). But what about the PDS purchases from those consumers who do not switch? The answer is that their PDS purchases are invariant to changes in market price. Hence the change in aggregate PDS sales due to a change in market price is entirely due to a demand switch.

Why are the PDS purchases of consumers who do not switch invariant to changes in market price? There are two categories of such consumers. First, there are the consumers who buy entirely from the market in both instances. These have zero demand for PDS grain in both instances as well. Second, there are the consumers who buy from the PDS in both instances. How do their PDS purchases change?

This is analyzed in Fig. 1, where, quantities of wheat are measured on the *x*-axis

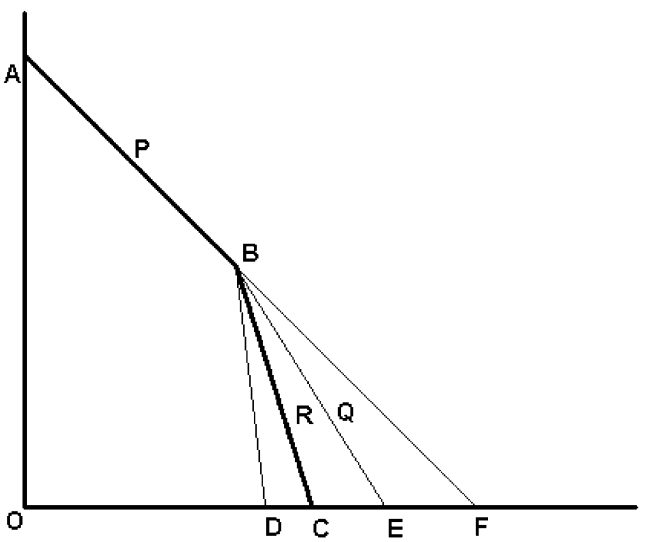

Fig. 1. The relationship between PDS purchases and market price.

while other commodities represented by money or a composite index are measured on the *y*-axis. Normalize the price of the composite commodity to be unity. The budget constraint of a consumer *i* who purchases wheat from the PDS is then represented by ABC with a kink at point B measuring the ration entitlement from the PDS. The slope of segment AB is at the level c_i (the cost of purchase of an unit of wheat from the PDS) and the slope of segment BC is at the level of the (initial) market price. Since we are concerned with analyzing choices of consumers who do not switch, we shall be considering variations in market price that do not violate the condition $P \geq c_i$.

In the initial situation, the consumer's demand could either be on the line segment AB or on the line segment BC or at the kink B. For each of these three cases, it can be shown that when the market price changes the initial situation continues to be optimal or is constrained optimal (i.e. optimal subject to the rationing constraint). The full reasoning of these cases is provided in the Appendix.

Therefore, in periods when the issue price is constant but the market price varies, a positive relationship between PDS sales and subsidy is evidence of demand switches.

Endogeneity of government behavior

We have so far assumed that entitlements are unchanging. In practice, while ration quotas are fixed according to household size and age composition, these quotas overstate the effective bound on PDS purchases since it is not uncommon for consumers to be turned away due to non-arrival of PDS supplies. The effective entitlements may therefore vary with PDS supplies. Furthermore, if the government supplies the PDS with more wheat as its market price rises (as in a price stabilizing policy), then a positive relation between PDS sales and the subsidy no longer captures the demand switch alone.

The supply intentions of the government can be measured by the 'allocation' variable. This is the amount of grain that the government allocates monthly, from its stocks, to distribution by the PDS. Using monthly data from January 1980 to December 1993, we tested for the response of wheat allocation to lagged levels of wheat subsidy. We regressed the log of allocations on its lags and the first and second lag of wheat subsidy and rejected the hypothesis that the wheat subsidy variables are insignificant (the *F*-statistic was $F(2,154) = 3.45$ and the associated *p*-value was 0.034). The evidence, therefore, does support the hypothesis that allocations are responsive to market prices. It is, therefore, important that the effect of market prices on PDS sales be estimated controlling for supply behavior by the government.

Illegal grain sales

Estimates suggest that a significant fraction, perhaps up to one third, of PDS grain supplies are diverted to the market by PDS retailers to profit illegally from the difference between the market price and issue price (Ahluwalia, 1993). Some of these illegal sales are made possible by denying legitimate consumers their full entitlements. More important, perhaps, is the use of bogus (or fictional) consumers.

The PDS retailer captures their entitlements. Could these illegal sales cause the subsidy and PDS sales to be positively related?

To answer this question, consider a slight extension of our analysis. First, let ϵ_i, the private costs of transacting in the PDS, include illegal payments to the retailer over and above the issue price. If these payoffs are invariant to changes in issue price or the market price, then ϵ_i is, as before, exogenous and the results remain unaltered. It is more natural to suppose, however, that the additional charge imposed by the retailer is an increasing function of the subsidy. Such an assumption includes the possibility that arbitrage is perfect, i.e. the additional amount charged by the retailer is the difference between market price and issue price.[13] Second, consider the PDS purchases by a consumer to include legal as well as illegal purchases from a PDS retailer. This means that the formal ration quotas established by the State need not be binding. These could be supplemented by illegal purchases. Thus, consumers with no formal access to the PDS could also purchase PDS grain.

Consider, once again, an increase in market price (issue price remaining unchanged). As the subsidy increases, some consumers will switch demands to the PDS. However, the increase in subsidy also leads, for at least some consumers, to higher costs for accessing PDS grain as retailers charge higher prices on illegal grain sales. Hence, the extent of demand switch (from the market to the PDS) is reduced. Similar arguments apply to decreases in market price. Thus, in the presence of illegal grain sales, empirical analysis may fail to uncover a significant relationship between PDS sales and market price even when demand switches are important. However, since the effects of illegal grain sales and demand switches work in opposite directions, an empirical finding of a significant positive relationship between PDS sales and market price surely indicates demand switches.

Demand switches: estimation

From eq. (9), we obtain an empirical PDS sales function as

$$s = \phi(\varepsilon, \mathbf{z}, \mathbf{m}) \tag{10}$$

where ϕ is a functional form chosen for empirical analysis, ϵ is the subsidy, $\mathbf{z}$ is a vector of demand shifters (such as income), and $\mathbf{m}$ are moments of the distribution of entitlements in the population.

As discussed earlier, effective entitlements vary because of variations in supply. Every month, the government allocates from its stocks a certain amount of grain for distribution through the public distribution system. We use this variable to measure the "supply-side" of the PDS. Identification (of demand switches) requires that we exclude data points where the issue price varies. Issue price remaining constant, movements in subsidy could be measured by P, or $(P-q)$ or (P/q). We use the

[13] We allow, however, the bribes to the PDS retailer to be individual specific.

ratio(P/q) because it is stationary (unlike the nominal values of market price) and is non-negative (unlike ($P-q$)) and thus convenient for a log specification.[14]

Table 2 presents the estimates of eq. (10) from a log-linear specification. The right hand side variables are the subsidy, allocations to PDS and national income (in log first differences). Besides PDS sales, we also treat the subsidy and PDS allocations as endogenous variables since shocks to PDS sales might be correlated with market prices (and hence the subsidy) and with allocations. The equation is estimated by generalized methods of moments using quarterly data from the first quarter of calendar year 1980 to the last quarter of calendar year 1993. As can be seen, after controlling for income and fluctuations in government supply, PDS sales and the wheat market price are positively related. A 10% decrease in subsidy (whether due to lower market price or higher issue price) results in a 6% decrease in PDS sales because some households switch demands from PDS to the market.

The response of households to changes in subsidy might not be instantaneous. To illustrate the dynamic effects of a change in subsidy on PDS sales, we use monthly data to estimate an unrestricted vector autoregression (VAR). We take the endogenous variables in the system to consist of wheat PDS sales (in logs), allocations of wheat to the PDS (in logs) and the subsidy (measured as $\log(P)-\log(q)$). The

Table 2
PDS sales and subsidy

Dependent Variable: Wheat Sales through the Public Distribution System (in logs)	
Variables	Coefficients
Constant	6.29
	(17.98, 0.00)
Subsidy (log(P/q))	0.58
	(3.00, 0.0047)
Allocations to the PDS (in logs)	0.15
	(3.09, 0.0036)
Income (GDP in log first differences)	−10.103
	(−6.41, 0.00)
Number of Observations	43
R^2	0.62
Test of overidentifying restrictions, $\chi^2(7)$	4.36
Estimation Method	GMM

The data is quarterly from 1st quarter of 1980 to 4th quarter of 1993. Quarters in which the issue price was changed are excluded. Subsidy and Allocations are endogenous variables. Instruments are lagged values of the dependent variable, income, subsidy, change in wheat stocks, change in wheat output, inflation rate, PDS allocations, log of rice sales through the PDS and twice lagged values of subsidy and PDS allocations. Figures in parentheses are *t*-values and p-values. R^2 is the correlation square between the dependent variable and its predicted value.

[14] For data reasons, the difference between market price and the issue price is sometimes negative. While issue prices are quoted in rupees, our data on market prices uses an index.

exogenous variables are current and lagged income (both measured as log of first differences). Model diagnostics indicate an optimal lag length of 3. Fig. 2 plots the dynamic response of wheat PDS sales to one-standard deviation shock to innovations of subsidy together with a 95% confidence band. It shows that the impact of subsidy on PDS sales lasts for nearly a year as households adjust their purchase behaviour to the new relative prices. The impacts reach their peak in the third month after which they gradually decline to zero.

Conclusions

As in many countries, the food subsidy in India is poorly targeted. Many of the poor receive insignificant amounts of subsidy and depend on the market to access supplies. In spite of this, a reduction in the food subsidy is not in their interest as the reduction in subsidy increases the market price of food. This result, as discussed in the introduction, will not be the outcome if consumers regarded grain from government supplies to be identical to the grain from the market. For, if the two were perfect substitutes, a reduction in the subsidy would decrease the market price or leave it unchanged depending on the strength of the income effect. Demand switches will not occur because as long as the market price remains higher than the ration price, consumers will not switch demand from the subsidised grain to market grain.

Econometrically, consumer behaviour in the Indian wheat market is better described by a model where consumers view the subsidised grain and market grain as imperfect substitutes and therefore switch demand between the market and the public distribution system according to the extent of subsidy in relation to the quality difference between the two sources. Methodologically, our contribution is a procedure which validates the demand-switching model using only aggregate data on public grain sales and prices. The method could therefore be applied to other countries as well.

Our finding implies that if the reduction in the food subsidy in India were to be accompanied by other institutional reforms, the market price of food may not rise.

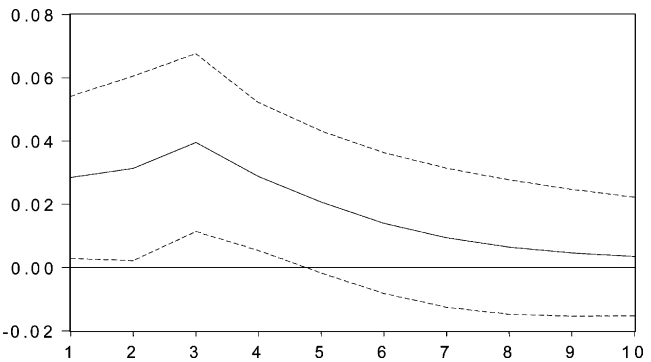

Fig. 2. Response of wheat PDS sales to one standard deviation shock to subsidy innovations.

Any serious reform would address consumer perceptions of quality. Why do they regard publicly supplied grain of lower quality? It is, after all, not a deliberate policy of the government to procure lower quality of grain.[15] In the case of wheat, government purchases take place at market prices, which means that private traders acquire comparable quality grain at the same prices as the government. At the point of sale, evidently, consumers do not regard the grain from the two sources as identical.

Clearly, relative to the grain in the market, consumers demand a discount on their purchases from the state marketing network, which represents their costs of transacting with the ration shops. The appearance of quality differences at the retail outlets is due to inefficiencies in the marketing chain, such as poor purchase decisions, lack of care in storage and handling, and indifferent and uncertain service at the ration shops. Therefore, unless the state institutions involved in the implementation of the food-subsidy regime are reformed, subsidy reductions will hurt even those among the poor who are not recipients of the subsidy. A fundamental implication of our finding is that for any given level of the subsidy, the market price of wheat is higher than what it would be if government grain were of the same quality as the market grain. The general point emerging then is that the inefficiency of the state institutions that implement food policy is central to market outcome and thus the welfare of the poor.

A less obvious reform in the current scenario in India would be for the government to downsize the procurement of grain. If the government were to procure less, it can offer a lower procurement price and the market price would accordingly be lower as a result of larger supplies in the market. Thus, subsidy reduction coordinated with lower procurement, may not lead to an increase in food prices. Such broader reform might also be necessary if subsidy reduction is to make a sizeable dent on government expenditure. We have seen that a reduction in subsidy leads consumers to switch their demand to the market. As a result, while government expenditure declines because of the decrease in public grain sales and in the per unit subsidy, it increases on account of larger stocks of grain if procurement remains unchanged. This suggests that subsidy reduction attempted through a hike in the ration price might not achieve its intended objective. It should not be difficult in future work to extend our analysis to obtain quantitative estimates of the impact of such subsidy reduction on government expenditures.

Appendix

It was claimed in the text that the change in aggregate PDS sales due to a change in market price is entirely due to a demand switch. To prove this we need to show

[15] It has been correctly pointed out by a referee that it would make sense for the government to deliberately procure lower quality grain because that would make the subsidy self-targeting towards the poor. However, when low quality is due to inefficiency in government intervention, this gain must be set against the deadweight loss of inefficiency. Further, to the extent that the poor do not have access to the subsidy, the self-selection operates only within groups with access to the subsidy and not in the entire population.

that the PDS purchases of those consumers who do not switch (i.e. continue to use the PDS) is invariant to changes in market price. Three cases can be distinguished. Consider first those consumers who are so poor that, at the initial level of subsidy, they do not draw their entire entitlement from the PDS, i.e. $x_i(P,Y_i + (\varepsilon-\varepsilon_i)E_i) < E_i$. In Fig. 1, the demand of such a consumer is represented as point P on the budget set OABC. An increase in market price shrinks the budget set to OABD. Point P, which is the maximal element over the larger budget set OABC, also belongs to the smaller budget set OABD and therefore continues to be the maximal element. A decrease in market price, on the other hand, expands the budget set to OABE. To show the maximal element is unaltered, consider the budget set OABF, which results when the market price drops to c_i. Relative prices at P are the same as relative prices at any point in the segment BF. P is the maximal element in the set OABF and is consequently the maximal element of subsets of OABF that contain P. P is therefore the maximal element of the set OABE. Thus, the purchases of PDS wheat by consumers in the interior is unaffected.

Consider next, a consumer located on the kink B, i.e. $x_i(P,Y_i + (\varepsilon-\varepsilon_i)E_i) = E_i$. At the initial level of market price, this consumer does not purchase any wheat from the market. Clearly, increases in market price leave the optimal unaffected at B. Decreases in market price could shift the maximal element from B to a point like Q (a point like P will never be chosen as that was available and disregarded in the initial situation). However, purchases from PDS cannot increase as they already at the maximum permissible level.

The third case is when a consumer buys wheat from the PDS and from the market, i.e. $x_i(P,Y_i + (\varepsilon-\varepsilon_i)E_i) > E_i$. Suppose this consumer is initially located at point R on the budget constraint ABC in Fig. 1. This consumer's purchase from the PDS equals her entitlement. Now suppose the market price falls and the budget set expands to OABE. The maximal point will shift but purchases from the PDS cannot increase as it is already at its maximum level. Suppose it decreases so that the maximal element in the set OABE moves from R to a point like P. But this contradicts the fact that R was optimal under the budget set OABC when P was also available. Hence, this consumer will not change the amount of wheat bought from the PDS. Now consider an increase in market price so that the budget set shrinks to OABD. Once again PDS purchase cannot increase beyond the ration entitlement. But can it decrease? The original maximal element R is no longer available. The new maximal element must lie either on the segment BD or on the segment AB of the budget constraint. It cannot, however, ever be optimal for a consumer to relocate to a point on AB. To see why, suppose the new maximal element is a point like P on segment AB. Here PDS purchases are lower than the entitlement. Now consider a scenario where the initial level of market price is such that the budget constraint is OABD. By assumption, the maximal element of this budget set is P. Now consider a decrease in market price resulting in the budget constraint OABC. By assumption, the maximal element over the expanded budget set is R. This implies that consumers not buying their full entitlement increase their purchases from the PDS when the market price falls. But this cannot happen as was demonstrated by the first case. A point

like P cannot, therefore, be optimal on the set OABD. The new maximal element must lie on the segment BD. Purchases from the PDS will consequently remain at the level of entitlement.

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