Arbitrage and Corruption in Food Subsidy Programs: Evidence from India's Public Distribution System

A. Kishore;

International Food Policy Research Institute (IFPRI), South Asia Office, India

Corresponding author email: a.kishore@cgiar.org

Abstract:

Would the households get to buy more of subsidized grains from a food safety-net program if the difference between the price in the program and in the open market were to increase? This is an important question for safety-net programs anywhere in the world, but particularly so for the Public Distribution System (PDS) of grains in India. The standard economic intuition suggests that price controls distort signals and create incentives for unintended transactions. Dreze and Sen (2013), however, posit an opposite entitlement effect where an increase in arbitrage potential increases the value of PDS entitlement. Increase in the stake in the PDS for the eligible beneficiaries results in increased accountability and ultimately an increase in household purchase of grains from the PDS. We test these two competing hypotheses using the India Human Development Survey (IHDS) panel data and find evidence for both kinds of effects. In states where welfare programs are better governed, the Dreze and Sen (2013) conjecture holds, but in states like Bihar and Jharkhand where welfare programs are poorly run, the opposite pattern holds as households' purchase of subsidized grains declines with increase in arbitrage.

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Acknowledgments

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Suman Chakrabarti, Avinash Kishore and Devesh Roy[1]

1. Introduction

Food subsidy programs in many developing countries are rife with corruption and pilferage (Mehta and Jha 2014). The most common form of corruption in these programs takes place through diversion of food away from the intended beneficiaries. Whether diversion of food from such programs increases or decreases with the price differential between the market and the price in the safety net is an important question. This question was at the heart of the debate around India's National Food Security Act (NFSA), 2013 which increased the price arbitrage in India's public distribution system (PDS) significantly by promising a monthly ration of 25 kg of coarse cereals, wheat or rice at Rs.1,2 or 3 per kilogram respectively to nearly two-thirds of all households. This change implies that average prices in the open market turned out to be six to seven times higher than the subsidized prices in the PDS.

The standard economic intuition suggests that price controls distort signals and create incentives for unintended transactions (Sowell, 2000). Further, unintended transactions increase in magnitude as the incentive (the arbitrage) increases (Banerjee, Mullianathan and Hanna, 2012). Greater incentives for back door sales that deny or diminish the entitlements to the designated beneficiaries is one such unintended transaction in case of the PDS, the incidence of which is expected to rise with the price wedge between subsidized and non-subsidized food.

[1] Suman Chakrabarti (s.chakrabarti@cgiar.org) is a research analyst in the South Asia Office of the International Food Policy Research Institute (IFPRI), New Delhi, India. Avinash Kishore (a.kishore@cgiar.org) is a research fellow in the South Asia Office of IFPRI, New Delhi, India. Devesh Roy (d.roy@cgiar.org) is a research fellow in the Markets, Trade and Institutions Division of IFPRI, New Delhi, India.

Drèze and Sen (2013) argue that the increase in arbitrage may also have an opposite effect. This is because the stakes of the intended beneficiaries is higher when PDS price is comparatively low i.e. when there are greater gains to be made from arbitrage. With higher stakes in the PDS, the price wedge mobilizes the beneficiaries to seek their entitlements more actively and definitively resulting in increased accountability and ultimately reduced corruption.

In this paper, we test these two opposing arguments using panel data from India Human Development Survey (IHDS).

Government of India sets the retail price of subsidized items sold through the PDS. But some state governments use their own budgetary resources to reduce prices even further. Market prices of grains included in the PDS can also vary across states. Thus, there exists inter-state variation in the effective arbitrage potential.

Summary findings show that diversion of rice and wheat from the PDS decreased from 54% in 2004-05 to 38% in 2011-12 even as arbitrage potential increased sharply. Further, the extent of diversion of grains was generally lower in states where the arbitrage potential was higher. Thus, both the cross-section and time-series data on leakage of grains from PDS seem to support the Dreze and Sen (2013) hypothesis.

However, it is possible that we see this trend because states that spend more efforts to control leakages could also be making the PDS more generous for example by topping up the federal subsidy. The arbitrage potential, greater uptake and therefore lower leakages could all coincide. Also, arbitrage will be lower when households buying more from PDS buy cheaper grains from the market as well. In this case also, one would see a negative relationship between arbitrage and household purchase of PDS grains and possibly a rejection of the Dreze and Sen argument, albeit spuriously.

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To mitigate concerns about potential biases discussed above, we use household panel data from the India Human Development Survey (IHDS). IHDS data allows us to address issues of unobserved factors that the repeated cross-section data from NSSO-CES used in existing literature cannot. IHDS is a nationally representative survey of over forty one thousand households. The same households were interviewed in 2004-05 and 2011-12 to create a panel.[2] In analysis with IHDS data, we estimate a negative and statistically significant association between amount of cereals purchased from PDS and the arbitrage potential using models that can control for unobserved household level factors. This is opposite of the Dreze and Sen (2013) conjecture supported in the aggregate data.

Thus, the IHDS panel shows that households (get to) buy smaller quantities of rice and wheat from PDS shops when the arbitrage increases. Does the IHDS panel negate the Dreze and Sen conjecture? Our analysis based on IHDS panel shows that it is not straightforward. There is heterogeneity across different states. An increase in arbitrage has a positive effect on households' purchase of PDS grains in some states (where PDS is better managed- see Khera 2011) while the opposite holds in some other states.

We then exploit the setting of a natural experiment that given the timeline was recorded in the IHDS data. Households in India are classified into 3 income categories for targeting PDS benefits: above poverty line or APL households, below poverty line or BPL households and Antyodaya or AAY households who are the poorest of the poor. APL households pay the highest price for PDS grains while the Antyodaya households pay the lowest with BPL households in between. A small fraction of households in the IHDS sample were reclassified from one category to another between the two rounds of survey.

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[2] See http://www.ihds.umd.edu/data.html more documentation on the IHDS data.

Our analysis shows that households that switched from APL to BPL or AAY status purchased larger quantities of grains from PDS as the value of their PDS entitlement increased significantly. Thus, analysis based on IHDS data suggests a more nuanced and varied relationship between arbitrage and average quantity of grains that households purchase from the PDS.

Thus, we show that whether increase in arbitrage potential for the food dealers leads to more corruption and leakage of cereals from the PDS or increases in household purchases of subsidized cereals depends on the quality of governance in the PDS. States where PDS is better governed, latter effect dominates and households tend to claim more of their entitlement as it becomes comparatively valuable and the diversion goes down. In cases of poorly managed states, the exact opposite effect seems to hold where dealers divert more and households get less when the value of the entitlement goes up.

Our results can be of great significance to food based social safety-net programs across the world, and especially so, for India where government has increased the budget allocation to the PDS very significantly (from 0.7 percent to more than 1 percent of GDP (Mishra, 2013)). Grains are now provided extremely cheap for a large section of the population to achieve food and nutritional security under the National Food Security Act (NFSA). A key argument for NFSA by the advocates was that a universal or near universal provision of cheap grains under PDS will improve the functioning of the system. Our results show that such an association is not straightforward. Making grains cheaper in the PDS may have an opposite effect as well unless supported by commensurate improvement in grain management.

The rest of the paper proceeds as follows. Section II discusses the background and institutional setting of PDS in India during our study period, while Section III describes the IHDS data and lays out the methods we employ in our investigation. Our findings and results

are presented in Section IV. Section V ties our results with the existing literature and Section VI concludes.

2. Background and hypothesis

India's public distribution system is the largest food safety net program in the world. In 2011-12, more than 550 million people purchased subsidized rice and/or wheat from the large network of 'fair price shops' (FPS) of the PDS. [3] In September 2013, India's National Food Security Act (NFSA) was signed into law. The NFSA expanded the scale of the PDS even further by entitling over 800 million people to 5 kg of subsidized cereal per month at very low prices.[4]

As with any government intervention that involves a price distortion, the risk of unintended consequences remains. The PDS is no exception. It has a reputation for being poorly implemented with extremely high rates of pilferage, referred to as 'leakages' in the literature (Dreze and Khera 2015; Khera 2011b; Drèze et al. 2015). Leakages refer to the amount of rice and wheat released by the Food Corporation of India (FCI) that does not reach PDS beneficiaries at delivery points.

Estimates of leakages are based on matching National Sample Survey Consumer Expenditure (NSS-CES) data, particularly on household purchases from the PDS with 'offtake' data from the FCI. Recent estimates show that in 2011-12, 41.7 percent of the 41.3 million metric tons of rice and wheat released by the FCI to state governments for the PDS did not reach households (Dreze and Khera 2015). However, even this high level of leakage represents an improvement from the 54 percent leakage estimates from 2004-05 (Himanshu and Sen 2013).

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[3] As per NSSO consumer expenditure data round 68, 44.1 percent of India's households reported purchasing rice or wheat from the PDS in the last one month. India's population was 1.25 billion as per the 2011 Indian census.
[4] NFSA entitles all beneficiaries of the PDS 5 kg/month of rice/wheat/coarse grains at INR 3/2/1 per kg, respectively.

However, some states are usually credited with better grain management than others, and leakages in those states are lower as well. For example, Tamil Nadu and Chhattisgarh, the poster states for a well-functioning PDS, had less than 10 percent leakage, compared to Uttar Pradesh, West Bengal, Assam, Madhya Pradesh, Rajasthan, Punjab and Gujarat where leakage was in excess of 50 percent. Yet, on average, the aggregate trends show that PDS leakage has been reducing in backdrop of an inflationary period of cereal prices (Kishore and Chakrabarti 2015).

Figure 1 shows how PDS 'access' measured by the percentage of households who purchased grains from the PDS in a given month has moved with arbitrage potential. There appears to be a positive relationship between the numbers of households who access the PDS with an increase in arbitrage potential over time. The only break in this trend is between 1990-00 and 2004-05 when the PDS transitioned into a targeted scheme. The PDS was, in fact, rechristened as Targeted Public Distribution System i.e. TPDS.

Targeting, however, resulted in more opacity, high exclusion errors and a less generous system overall (Himanshu and Sen, 2011; Khera, 2011). Thus, fewer households were able to access the PDS even when there was an increase in arbitrage potential. Since 2004-05 however, the PDS has continued to become more generous and open and it appears that more households are able to access it for cheaper grains when faced with higher open market prices.

Figure 1- Increase in use of fair price shops with rising price difference between market and central issue prices
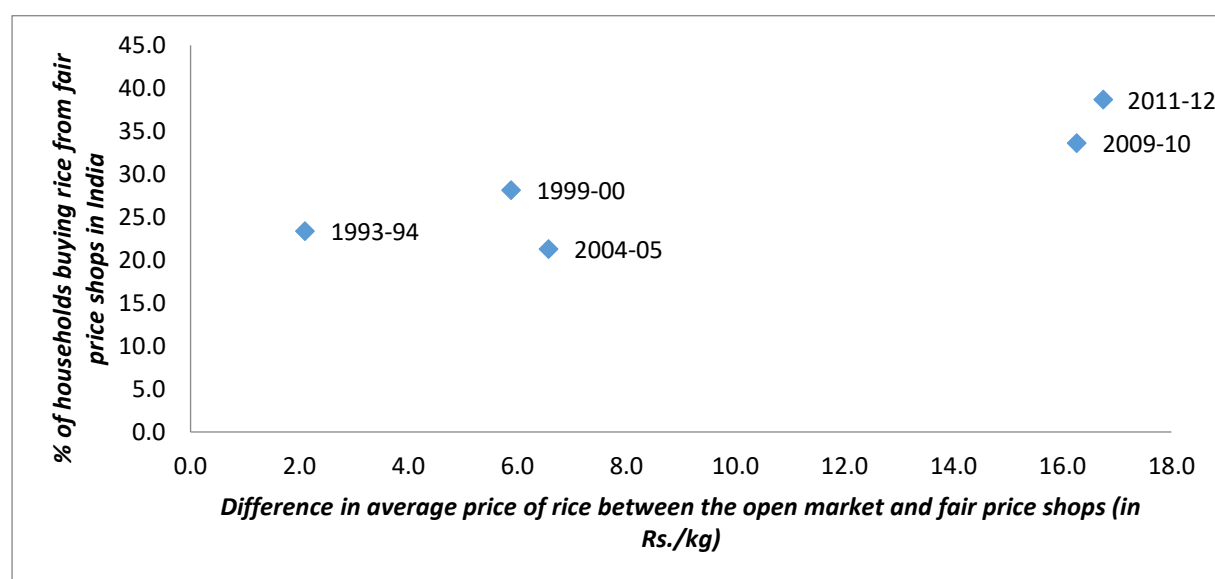
Source: Data from National Sample Survey Office (NSSO) consumption surveys rounds 50, 55, 61, 66, and 68.

The years between 2004-05 and 2011-12 saw a sharp rise in the price of rice and wheat in India accompanied by an increase in the quantities purchased from FPS. Table 1 shows that in the five years between 2004-05 and 2009-10, the nominal price of rice and wheat nearly doubled in the open market. Price rise continued even in 2011-12. A recent study suggests that a 10 per cent increase in prices, on average, causes a welfare loss of 5 to 6 per cent of monthly income in rural areas and 3 to 4 per cent welfare loss in urban areas of India (Weber 2014). A similar study from Mexico finds that in situations when sharp price rises result in welfare losses, food subsidies can reverse the regressive nature of observed price increases, though, they may cause some price distortions as well (Attanasio et al. 2013).

Table 1: Cereal prices and procurement from the PDS between 2004-05 and 2011-12

	2004-05	2009-10	2011-12
Average price of rice (INR/kg)	11.85	20.34	22.23
Average price of wheat (INR/kg)	9.73	16.09	16.99
Average price of PDS rice (INR/kg)	5.77	4.86	4.91

Average price of PDS wheat (INR/kg)	5.37	6.37	6.5
Average quantity of PDS rice (kg/person/month) purchased	1.05	1.56	1.79
Average quantity of PDS wheat (kg/person/month) purchased	0.25	0.52	0.62
Average percentage households purchasing PDS rice	20.77	32.36	38.85
Average percentage households purchasing PDS wheat	8.14	21.63	26.16
Average percentage leakage of rice	41.5	33.4	32.6
Average percentage leakage of wheat	74.9	64.2	57.4
Monthly per-capita consumption expenditure (INR)	851.50	1493.74	2050.87

Source: Authors estimates from NSS-CES rounds 61, 66 and 68 and FCI data of grain offtake from the PDS 2004-05, 2009-10 and 2011-12.

In India, both the percentage of households accessing the PDS for rice and wheat and the per capita quantity of grains purchased from FPS increased between 2004-05 and 2009-10 just when the prices rose sharply in the open market (Table 1). The combined effect of changes on both the extensive (purchases between market and the PDS) and the intensive margins (greater uptake of the PDS) is reflected in a steady decline of diversion of rice and wheat during this period.

Figure 2 plots the percentage of total quantity of grains (rice+wheat) diverted from the PDS in each state against the arbitrage potential across three rounds of NSSO-CES. It shows a clear negative correlation between arbitrage and diversion. Here, arbitrage potential is estimated as the weighted mean of price differences for rice and wheat where the weight equals the share of rice and wheat in the total offtake from FCI. The relationship between arbitrage potential and leakage as apparent in figure 2, was used as an argument to advocate for the provision of grains at very low prices in the PDS in the follow up to NFSA (Himanshu and Sen, 2011; Dreze and Sen, 2013). While these observations and correlations are suggestive, an impact study is necessary to offer evidence of causality between arbitrage potential and the leakages/diversion from the food distribution system. Doing so certainly

requires analysis of household purchase of grains from the PDS i.e. employing disaggregated

data.

Figure 2: Leakage from PDS versus arbitrage at the state level

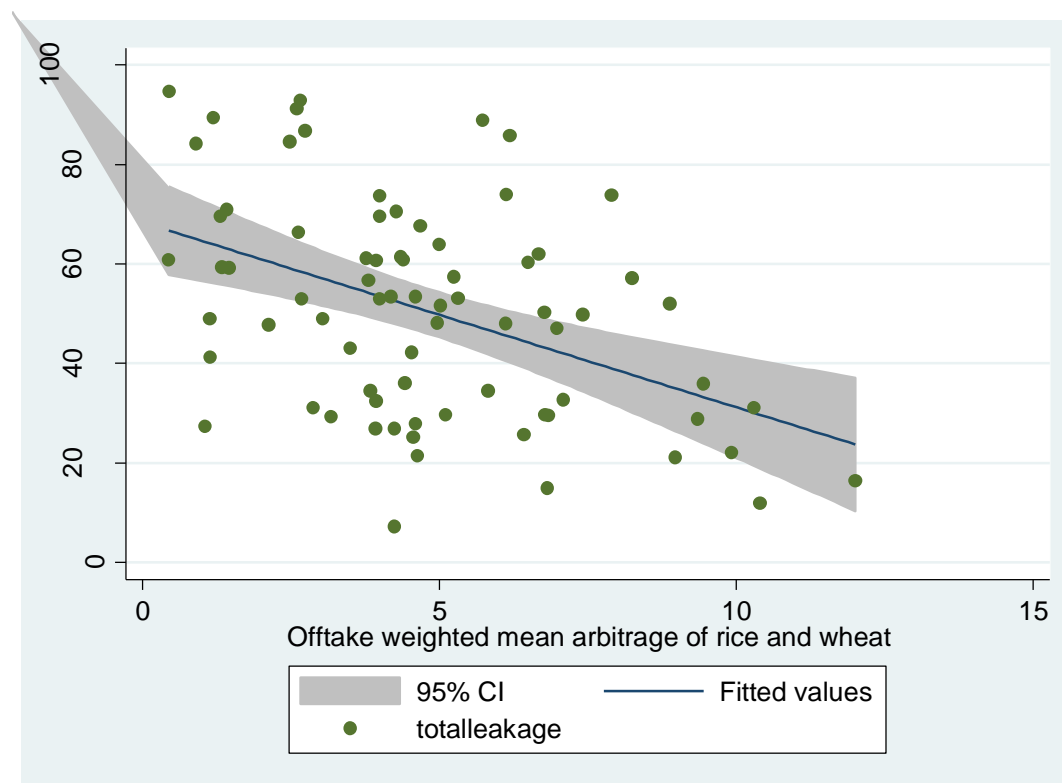Source: Authors estimates from NSS-CES rounds 61, 66 and 68 and FCI data of grain offtake from
the PDS 2004-05, 2009-10 and 2011-12.

Hypothesis

The simultaneous increase in market price of grains and reduction in diversion from the PDS

runs counter to what the standard economic theory would predict. As discussed above, food

subsidy can lead to unintended transactions, the magnitude of which would increase as the

incentive (the arbitrage) increases (Banerjee, Mullainathan, and Hanna 2012). Dreze and Sen

argue for the opposite effect i.e. a positive relationship between arbitrage potential and uptake

of the PDS. A theoretical model of pilferage by Mehta and Jha (2014) also predicts

ambiguous effects in this context. The authors contend that arbitrage opportunities are higher when subsidies are large, but anti-graft measures rely greatly on incentivizing citizens to combat corruption. Therefore, pilferage rates need not rise as price subsidies are increased. These two views form the bases for our hypotheses underlying the link between arbitrage potential and uptake of subsidized food.

Simple calculations show that the value of the PDS entitlement doubled as a percent of per-capita expenditure between 2004-05 and 2009-10.[5] These changes provide an ideal setting to study the empirical link between subsidies and realized purchases of subsidized food. In this paper, we empirically test the opposing arguments underlying the link using data from various household consumption expenditure surveys conducted between 2004-05 and 2011-12.

There was a sharp rise in the price of cereals during this period. This allows us to exploit large price variations to trace the direction and magnitude of the effect of change in arbitrage potential on PDS purchase. Based on three different datasets (details in the next section), we try to answer two interrelated questions in this paper:

(i) Does an increase in arbitrage decrease the diversion of grains in the PDS?

(ii) If not, under what context does the standard economic intuition continue to hold?

Data and methods

Most existing studies on leakage in PDS use state level aggregate household purchase of PDS rice and wheat and the total release from the FCI (Himanshu and Sen 2013; Khera 2011b;

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[5] From Table 1 using the formula: Value of subsidy= ((Open market price minus PDS price)*PDS quantity purchased)/ Monthly expenditure
((11.85-5.77)*1.05) + ((9.73-5.37)*0.25) / 851.80 = 9.12 + 1.09 / 851.80 = 1.2 percent of MPCE in 2004-05
((20.34-4.86)*1.56) + ((16.09-6.37)*0.52) / 1493.74 = 24.14 + 8.09 / 1493.74 = 2.1 percent of MPCE in 2009-10

Dreze and Khera 2015). The gap between release and uptake by households is the measure of leakage.

However, it is possible that the increase in the price wedge and plugs in corruption happened because of other factors but were not related in a causal way. Hence, changes in the governance of the PDS in different states (reduced or increased leakage) could have happened simultaneously, but the former did not cause the latter. If so, regressing leakages or average quantity of grains purchased by households from PDS shops) against arbitrage potential can return statistically significant coefficients but those could clearly be biased. We try to overcome this problem by employing more disaggregated data from different sources to test the competing theories on arbitrage potential and leakage in the PDS. Table 2 summarizes the key features of the four data-sets used in this paper.

Table 2. Key features of data sets used in the study

	FCI	NSS-CES	IHDS
Sample size	156	327,161	69,264
Geographic coverage	29 states	35 states	35 states
Time period	2004-05, 2009-10, 2011-12	2004-05, 2009-10, 2011-12	2004-05, 2011-12
Outcome used	Rice and wheat offtake	Rice and wheat purchases from PDS	Rice and wheat purchases from PDS
Predictors variables used	None available	Market price, PDS price	Market price, PDS price, star states, ration card switchers
Representative	Yes- State level	Yes - National and state level	Yes - National
Type	Aggregate	Repeated cross-section at household level	Panel at household level

Source: Authors construction

First, we use data on purchase of rice and wheat from PDS shops and from other sources in the thick rounds of CES carried out by the NSSO. Thick round of CES are carried out by NSSO every five years and they are called so because they survey almost twice the number of

households compared to the annual "thin" rounds. We use data from 61st, 66th and 68th rounds conducted in 2004-05, 2009-10 and 2011-12. NSSO CES sample is representative not only at the national, but also at the state level. So, we can use NSSO data to estimate total household purchase of PDS grains in a state in every round.

Following Gulati et al (2012), we compare the estimated total household purchase of PDS grains with the total quantity of rice and wheat that the state collected from the FCI in that period. We test the relationship between the amount of grains diverted from the PDS in states and the arbitrage potential between the median market prices and the average subsidized price of grains using data from all three rounds of NSSO CES. We estimate both POLS regressions (equation 1) and regressions with state fixed effects and time trend (equation 2).

$$Leakage_{tsc} = \alpha + \beta arbitrage\ potential_{tsc} + \varepsilon_{tsc} - - - - - - - - - - - - (1)$$

$$Leakage_{tc} = \alpha + \beta arbitrage\ potential_{tc} + \gamma_s + \mu_t + \varepsilon_{tc} - - - - - - - - - - \quad (2$$

Where '$Leakage$' is the percentage of cereal grain diverted from the PDS for cereal c (rice or wheat) in state s and year t and 'arbitrage potential' is the difference between median price of the grain in the open market and the PDS. γ_s controls for state fixed effects and μ_t controls for the time trend. ε_{tsc} is the error term. The coefficient β on arbitrage is the coefficient of interest. We call β, the 'arbitrage effect'. We run regressions separately for rice and wheat and for rice and wheat together. We estimate arbitrage as the weighted average of arbitrage for rice and wheat where weight equals the share of the grain in the total offtake of rice plus wheat from FCI by a specific state in a particular period.

From leakage to household purchase of PDS grains
We measure arbitrage as the difference between the market price of a cereal and its price in PDS. Though individual households are often assumed to be price takers, the price a

household pays for a cereal in the open market may vary with the household's income level (Deaton and Dupriez, 2011). Richer households may be buying more expensive varieties of rice and wheat. They are also less likely to buy cereals from PDS or buy smaller quantities. As a result, using market price reported by the household to measure arbitrage effect, could result in biased estimates. Hence, we use the average market price of a grain in the village to mitigate the possible bias from purchase behaviour of households unrelated to arbitrage.

Note that there is large inter-state variation in capacity of implementing development and welfare schemes in India (Besley and Burgess, 2001), including in case of PDS. Further, it is possible that popularity of PDS in states may be correlated with the market prices of rice or wheat in that state. State fixed effects in equation (3) control for the time invariant state characteristics.

While the arbitrage values increased from 2004-05 to 2011-12, the management regime of PDS also changed in some states. All such changes cannot be accounted for by linear state-specific time-trends. Similarly, many households switched from APL to BPL category in this period. This switch also changes the arbitrage value for the households over and above the average increase in the arbitrage in a particular area. So, the potential of omitted variable bias exists with the repeated cross-section data.

We try to address these issues by using the household level panel data from the IHDS.[6] The IHDS survey contains a consumption expenditure module that collected information on households' purchase of rice and wheat from PDS and other sources just like the NSSO-CES. We used data from the CES module of IHDS to estimate arbitrage effect on PDS purchases for the same households over a period of 7 years that correspond closely with the 61st and the

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[6] See http://www.ihds.umd.edu/data.html more documentation on the IHDS data.

68th rounds of the NSSO used above. IHDS data allows us to control for unobserved household level heterogeneity by including household fixed effects (equation 4).

$$PDSpurchase_{it} = \beta arbitrage_{it} + \rho_i + T_t + \varepsilon_{it} \; - - - - - - - - - - - - - (4)$$

Where $PDSpurchase_{it}$ is the average monthly purchase of rice or wheat (in kg) from the PDS by household i in year t and $arbitrage_{it}$ is the difference between average price of the grain in the open market in a primary sampling unit and the PDS price faced by the household i in year t. ρ_i controls for the household fixed effects and T_t controls for common national time trend. ε_{it} is the random error. In another variant of this model, we add an interaction term between a dummy variable for states with improved PDS with the arbitrage value.

The improved PDS dummy takes the value of 1 for Chhattisgarh, Himachal Pradesh Odisha and Tamil Nadu in period 2 only and zero for these four states in period 1 and for all other states in both periods 1 and 2 (equation 5). These four states implemented major PDS reforms between 2004-05 and 2009-10 (Kishore and Chakrabarti, 2015). The interaction term captures if the arbitrage effect on PDS purchase by households is different in states where PDS is better governed. Finally, the household panel data allows us to control for the switch in ration card status (APL, BPL or Antyodaya) of a household from one period to another (equation 6)—something we could not do with the repeated cross-section from NSSO-CES.

$$PDSpurchase_{it}$$
$$= \beta MarketPrices_{it} + \alpha_i + T_t + \theta Marketprice_{it} * ReformedPDS + \varepsilon_{it}$$
$$- (5)$$

$$PDSpurchase_{it} = \beta Marketprice_{it} + \alpha_i + T_t + \theta Marketprice_{it} * ReformedPDS +$$

$$\pi SwitchtoBPL + \varepsilon_{it} \ -(6)=$$

Where *ReformedPDS* is the dummy variable discussed above. *SwitchtoBPL* in equation 6 is a dummy variable that takes the value of 1 in period 2 for households whose ration card status changed from APL to BPL or AAY and zero otherwise. This switch entails a significant increase in the wedge between market prices and PDS prices for the beneficiary household.

Descriptive statistics and results

Table 3 presents summary values for household characteristics from the two rounds of the IHDS data. The IHDS data also shows similar trends in arbitrage values for rice and wheat and increase in the average quantity of these grains purchased by the households. IHDS data also shows a large increase in the fraction of AAY and BPL households and a corresponding decline in the APL households. Nearly one-fourth of all APL households and households with no ration-cards in the first round of IHDS were reclassified as BPL or Antyodaya households in the second round. Further, fewer households report not being able to get a ration card due to bureaucratic reasons in the latter period.

Table 3: Descriptive statistics from IHDS samples

	Round 1 2004-05	Round 2 2011-12
Total PDS rice consumed per household per month (kg)	5.072	10.69
Market price of rice consumed per household per month (INR/kg)	11.48	21.27
Difference between market and PDS price of rice consumed per household per month	6.158	16.81
Total PDS wheat consumed per household per month (kg)	2.184	6.696
PDS mean price of wheat consumed per household per month (INR/kg)	5.102	6.030
Difference between market and PDS price of wheat consumed per household per month	4.410	9.334
Household has AAY card	2.48	8.61
Household has BPL card	34.4	47.0
Household has APL card	47.4	40.5
Star states: Himachal Pradesh, Chhattisgarh , Odisha,	19.3	22.1

Tamil Nadu		
Star state interaction with market price of rice	2.118	4.626
Households that changed over to an AAY card from no card, BPL card or APL card		7.34
Households that changed over to a BPL card from no card or APL card		18.7
Households that changed over to an APL card from no card		5.04
Ration card not possessed because of bureaucratic reasons	7.11	2.75
Total number of assets possessed by the household	11.66	15.01
Month per-capita consumption expenditure	881.8	2171.5
Household size	5.316	4.857
Urban areas	31.5	32.8
Highest education level achieved by adults in the household (years)	7.369	7.962
Observations	34,643	34,621

Source Indian Human Development Survey Data corresponding to years 2004-05 and 2011-12

Table 3 shows significant changes in household characteristics over the 7 year period. We use household fixed effects to control for the time-invariant household characteristics when using IHDS panel data. As discussed above, we are also able to control for the change in ration-card status in IHDS data.

Leakage of rice and wheat from PDS: State level results from NSSO and FCI data

States received 25.24 million metric tons (MT) of rice and wheat from FCI in 2004-05 for PDS. NSSO-CES suggests that, of this, only 12.10 million MT (or 48%) reached households. The rest (13.14 million MT) was diverted to the black market. Diversion of grains from PDS as a percentage of the total offtake reduced from 52 percent in 2004-05 to 46.9 percent in 2009-10, but the total quantity of subsidized grains diverted increased from 13.14 million MT to 19.86 million MT. Between 2009-10 and 2011-12, diversion from PDS reduced by another 3 percentage points, while the total quantity diverted further increased to 21.95 million MT. Thus, total quantity of subsidized cereals allocated to PDS increased between 2004-05 and 2011-12 and a greater share of this increased allocation reached households. Even as

household purchase of PDS cereals increased, the quantity of cereals diverted from the system also increased.

How did the leakage of rice and wheat from PDS change across states over the three NSSO rounds as arbitrage potential between the market prices and the subsidized prices moved? Table 4 shows the results from a series of POLS and FE regressions between leakage (expressed as a percentage of total offtake of grains) and arbitrage. A simple POLS regression (column 1) shows that a one rupee increase in arbitrage is associated with reduction in diversion by 1.5 percentage points. The coefficient is also statistically significant. Later, we introduce a survey round dummy (column 2) to measure the relationship between arbitrage and diversion across states in a given year. The inter-state comparison also shows a positive relationship. Column 3 shows us the same relationship across years within a state. Again, over time, the diversion from PDS decreases as arbitrage increases. The relationship between arbitrage and diversion remains negative, but becomes statistically insignificant when we introduce both time and state fixed effects. This could be because of limited degrees of freedom.

In sum, the analysis of state level data on arbitrage and leakage seems to support the Dreze and Sen conjecture that an increase in the value of entitlements leads to greater access and use of the PDS, resulting in an overall decline in leakage.

Table 4: Models for leakage from PDS on arbitrage - state level

Dependent Variable = Percentage of total off-take Leaked from PDS	(1)	(2)	(3)	(4)
	Pooled - OLS	Pooled - OLS	State FE	State FE
arbitrage	-1.52***	-1.52**	-1.29**	-1.00
	(0.41)	(0.54)	(0.42)	(0.66)
year=2009		1.42		-2.34
		(6.99)		(6.80)
year=2011		-0.66		-5.00

	(7.33)		(7.31)
Dummy cereal=wheat			
Constant	64.29***	64.11***	45.92***	46.45***
	(4.41)	(4.63)	(10.56)	(10.69)
R-squared	0.08	0.08	0.45	0.45
N	156	156	156	156

Standard errors in parentheses
Source NSSO Consumption Expenditure Data corresponding to years 2004-05, 2009-10 and 2011-12 and FCI offtake data for 2004, 2009 and 2011
$^+ p < 0.10, ^* p < 0.05, ^{**} p < 0.01, ^{***} p < 0.001$

Results from the IHDS panel data

Regression results from the IHDS panel are shown in Tables 8 to 10. We control for household fixed effects and survey year dummy in all regressions with IHDS data. Columns 1 and 2 in table 5 show estimates of equation 4 for rice and wheat, respectively. IHDS shows the opposite result: household purchase of PDS rice and wheat decreases significantly when the market price of these grains increases. We use market price, instead of arbitrage, because the PDS price is fixed by the government, and so, the change in arbitrage comes mainly from the change in market prices of grains. We find qualitatively similar results even when we use arbitrage as the independent variable. Either way, our results with IHDS data are opposite to what we obtained from the NSSO-CES data. What explains the difference in the results?

Table 5. Impact of increase in arbitrage on Purchase of PDS Rice and Wheat—IHDS Data

VARIABLES	(1) KgRicefromPDS	(2) KgWheatfromPDS
marketpriceofrice	**-0.0561***	
	(0.00734)	
marketpriceofwheat		**-0.0586***
		(0.00488)
Year (2011)	3.824739	2.434348***
	(.1092971)	(0.0737698)
bpl_card	6.369***	4.536***
	(0.175)	(0.141)
apl_card	2.102***	0.146
	(0.169)	(0.126)
aay_card	9.103***	7.982***

	(0.262)	(0.280)
No_card	-0.863***	-0.496***
	(0.240)	(0.157)
Value_assets	-0.0333**	-0.0161
	(0.0158)	(0.0121)
Consumption_expenditure	-0.000169***	-7.80e-05***
	(2.36e-05)	(1.36e-05)
householdsize	0.306***	0.142***
	(0.0258)	(0.0291)
Urban_resident	1.029***	-0.528**
	(0.378)	(0.241)
Constant	0.190	0.386
	(0.291)	(0.244)
Household FE	**YES**	**YES**
Observations	69,204	69,130
R-squared	0.164	0.156
Number of hh_id	34,643	34,643

Standard errors in parentheses

Standard errors in parentheses.
Source IHDS Data corresponding to years 2004-05 and 2011-12
Standard errors clustered at the state level
$^+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Using the IHDS data we are also able to test one of the predictions of the Mehta and Jha (2014) model. The authors contend that arbitrage opportunities are higher when subsidies are large, but anti-graft measures rely greatly on incentivizing citizens to combat corruption. Therefore, pilferage rates need not rise as price subsidies are increased. From the literature on the PDS, we know that some states in India are better at keeping checks on entitlements and delivery of grains (Khera 2011a; Kishore and Chakrabarti 2015; Chakrabarti and Rajkhowa 2015; Drèze and Khera 2013). These star states are referred to as 'new-style' PDS states by Dreze and Sen (2013) and include Himachal Pradesh, Chhattisgarh, Odisha and Tamil Nadu.

These four states have a reputation for low exclusion errors, regular supply, relatively small leakages, increased accountability, quality cereals, and a political will to enforce reforms. In table 6, we test if increase in arbitrage has a different effect in star states where PDS is better governed. We do so by estimating equation 5, with an interaction term between states with reformed PDS and the market price. We find that the interaction term has a positive and

statistically significant coefficient for rice. Thus, an increase in arbitrage leads to reduced purchase of rice from PDS in other states, but in states with reformed PDS, increase in arbitrage leads to increase in household purchase of PDS rice. The effect is small for wheat because three out of four of these states deliver only rice through their PDS.

Table 6. Impact of increase in arbitrage in states with reformed PDS

VARIABLES	(1) kgRicePDS	(3) kgWheatPDS
Market price of rice	-0.0825***	
	(0.00742)	
Reformedstate*mktprice_rice	0.108***	
	(0.00552)	
Reformedstate*mktprice_wheat		0.0580*
		(0.00483)
marketpriceofwheat		-0.0360***
		(0.00524)
Year (2011)	3.487697***	2.516517***
	(.110035)	(.0747935)
bpl_card	6.384***	4.523***
	(0.174)	(0.141)
apl_card	1.995***	0.172
	(0.169)	(0.126)
aay_card	9.131***	7.982***
	(0.261)	(0.278)
nocard_bureau	-0.790***	-0.535***
	(0.239)	(0.157)
assets	-0.0645***	-0.00692
	(0.0157)	(0.0121)
expenditure	-0.000168***	-7.96e-05***
	(2.35e-05)	(1.38e-05)
Household size	0.312***	0.140***
	(0.0257)	(0.0291)
urban	0.709*	-0.347
	(0.376)	(0.243)
Constant	0.920***	0.0380
	(0.291)	(0.248)
Observations	69,204	69,130
R-squared	0.173	0.158
Number of hh_id	34,643	34,643

Apart from the change in market price, arbitrage for a household could also increase if its ration card status changes. BPL and Antyodaya households are entitled to larger quantities of subsidized rice and wheat at a cheaper price compared to the APL households. As discussed earlier, the card status of a large number of household changed from having no card or APL card only to BPL/AAY card. A switch from no-card or APL card to a BPL or an AAY card leads to a significant increase in household purchase of PDS rice and wheat (columns 1 and 2, Table 7). The increase is PDS purchase is an order of magnitude smaller for households who switch from no-card to APL card. This is not surprising because the PDS prices are significantly higher for APL card holders.

Table 7. Impact of Change in Ration-Card Status on PDS Purchases

VARIABLES	kgRicePDS	kgWheatPDS
marketpricerice	-0.0756***	
	(0.00591)	
reformedPDS*mktprice_rice	0.105***	
	(0.00562)	
marketpricewheat		-0.0224***
		(0.00522)
reformedPDS*mktprice_wheat		-0.0628***
		(0.00483)
Switch_to_BPL	7.340***	6.146***
	(0.184)	(0.164)
Switch_to_AAY	6.996***	7.371***
	(0.319)	(0.305)
Switch_to_APL	0.726***	0.675***
	(0.199)	(0.140)
assets	-0.0632***	-0.0142
	(0.0160)	(0.0121)
expenditure	-0.000141***	-5.56e-05***
	(2.48e-05)	(1.34e-05)
hhsize	0.336***	0.149***
	(0.0282)	(0.0293)
urban	0.899**	-0.201
	(0.370)	(0.243)

Year (2011)	2.496009***	1.578895***
	(.1075278)	(.0767493)
Constant	3.917***	1.648***
	(0.263)	(0.230)
Household FE	YES	YES
Observations	69,223	69,149
R-squared	0.165	0.150
Number of hh_id	34,643	34,643

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Analysis of IHDS data thus leads us to a more nuanced understanding of the impact of change in arbitrage on household purchase of PDS grains. Normally, increased arbitrage leads to reduced household purchase of grains from PDS, but in states where PDS has been reformed and is relatively better governed, the effect is opposite and in line with DSP. Further, comparing households whose ration card status changed with those whose status did not change shows that a significant increase in the value of PDS entitlement indeed leads to a big increase in the quantity of grains purchased from the PDS irrespective of the governance regime. However, we should keep in mind that households whose card status changed favorably, may be systematically different from other households. Therefore, the impact we see in table 7 may not be entirely due to the increase in the value of PDS entitlement per se.

IHDS panel data allows us to do a more rigorous analysis of the arbitrage effect, but there is a 7-year gap between the two rounds of IHDS. We address the possible issues with large time gap in the panel data for causal estimation by employing an alternative dataset.

Thus, analysis of household panel data from IHDS suggests that the impact of arbitrage on households' access to subsidized grains is context specific. Higher arbitrage could hurt consumers of a social-safety net program if it is not well managed and monitored. On the other hand, in regions with reasonably well governed safety-net programs, households'

utilization of the entitlement increases with the increase in arbitrage, as suggested by Dreze and Sen (2013) and Mehta and Jha (2014).

Discussion

Rice and wheat are staple foodgrains in India with small negative price elasticity values and small positive income elasticity values. The elasticity of substitution between grains from PDS and from other sources is also high for a large section of consumers. Therefore, households would purchase more from fair-price shops when prices go down in PDS or they go up in the open market—if they are allowed to do so. PDS dealers and other officials responsible for managing the system have opposite incentives. They would want to divert more grains from the system when arbitrage increases. The net impact of increase in arbitrage on delivery of subsidized food will depend on the relative bargaining power of the two groups: beneficiaries of the scheme and the agents responsible for grain management. If the consumers are not organized and the government is not responsive to their needs, PDS managers will steal more when arbitrage goes up. In such a situation, increase in the value of PDS entitlement of households may hurt their interests. However, if the government is responsive to people's needs, it will exert more effort to monitor grain delivery in PDS and the probability of a corrupt PDS official being penalized will be higher. Then PDS officials will be less likely to divert grains even if potential returns from diversion go up. In such a situation, consumers will benefit from increase in the value of PDS entitlement as it happened in the "new-style PDS states (Dreze and Khera, 2014; Kishore and Chakrabarti, 2015). Thus, at least in the short-term, the impact of an increase in the value of PDS entitlement, either due to increase in market prices of subsidized grains or decrease in subsidized prices or both will depend on how well the system is monitored.

Dreze and Sen (2013) argue that the increase in value of PDS entitlement will induce beneficiary households to exert more pressure on the elected government to improve the monitoring of the PDS which in turn will lead to lower pilferage from the system. It is a plausible argument. Our analysis does not support or refute this argument, because our most rigorous results are based essentially on short-term changes in arbitrage and therefore cannot capture this medium or long-term response of high arbitrage on accountability levels in the PDS and its performance.

The implementation of NFSA across India offers an opportunity to test this hypothesis. After NFSA, the arbitrage between market prices and PDS prices of rice and wheat have increased significantly. PDS prices tend to be stickier than the market prices. So, the arbitrage will rise further in years to come. If this increase in arbitrage leads to a nationwide improvement in performance of PDS remains to be seen.

6. Conclusion

Overall, we find that the impact of arbitrage on corruption in a food safety-net program depends on the context. For the PDS, in states with high levels of accountability, a higher subsidy in safety-net may lead to increase in transfers to households while in areas where the system is less accountable, an increase in the subsidy without an improvement in enforcement mechanisms is likely to increase the diversion of subsidized goods and reduced transfers to intended beneficiaries. This result has important policy implications for India, where the NFSA is currently being implemented. The low price ceiling introduced by NFSA will likely make arbitrage larger and in numerous states where the PDS remains opaque, our results suggest that pilferage may remain high. Administrative reforms such as computerization of FPS will be key in checking leakage from the PDS as its scale increases. Furthermore, new research into local nuances of leakage in the PDS illustrates the potential for local informal

devices to provide significant enforcement of service delivery agents, and to demarcate the important aspects that shape the efficacy of such mechanisms (Nagavarapu and Sekhri 2012).

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