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

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Abstract

Would the households get to buy more of subsidized grains from a food safety-net program if the difference between the price of grains in the program and the open market were to increase? This is an important question for social safety-net programs everywhere in the world, but even more so for the Public Distribution System (PDS) of India—the largest food-based safety-net program in the world. The standard economic intuition suggests that price controls distort price signals and create incentives for unintended transactions and the unintended transactions increase in magnitude as the incentive (the arbitrage) increases. However, Dreze and Sen have argued that the increase in arbitrage between PDS and open market prices of grains increased the value of PDS entitlement, giving people much greater stake in the system leading to increased accountability and increase in household purchase of grains from PDS. We test these two opposing arguments empirically in this study using repeated cross sections of consumer expenditure surveys by National Sample Survey Organization (NSSO) and panel datasets from India Human Development Survey (IHDS) and Village Dynamics in South Asia (VDSA) and find evidence for both arguments. Our analysis shows that whether more subsidy in a food safety net program benefits the households or leads to higher diversion, depends on how well the system is managed. In states where PDS is better governed, households get to buy more rice from the PDS when the arbitrage increases. However, in states like Bihar and Jharkhand where PDS is poorly run, household purchase of subsidized grains goes down as the arbitrage goes up.

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Suman Chakrabarti, Avinash Kishore and Devesh Roy[1]

1. Introduction

Large scale food subsidy programs in many developing countries are rife with corruption and pilferage (Mehta and Jha 2014). Whether diversion of grains from such programs increases or decreases when the difference between the subsidized price in the program and the open market price increases, is an important question for all welfare programs. 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 only to two-thirds of all households. The standard economic intuition suggests that price controls distort price signals and create incentives for unintended transactions (Sowell, 2000) and the unintended transactions increase in magnitude as the incentive (the arbitrage) increases (Banerjee, Mullianathan and Hanna, 2012). However, some economists like Drèze and Sen (2013) have argued that the increase in arbitrage may also have an opposite effect : it does not merely create incentives for 'back door' sales, but instead garners a greater citizen's stake in food subsidy programs which may even reduce net pilferage. They contend that the increase in arbitrage between PDS and open market prices of grains increased the value of the PDS entitlement, giving people much greater stake in the system leading to increased accountability and reduced corruption in the system. We test these opposing arguments in this study using data from several rounds of consumer expenditure surveys by the National

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Sample Survey Organization (NSSO), the India Human Development Survey (IHDS) and the Village Dynamics in South Asia (VDSA). .

Government of India sets the retail price of subsidized items sold through the public distribution system. But some state governments used their own budgetary resources to reduce prices even more. This created inter-state variation in PDS prices of grains and the arbitrage. A scatter-plot of the percentage of total grains leaked from PDS in each state against arbitrage over the three NSSO rounds seems to support the Dreze and Sen Argument. Diversion of rice and wheat decreased from 54% in 2004-05 to 38% in 2011-12 even as arbitrage increased sharply. Further, in any given year, the extent of diversion of grains was generally lower in states where the arbitrage was higher. A pooled OLS (POLS) regression of leakage against arbitrage shows that a one-rupee increase in the arbitrage is associated with 0.4 to 1.5 percent reduction in diversion of rice and wheat from PDS. We find qualitatively similar results even when we look at trends within states over time (OLS with state fixed effects) or compare diversion across states in a given year (OLS with year dummies).

Next, we use household level data from a repeated cross-section of 0.3 million households from three rounds of the NSSO-CES to see how the increase in arbitrage affects the quantity of grains households (get to) purchase from PDS. When we estimate a POLS model with unit level data across states and years, we find that households, on average, buy more grains from TPDS when the price gap ($P_{market} - P_{PDS}$) is higher. The positive and significant relationship between the price gap and the quantity of grains purchased from PDS persists for both rice and wheat when we compare households across states in a NSSO round (NSSO-round fixed effects) or within states across years (state fixed effects). The state level data on leakage and household level data on quantity of rice and wheat purchased from PDS seem to support the Dreze and Sen Hypothesis. However, it is possible that we see this trend because states spent more effort to control leakage when they used their own budgetary resources to make PDS

more generous. Regressions with repeated cross-sections have one more possible source of endogeneity. Arbitrage values will be lower for households that buy cheaper grains from the market and therefore have lower arbitrage. The same households are also likely to buy more from PDS shops. If so, we will see a negative relationship between arbitrage and household purchase of PDS grains and a spurious rejection of the Dreze and Sen Argument.

We use household level panel data from the India Human Development Survey (IHDS) and Village Dynamics in South Asia (VDSA) to address the endogeneity issues in the analysis with repeated cross-section data. IHDS is a nationally representative survey of 41,554 households. The same households were interviewed in 2004-5 and 2011-12 to create a panel dataset[2]. When we regress quantity of cereals purchased from TPDS on the price arbitrage ($P_{market} - P_{PDS}$) with the IHDS data and control for household fixed-effects, we get a negative and statistically significant coefficient on arbitrage. Thus, the IHDS panel shows that households (get to) buy smaller quantities of rice and wheat from PDS shops when the arbitrage increases. However, when we add an interaction term between the arbitrage and a dummy for states reputed to have a better governed PDS (Khera, 2011) to the regression, the interaction term has a positive and significant coefficient. This suggests that increase in arbitrage has a positive effect on households' purchase of PDS grains in states where PDS is better managed.

Households in India are classified into 3 income categories for targeting PDS benefits to the poorest: 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 paid the lowest with BPL households in between. A small fraction of households in the IHDS sample were reclassified

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

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

It is possible that in the seven years between two IHDS rounds, increase in the market price of cereals and a general improvement (or deterioration) in PDS—both happened simultaneously, but the first did not cause the second. If so, regressing PDS purchase against arbitrage will return biased coefficient on arbitrage. We try to address this issue by using a high frequency data on household consumption from VDSA. VDSA collected monthly data on household purchase of rice and wheat from PDS shops and open market for more than a 1000 households from 2009 to 2014 in 7 states of India. We use data from 2009 to 2012 for Bihar, Jharkhand, Karnataka and Telangana (old Andhra Pradesh). Households in VDSA are not a representative sample of the respective states, but the rich high frequency data is ideal to understand the interrelationship between our variables of interest. VDSA data has an added advantage that it collected independent price data every month for each village in the sample. We run similar regressions with VDSA data, but add month-of-the-year dummy to control for any seasonality in PDS purchase or consumption of cereals. It is unlikely that the PDS governance regime will change from month to month. Therefore, the high frequency data from VDSA allows us to estimate the causal impact of change in arbitrage on household purchase of PDS grains. Results from the VDSA data are similar to our earlier results with the IHDS data. Rise in market price or increase in arbitrage between the market price of cereals and price in PDS leads to a significant reduction in the quantity of subsidized rice and wheat households buy in Bihar and Jharkhand and a significant increase in quantities purchased in Karnataka and Telangana. What explains the opposite effects of arbitrage across

states? Bihar and Jharkhand are known to be the states where PDS is very poorly managed while Karnataka and Telangana rank among the states with better PDS (Khera, 2011). Thus, our analysis suggests that whether increase in arbitrage leads to more corruption and more leakage of cereals from PDS or increase in household purchases of subsidized cereals depends on the quality of governance of PDS. States where PDS is well governed, households claim more of their entitlement as it becomes more valuable and the diversion goes down. We see an opposite effect in states with poorly governed PDS. Here dealers divert more and households get less when the value of the entitlement goes up.

Our results are of great significance to food based social safety-net programs across the world, and especially so, for India where government has massively increased budget allocation to the PDS (from 0.7 percent to more than 1 percent of GDP (Mishra, 2013)) to make grains dirt cheap for a large section of the population to achieve food and nutritional security. A key argument for NFSA was that a universal provision of really cheap grains under PDS will improve the functioning of the system. Our results show that making grains cheaper in PDS may have an opposite effect unless the grain management improves. Whether the increase in the value of PDS entitlement itself will lead to greater accountability and better delivery remains to be seen.

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 data sources 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 in the world. In 2011-12, more than 550 million people purchased subsidized rice or wheat[3]from the large network of 'fair price shops' (FPS) of the PDS. 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. The PDS 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. 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 (Dreze and Khera 2015) of rice and wheat released by the FCI to state governments for the PDS did not reach households. However, even this high level of leakage represents an improvement from the 54 percent leakage estimates from 2004-05 (Himanshu and Sen 2013). Furthermore, some states boast of 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

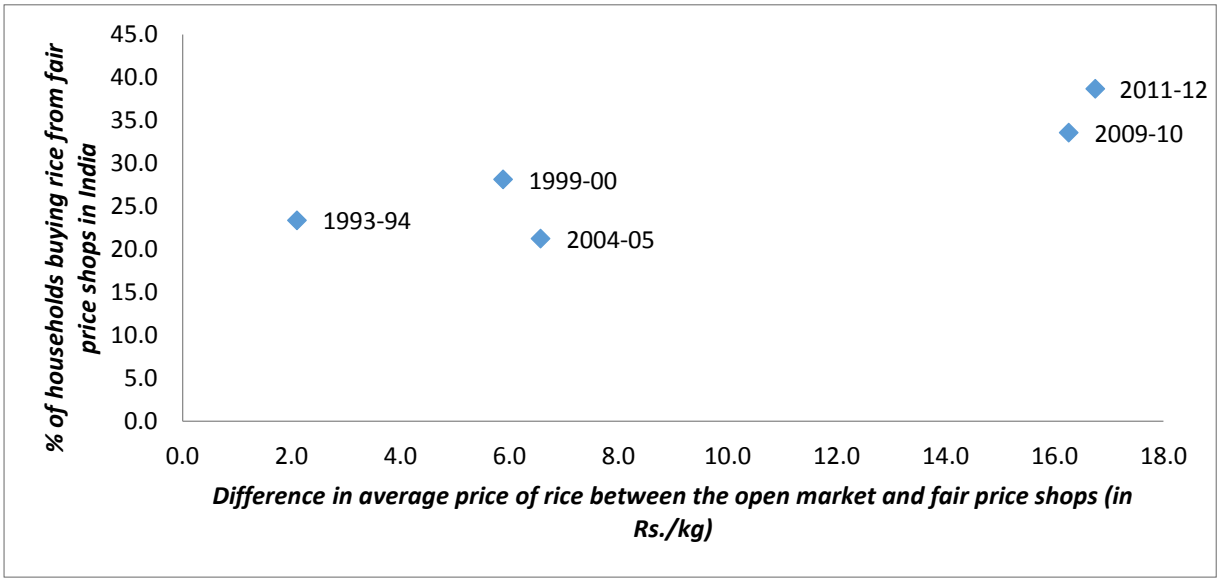
[3] As per NSSO consumer expenditure data round 68, 44.1 percent of India's households reported purchasing rice or wheat from the PDS in the last one month. India's population was 1.25 billion as per the 2011 Indian census.

[4] NFSA entitles all beneficiaries of the PDS 5 kg/month of rice/wheat/coarse grains at INR 3/2/1 per kg, respectively.

show that PDS leakage has been reducing in backdrop of an inflationary period of cereal grain prices (Kishore and Chakrabarti 2015).

Figure 1 shows how PDS 'access' measured by the percentage of households that purchased cereal grains from the PDS in a given month has moved with arbitrage. There appears to be a positive relationship between the numbers of households that access the PDS with an increase in arbitrage over time. The only break in this trend is seen between 1990-00 and 2004-05 when the PDS transitioned into a targeted scheme. Targeting resulted in more opacity, high exclusion errors and a less generous system overall. Thus fewer households were able access the PDS even when there was an increase in arbitrage. 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 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 the price of rice and wheat in India accompanied by an increase in the quantities purchased from PDS shops. 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 from India 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 (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

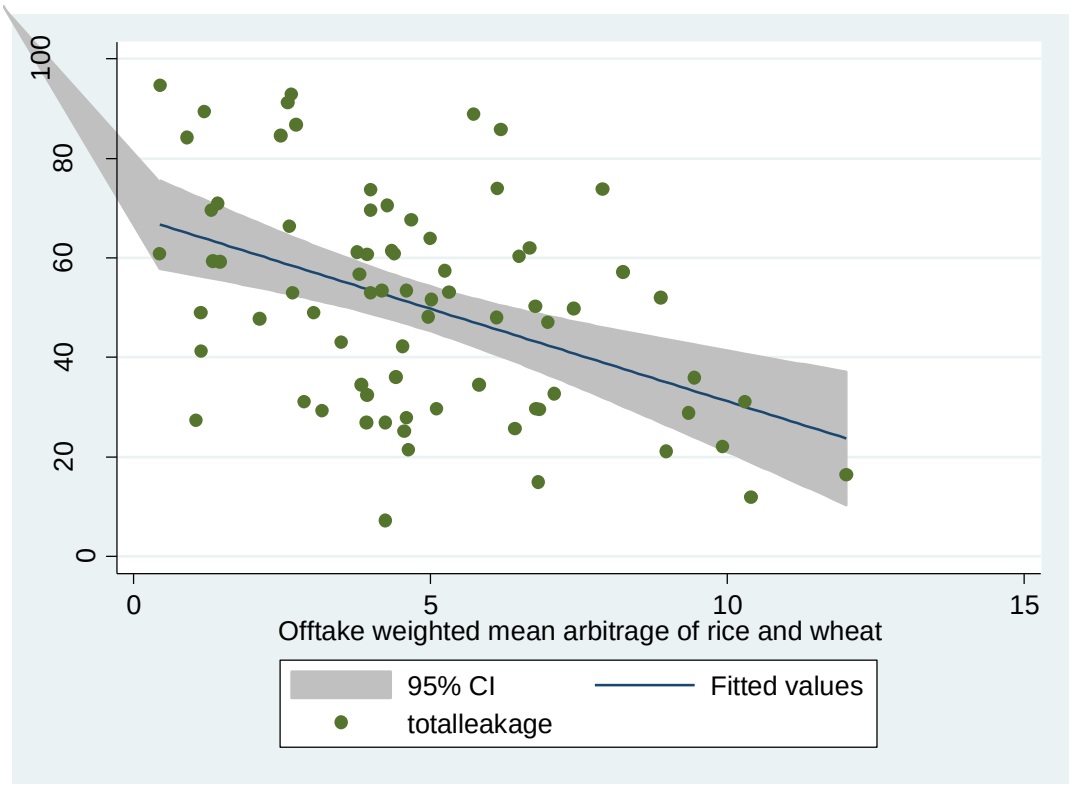
	2004-05	2009-10	2011-12
Average price of rice (INR/kg)	11.85	20.34	22.23
Average price of wheat (INR/kg)	9.73	16.09	16.99
Average price of PDS rice (INR/kg)	5.77	4.86	4.91
Average price of PDS wheat (INR/kg)	5.37	6.37	6.5
Average quantity of PDS rice (kg/person/month) purchased	1.05	1.56	1.79
Average 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 total households accessing the PDS for rice and wheat and the per capita quantity of grains purchased from fair-price shops increased between 2004-05 and 2009-10 as the prices rose sharply in the open market (Table 1). The combined effect of changes on both the extensive and the intensive margins is reflected in a steady decline of diversion of rice and wheat during this period. A scatterplot of percentage of total quantity of grains (rice+wheat) diverted from PDS in each state against the arbitrage across three rounds

of NSSO-CES shows a negative correlation between arbitrage and diversion. Here arbitrage 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 (figure 2). The relationship between arbitrage and leakage, apparent in figure 2, was used as an argument to advocate for the provision of grains at very low prices in the NFSA. However, a rigorous estimate the causal impact of arbitrage on household purchase of grains from the PDS requires analysis of 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. The standard economic intuition suggests that price controls distort price signals and create incentives for unintended transactions (Sowell, 2000) and the unintended transactions increase in magnitude as the incentive (the arbitrage) increases (Banerjee, Mullainathan, and Hanna 2012). However, Dreze and Sen (2013) argue that the increase in arbitrage between PDS and open market prices of grains increased the value of TPDS entitlement, giving people much greater stake in the system leading to increased accountability and reduced corruption in the PDS. Back of the envelope calculations show that the value of the PDS entitlement doubled as a percent of per-capita expenditure between 2004-05 and 2009-10[5]. A theoretical model of pilferage in PDS by Mehta and Jha (2014) also predicts ambiguous effects of increase in price subsidy on subsidized food deliveries and pilferage. 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.

In this paper, we empirically test these opposing arguments as they apply to India's public distribution system 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 allowing us to exploit large price variations to trace the direction and magnitude of the effect of change in arbitrage on PDS purchase. We try to answer two interrelated questions in this paper:

[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

First, does an increase in arbitrage decrease the diversion of grains in the PDS? If not, under what context does the standard economic intuition continue to hold?

We employ three different data-sets to answer these questions, the details of which are discussed in the next section.

3. Data and methods

Most of the existing studies on leakage in PDS use state level aggregate estimates of total household purchase of PDS rice and wheat and the total off-take from the FCI (Himanshu and Sen 2013; Khera 2011b; Dreze and Khera 2015). However, there can be serious endogeneity concerns in such analysis. It is possible that the increase in the difference between market price of grains and the subsidized rates and changes in the governance regime of PDS in different states (improvement or deterioration) happened simultaneously, but the former did not cause the latter. If so, regressing leakages or grains (or average quantity of grains purchased by households from PDS shops) against arbitrage will return statistically significant beta coefficients, that may be misleading. Therefore, we employ more disaggregated data from different sources to test the competing theories on linkage between arbitrage and leakage in PDS.

First, we use household level 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 the 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 household purchase of PDS grains with the total quantity of rice and wheat the state collected from the FCI in that period. The difference between the off-take from FCI and the total household purchase is considered as the amount diverted from the PDS. We test the relationship between the amount of grains diverted from the PDS in states and the arbitrage 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 panel data regressions with state fixed effects and time trend (equation 2).

$$Leakage_{tsc} = \alpha + \beta Arbitrage_{tsc} + \varepsilon_{tsc} \quad (1)$$

$$Leakage_{tc} = \alpha + \beta Arbitrage_{tc} + \gamma_s + \mu_t + \varepsilon_{tc} \quad (2)$$

Where 'Leakage' is the percentage of cereal grain diverted from the PDS for cereal 'c', in state 's' and year 't', and 'Arbitrage' is the difference between median price of the grain in the open market and the PDS. 't' corresponds to the years of the matched NSS-FCI data (2004-05, 2009-10, and 2011-12), 's' to 29 Indian states for which leakage could be computed, and 'c' to the grain (rice or wheat) we estimate the equation for. γ_s controls for the state fixed effects and μ_t controls for the time trend. ε_{tsc} is the error term. The coefficient β on arbitrage is the parameter of interest. We call β, the 'arbitrage effect'.

We run regressions separately for rice and wheat and for rice and wheat together. In regressions (and scatter-plots) with both rice and wheat, 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 that state in that period.

From leakage to household purchase of PDS grains

Estimates of leakage of grains from PDS are available only at the national and the state levels. More disaggregated data of grain allocation to PDS are not available. So, instead of looking at the impact on arbitrage on leakage, we look at its impact on the kilograms of cereals purchased by the household from PDS shops. The monthly quota of PDS rations is less than the households' total consumption of rice or wheat for most households. Also, for various reasons, most households do not buy their full quota of grains. Therefore, holding other things (like seasonality in consumption patterns) constant, most households would increase the quantity purchased from PDS, if grains become cheaper there or more expensive in the open market. If we see that the household purchase of PDS grains goes down with increase in arbitrage, we can safely assume that the household is unfairly not getting its full quota. Thus, looking at households' purchase of PDS cereals gives us an indirect, but credible indicator of increase (or decrease) in corrupt diversion of gains from the PDS. All the analysis in this paper, except results shown in figures 1 & 2 and tables 6 & 7 uses household purchase of cereals as the outcome variable.

We estimate the following model with the unit level NSS-CES data to estimate the arbitrage effect on household purchase of PDS rice or wheat

$$PDSPurchase_{tisv} = \alpha + \beta Arbitrage_{tsv} + \delta X_{ti} + T_t + S_s + \varepsilon_{tsi} \qquad (3)$$

Where 'PDSPurchase' is the average monthly purchase of rice or wheat (in kg) from the PDS by household 'i' in year 't', and 'Arbitrage' is the difference between average price of the grain in the open market and the PDS in a village or hamlet (the primary sampling unit in

NSSO) ‘v’ in year ‘t’. T and S represent NSS-round and state fixed effects respectively. Standard errors are clustered at the state level.

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 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, could result in biased estimates of the arbitrage effect. We use the average market price of a grain in the village to mitigate the possible bias.

There is large inter-state variation in India in state capacity and the performance of development and welfare schemes (Besley and Burgess, 2001), including PDS. Further, it is possible that popularity of PDS in states may be correlated with the market prices of rice or wheat there. We use state fixed effects to control for the time invariant state characteristics. Figure 1 shows that over the last few years, PDS has improved across India with significant inter-state variations in the levels of improvement. Chhattisgarh, Himachal Pradesh and Odisha are some of the outstanding states in this respect (Kishore and Chakrabarti, 2015). We use state-specific time trend to control for such variations.

Using three rounds of NSSO-CES data allows us to use panel data techniques and a rich set of controls for household characteristics to parse out the arbitrage effect on household purchase of cereals from PDS, but serious endogeneity issues remain in the analysis with repeated cross-section of households. For example, while the arbitrage values increased from 2004-05 to 2011-12, the management regime of PDS also changed in some states. Not all such changes can 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 omitted variable bias remains in the analysis with the repeated cross-section data.

We tried to address endogeneity issues by using the household level panel data from the IHDS. The IHDS is a nationally representative survey of 41,554 households across India. IHDS interviewed the same households in 2004-5 and 2011-12, to create a panel dataset[6]. The IHDS survey has a consumption expenditure module were to collect recall data on households' purchase of rice and wheat from PDS and other sources 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 68th rounds of the NSSO used earlier in this study. IHDS data allows us to control for the household fixed effects (equation 4).

$$PDSPurchase_{it} = \beta Arbitrage_{it} + \alpha_i + T_t + \varepsilon_{it} \qquad (4)$$

Where 'PDSPurchase' is the average monthly purchase of rice or wheat (in kg) from the PDS by household 'i' in year 't', and 'Arbitrage' 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 in year 't'. α_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

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

reforms between 2004-05 and 2009-10 (Kishore and Chakrabarti, 2015). The interaction term tests 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.

$$PDSPurchase_{it} = \beta MarketPrice_{it} + \alpha_i + T_t + \theta MarketPrice_{it} * ReformedPDS + \varepsilon_{it} \quad (5)$$

$$PDSPurchase_{it} = \beta MarketPrice_{it} + \alpha_i + T_t + \theta MarketPrice_{it} * Reformed_{it} + \pi SwitchtoBPL + \varepsilon_{it} \quad (6)$$

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 changes from APL to BPL or AAY and zero everywhere else. This switch entails a significant increase in the arbitrage between market prices and PDS prices for the beneficiary household.

There was a gap of seven years between the two rounds of IHDS survey. Both the arbitrage levels and the public distribution system changed a great deal in the time between the two rounds. While the increase in the market price of cereals and the general improvement in PDS happened together, but the first might not have caused the second. If so, the changes in PDS purchase that we attribute to changes in arbitrage may have been caused by some omitted variable(s) that affected both.

We employ high frequency data on households' purchase of cereals from the VDSA to test the causal relationship between arbitrage and off-take from PDS. The VDSA coordinated by ICRISAT collected monthly data on households' purchase of rice and wheat from PDS and other sources for more than a 1000 households across 7 states of India for years 2009 to 2014. The VDSA data is not collected from a representative sample of households in India or even

the 7 survey states, but the high frequency of data is ideal for causal estimation of the impact of arbitrage on household purchase of cereals from PDS. VDSA data also allows us to control for any seasonality in household consumption or purchase behaviour. We could not do so with the IHDS panel because households were not necessarily surveyed in the same month of the year in both rounds. Further, unlike NSSO and IHDS, VDSA collected independent price data every month for each village in the sample. Thus we do not have to worry about endogeneity between market prices paid by households and their PDS purchase behaviour. We estimated two sets of regressions with the VDSA data: one for households in Karnataka and Telangana and another for households in Bihar and Jharkhand. The first two states have the reputation for relatively well managed PDS while the latter two are considered as states among states with the worst PDS in India (Khera 2011). We use regressions very similar to equation 4, but this time we also add a month-of-the-year dummy to control for seasonality in household purchase or consumption behaviour (equation 7). The VDSA data allows us to identify the causal impact of changes in the arbitrage or the market price of cereals[7] on PDS purchases in the short-term.

$$PDSPurchase_{it} = \beta Arbitrage_{it} + \alpha_i + T_t + \theta monthoftheyeardummy + \varepsilon_{it} \quad (7)$$

Table 3 summarizes the key features of the four data-sets used in this paper.

We present regressions results in the next section.

Table 3. Key features of data sets used in the study

	FCI	NSS-CES	IHDS	VDSA
Sample size	156	327,161	69,264	26,825
Geographic coverage	29 states	35 states	35 states	4 states – Bihar, Jharkhand,

[7] In short-term, arbitrage values change mainly because of fluctuations in the market price.

				Karnataka and Telangana
Time period	2004-05, 2009-10, 2011-12	2004-05, 2009-10, 2011-12	2004-05, 2011-12	2008-2014
Outcome used	Rice and wheat offtake	Rice and wheat purchases from PDS	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	Market price, PDS price
Controls used	None available	Season, occupation, education, caste, religion, access to amenities, expenditure, residence, household size	Household fixed effects, ration card, reason for not having a card, household assets, expenditure, household size, residence	Household fixed effects
Representative	Yes- State level	Yes - National and state level	Yes - National	No
Type	Aggregate	Repeated cross-section at household level	Panel at household level	Panel at household level

Source: Authors construction

4. Results

Table 4 presents the average values of the key household characteristics in each round of the NSSO-CES. Per capita consumption of PDS rice and wheat increased by 70 percent and 147 percent respectively between 2004-05 and 2009-10. Average arbitrage between market and PDS prices for both cereals also increased sharply in this period. We can observe an improvement in most indicators such as access to LPG and electricity as well as monthly expenditure over the 7 years of the study period.

Table 4: Descriptive statistics from the NSS-CES samples

	(1) Mean/%	(2) Mean/ %	(3) Mean/ %
	2004-05	2009-10	2011-12
Per-capita consumption of rice (kg/month) from PDS	1.055	1.557	1.792
Arbitrage of rice (INR)	2.917	8.785	10.83
Per-capita consumption of wheat (kg/month) from PDS	0.252	0.518	0.623
Arbitrage of wheat (INR)	1.376	4.863	6.573
Self-employed in non-agriculture	14.3	14.4	15

Agricultural labor	9.28	6.5	4.81
Other rural labor	6.92	10.2	8.61
Self-employed in agriculture	22.4	16.5	16.5
Self-employed in urban areas	14.2	15.5	15.4
Labor in urban areas	4.61	5.52	5.3
Tribes	13.2	13	13.4
Caste	16.1	16.2	15.4
Other backward classes	37.1	37.6	39.3
Hindu households	76.4	76.2	75.8
Islamic households	11.9	12.3	12.9
Christian households	6.87	6.91	6.95
Monthly per-capita consumer expenditure (INR)	848.8	1493.7	2050.9
Household size (no. of people)	4.898	4.646	4.574
Household dependency ratio	0.669	0.58	0.561
Household sex ratio	1.104	1.085	1.09
Maximum years of education attainted by males in the household	7.819	9.259	9.586
Maximum years of education attainted by females in the household	6.201	7.643	8.029
Percentage Urban population	36.3	41.4	41.3
Households with access to LPG (fuel)	28.3	38.8	42.8
Households with access to electricity	73.6	82.2	87.1
Observations	124451	100855	101662

Source NSSO Consumption Expenditure Data corresponding to years 2004-05, 2009-10 and 2011-12

Table 5 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 these grains purchased by 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 5: Descriptive statistics from IHDS samples

	Round 1 2004-05	Round 2 2011-12
Total PDS rice consumed per household per month	5.072	10.69

(kg)		
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, Tamil Nadu	19.3	22.1
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

Tables 4 and 5 show significant changes in household characteristics over the 7 year period. We add available household controls in regressions with the NSSO data while we use household fixed effects to control for the time-invariant household characteristics when using IHDS panel data. 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 millionMT 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, but 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 with change in arbitrage between the market prices and the subsidized prices? Table 6 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 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 not significant 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 6: 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
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Change in arbitrage and household purchase of PDS grains: Results from NSS unit level data

Analysis of state-level data on diversion of grains from PDS, while useful, is incomplete if we want to understand the effect of change in arbitrage on the quantity of subsidized grains that households get to purchase. We need to analyse household level data for this purpose. We start by creating a repeated cross-section of household data from three NSSO rounds and applying panel data techniques to this dataset. Table 7 presents results from this analysis.

In columns (1) and (2), we regress the per capita average quantity of rice and wheat purchased from PDS against arbitrage and a rich set of household controls. The POLS regressions show that, as arbitrage increases by one rupee, the purchase of rice from the PDS goes up by 0.1 kg per-capita per month and the purchase of wheat increases by 0.05 kg per capita per month. Introducing year fixed effects to the POLS model (columns 3 and 4) does not lead to qualitative differences in the results. The arbitrage effect on PDS purchase of rice and wheat becomes an order of magnitude smaller once we control for time-invariant state characteristics (columns 5 and 6) to the earlier models. The arbitrage effect obtained in panel data models is robust to the introduction of state specific time trends. Therefore, our analysis

of the repeated cross-section data from NSSO-CES supports the Dreze and Sen Conjecture. A ten rupee increase in the arbitrage is associated with increased PDS purchase of rice and wheat by 0.4 to 0.5 kg/month/person. This increase is approximately 15 percent of the average quantity of rice purchased from PDS in 2004-05 and nearly 80 percent of the average wheat purchased from PDS.

As discussed earlier, analysis with repeated cross-section data is fraught with problems of endogeneity or omitted variable bias. Next, we analyse this relationship using the household panel dataset from IHDS.

Table 7: Models for per-capita consumption of rice / wheat (kg/month) from PDS on arbitrage with controls – NSS unit level data

	(1) Rice	(2) Wheat	(3) Rice	(4) Wheat	(5) Rice	(6) Wheat	(7) Rice	(8) Wheat
Arbitrage of rice (Rs./kg)	0.10***		0.10***		0.04**		0.04***	
	(0.01)		(0.02)		(0.01)		(0.01)	
Arbitrage of wheat (Rs./kg)		0.05**		0.04**		0.04***		0.05***
		(0.01)		(0.01)		(0.01)		(0.01)
Dummy for season October to December	-0.04+	0.00	-0.04+	0.00	-0.01	0.00	-0.01	-0.00
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Dummy for season January to March	-0.06+	-0.01	-0.06+	-0.00	-0.02	-0.01	-0.02	-0.01
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Dummy for season April to June	-0.09**	-0.01	-0.09*	-0.01	-0.03	-0.01	-0.03	-0.01
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
Dummy for Self-employed in non-agriculture	0.16	-0.01	0.16	-0.02	0.23**	0.03	0.23***	0.04*
	(0.10)	(0.04)	(0.10)	(0.04)	(0.08)	(0.02)	(0.05)	(0.02)
Dummy for agricultural labor	0.73***	0.10	0.74***	0.11	0.79***	0.21*	0.78***	0.21***
	(0.19)	(0.12)	(0.19)	(0.12)	(0.14)	(0.08)	(0.10)	(0.05)
Dummy for other rural labor	0.62***	0.24**	0.62***	0.22**	0.55***	0.21***	0.55***	0.21***
	(0.16)	(0.07)	(0.15)	(0.07)	(0.12)	(0.05)	(0.08)	(0.04)
Dummy for self-employed in agriculture	-0.13	-0.09*	-0.13	-0.08*	-0.09	-0.12**	-0.08	-0.11***
	(0.10)	(0.04)	(0.10)	(0.04)	(0.09)	(0.04)	(0.06)	(0.03)
Dummy for	0.12	0.08**	0.12	0.08**	0.23***	0.07**	0.23***	0.07***

self-employed in urban areas								
	(0.07)	(0.02)	(0.07)	(0.02)	(0.06)	(0.02)	(0.04)	(0.01)
Dummy for labor in urban areas	0.55**	0.12*	0.55**	0.10*	0.47***	0.15**	0.47***	0.15***
	(0.15)	(0.05)	(0.16)	(0.05)	(0.12)	(0.05)	(0.08)	(0.03)
Dummy for tribes	0.96**	0.07	0.96**	0.04	0.30*	0.15*	0.30***	0.15***
	(0.33)	(0.10)	(0.33)	(0.10)	(0.11)	(0.06)	(0.08)	(0.04)
Dummy for caste	0.15	0.17**	0.15	0.16**	0.06	0.20***	0.08+	0.20***
	(0.14)	(0.06)	(0.15)	(0.06)	(0.06)	(0.05)	(0.04)	(0.03)
Dummy for other backward classes	0.15	-0.11	0.15	-0.11	-0.00	0.05+	0.01	0.06**
	(0.24)	(0.08)	(0.24)	(0.08)	(0.05)	(0.03)	(0.04)	(0.02)
Dummy for Hindu households	-0.36	-0.04	-0.36	-0.04	-0.04	0.02	-0.03	0.01
	(0.50)	(0.09)	(0.50)	(0.09)	(0.06)	(0.04)	(0.06)	(0.03)
Dummy for Islamic households	0.18	-0.08	0.18	-0.10	0.12	-0.02	0.13	-0.03
	(0.85)	(0.09)	(0.85)	(0.09)	(0.36)	(0.05)	(0.22)	(0.04)
Dummy for Christian households	0.33	-0.33**	0.33	-0.33**	-0.13	-0.03	-0.13	-0.02
	(0.74)	(0.09)	(0.74)	(0.09)	(0.11)	(0.04)	(0.10)	(0.03)
Dummy for monthly per-capita consumer expenditure	-0.00*	-0.00	-0.00*	-0.00*	-0.00*	-0.00+	-0.00**	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Dummy for household size (no. of people)	-0.09***	-0.02+	-0.09***	-0.01+	-0.05***	-0.03***	-0.05***	-0.03***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Dummy for household dependency ratio	-0.31***	-0.04*	-0.31***	-0.04*	-0.26***	-0.06***	-0.26***	-0.06***
	(0.07)	(0.02)	(0.07)	(0.02)	(0.06)	(0.02)	(0.04)	(0.01)
Dummy for household sex ratio	0.08***	0.01	0.09***	0.01	0.07***	0.02***	0.07***	0.02***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.00)	(0.01)	(0.00)
Dummy for highest year of education attainted by males in the household	-0.05***	-0.01*	-0.05***	-0.01*	-0.04***	-0.01**	-0.04***	-0.01***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)
Dummy for highest year of education attainted by females in the household	-0.03*	-0.02**	-0.03*	-0.02***	-0.04***	-0.01***	-0.04***	-0.01***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
Dummy for urban areas	-0.23+	-0.12	-0.23+	-0.10	-0.19+	-0.06+	-0.19**	-0.06*
	(0.12)	(0.08)	(0.11)	(0.08)	(0.10)	(0.03)	(0.07)	(0.02)
Dummy for households	-0.17	-0.12**	-0.17	-0.13**	-0.34***	-0.15**	-0.34***	-0.14***

with access to LPG (fuel)								
	(0.12)	(0.04)	(0.12)	(0.04)	(0.09)	(0.04)	(0.06)	(0.03)
Dummy for households with access to electricity	0.28	0.07	0.27	0.05	-0.12	-0.02	-0.15^{+}	-0.01
	(0.21)	(0.09)	(0.21)	(0.09)	(0.10)	(0.03)	(0.09)	(0.03)
Year=66			-0.01	0.18**	0.39**	0.15**		
			(0.14)	(0.05)	(0.13)	(0.05)		
Year=68			0.07	0.24***	0.60***	0.21***		
			(0.17)	(0.06)	(0.15)	(0.05)		
Constant	1.76**	0.67***	1.75**	0.61***	1.97***	0.54***	2.31***	0.63***
	(0.63)	(0.12)	(0.62)	(0.12)	(0.25)	(0.07)	(0.19)	(0.06)
State fixed effects	No	No	No	No	Yes	Yes	No	No
Year-state fixed effects	No	No	No	No	No	No	Yes	Yes
R-squared	0.16	0.07	0.16	0.07	0.10	0.08	0.09	0.06
N	326,968	326,968	326,968	326,968	326,968	326,968	326,968	326,968

Standard errors in parentheses
Source NSSO Consumption Expenditure Data corresponding to years 2004-05, 2009-10 and 2011-12
Standard errors clustered at the state level
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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 8 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 exactly opposite to what we saw in the NSS-CES data. What explains the difference in the results?

Table 8. Impact of increase in arbitrage on Purchase of PDS Rice & 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 test one of the predications 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 9, 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 has the opposite effect: it 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 9. Impact of increase in arbitrage in states with reformed PDS

	(1)	(3)
VARIABLES	kgRicePDS	kgWheatPDS
marketpriceofrice	-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)
hhsize	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

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Apart from 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 huge increase in household purchase of PDS rice and wheat (columns 1 and 2, Table 11). The increase is PDS purchase in an order of magnitude smaller for households that switch from no-card to APL card. This is not surprising because the PDS prices are significantly higher for APL card holders.

Table 11. 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 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 what Dreze and Sen posit. 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 does indeed lead 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 10 may not be entirely due to the increase in the value of PDS entitlement only.

IHDS panel data allows us to do more rigorous analysis of the arbitrage effect, but there is a 7-year gap between the two rounds of IHDS. Many changes took place in the PDS in these 7 years. This poses a problem in causal estimation of change in arbitrage on PDS purchases. It is possible that the changes in household purchases of PDS grains that we attribute to change

in arbitrage were actually driven by some other omitted variable that is correlated both to the arbitrage and the household behavior. We address this challenge to causal estimation using data from monthly consumer expenditure surveys carried out by VDSA in Bihar, Jharkhand, Karnataka and Telangana between 2009 and 2012.

We present results from estimating equation 7 with VDSA data from Bihar and Jharkhand in Table 11 and Karnataka and Telangana in table 12. In addition to household, state and year fixed effects, VDSA data also allows us to control for seasonality in household consumption and purchase behavior by adding month-of-the-year dummy. Results from Bihar and Jharkhand suggest that the market price is negatively related to household purchases from the PDS. All coefficients on market price are negative and statistically significant. We run the same regressions with arbitrage and find similar results – higher arbitrage reduces household purchase of PDS rice and wheat in Bihar and Jharkhand. We find exact opposite results when we run the same regressions with data from Telangana and Karnataka. Here, an increase in arbitrage leads to increase in household purchase of PDS rice.

PDS is poorly managed in Bihar and Jharkhand and relatively well managed in Karnataka and Telangana. VDSA data show that increased arbitrage has negative effect on consumers in states with poorly governed PDS and positive effect in states where PDS is better managed.

Table 11: Models for per-household consumption of rice/wheat (kg/month) from PDS on arbitrage or market price in Jharkhand and Bihar – VDSA data

	(1)	(2)	(3)	(4)	(5)	(6)
	Rice	Wheat	Rice	Wheat	Rice	Wheat
Market price (Rs./kg)	-0.0348**	-0.0852***	-0.0398**	-0.174***		
Price arbitrage (Rs/kg)					-0.0460***	-0.0741**
Year		0.270***	-0.041	0.665***	0.0838	0.479**
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Month of the year FE	No	Yes	Yes	Yes	Yes	Yes

Sub-sample of only households that ever used PDS in the sample	No	No	Yes	Yes	Yes	Yes
Sub-sample of only households from Bihar	No	Yes	No	Yes	No	Yes
Constant	10.85***	0.343	18.33***	0.884	19.68***	1.273
Observations	11424	5,670	6552	2,122	5,651	2,114
R-squared	0.002	0.014	0.017	0.035	0.02	0.036
Number of unique HHs	322	162	184	60	180	60

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Models for per-household consumption of rice (kg/month) from PDS on arbitrage or market price in Andhra Pradesh and Karnataka – VDSA data

	(1)	(2)	(3)	(4)	(5)
	Rice	Rice	Rice	Rice	Rice
Market price of rice (Rs./kg)	0.237***	0.242***	0.0624***		
Price arbitrage rice (Rs/kg)				0.489***	0.500***
Year	-3.291***	-3.338***	-1.849***	-4.208***	-4.291***
Household FE	Yes	Yes	Yes	Yes	Yes
Month of the year FE	Yes	Yes	Yes	Yes	Yes
Sub-sample of only households that ever used PDS in the sample	No	Yes	Yes	No	Yes
Constant	43.31***	43.91***	31.43***	49.00***	49.85***
Observations	15,401	15,167	14,238	15,401	15,167
R-squared	0.129	0.13	0.098	0.137	0.14
Number of unique HHs	373	367	366	373	367

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Thus, analysis of both household panel datasets—IHDS and VDSA—suggests that the impact of arbitrage on households' access to subsidized grains is context dependent. 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).

5. 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. This is what we see in the VDSA data in Bihar and Jharkhand. 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).

References

Attanasio, Orazio, Vincenzo Di Maro, Valérie Lechene, and David Phillips. 2013. "Welfare Consequences of Food Prices Increases: Evidence from Rural Mexico." *Journal of Development Economics* 104. Elsevier B.V.: 136–51. doi:10.1016/j.jdeveco.2013.03.009.

Banerjee, Abhijit, Sendhil Mullainathan, and Rema Hanna. 2012. "Corruption," 1–72. doi:10.3386/w17968.

Besley, Timothy and Robin Burgess. 2001. "The Political Economy of Government Responsiveness: Theory and Evidence from India.

Chakrabarti, Suman, and Pallavi Rajkhowa. 2015. "What Is the Cost of Providing One Rupee of Support to the Poor ? Assessing the 'New' PDS." *Economic And Political Weekly* l (52): 83–91.

Deaton, Angus, and Olivier Dupriez. 2011. "Using Unit-values to Assess Spatial Price Differences: Evidence from India and Brazil." *ICP Technical Advisory Group Meeting in Washington DC*. 2011.

Drèze, Jean, Himanshu, Reetika Khera, and Abhijit Sen. 2015. "Clarifi Cation on PDS Leakages" l (39): 72–73.

Dreze, Jean, and Reetika Khera. 2015. "Understanding Leakages in the Public Distribution System." *Economic and Political Weekly* L (7): 39–42. doi:10.1177/014473940002000203.

Drèze, Jean, and Reetika Khera. 2013. "Rural Poverty and the Public Distribution System." *Economic and Political Weekly* XLVII (45 & 46): 55–60.

Drèze, Jon., & Amartya Sen. (2013). An Uncertain Glory: India and its Contradictions. Princeton University Press.

Gulati, A., Gujral, J., Nandakumar, T., Jain, S., Anand, S., & Rath, S. (2012). "National Food Security Bill: Challenges and Options. New Delhi: Commission for Agricultural Costs and Prices, Ministry of Agriculture, Government of India.

Himanshu, and Abhijeet Sen. 2013. "In-Kind Food Transfers - I." *Economic and Political Weekly* 48 (45-46): 46–54. http://www.epw.in/special-articles/kind-food-transfers-i.html\nhttp://www.epw.in/system/files/pdf/2013_48/45-46/InKind_Food_Transfers__I.pdf.

Khera, Reetika. 2011a. "Revival of the Public Distribution System :" xlvi (44): 36–50.

———. 2011b. "Trends in Diversion of Grain from the Public Distribution System." *Economic and Political Weekly* xlvi (21): 106–14.

Kishore, Avinash, and Suman Chakrabarti. 2015. "Is More Inclusive More Effective ? The ' New - Style ' Public Distribution System in India." *Food Policy* 01421 (March): 19. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129061.

Mehta, Aashish, and Shikha Jha. 2014. "Pilferage from Opaque Food Subsidy Programs: Theory and Evidence." *Food Policy* 45. Elsevier Ltd: 69–79. doi:10.1016/j.foodpol.2014.01.002.

Nagavarapu, Sriniketh, and Sheetal Sekhri. 2012. "Informal Monitoring Mechanisms in Public Service Delivery : Evidence from the Public Distribution System in India." *Journal of Development Economics* 121. Elsevier B.V.: 63–78. doi:10.1016/j.jdeveco.2016.01.006.

Niehaus, Paul, Antonia Atanassova, Marianne Bertrand, and Sendhil Mullainathan. 2013. "Targeting with Agents." *American Economic Journal: Economic Policy* 5 (1): 138–206. doi:10.1257/pol.5.1.206.

Weber, Regine. 2014. “Welfare Impacts of Rising Food Prices : Evidence from India.” *International Conference of Agricultural Economists*.