Leakage and Corruption in India's Public Distribution System

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Abstract: In India's Public Distribution System (PDS) subsidized food allocations are differentiated by the poverty status of beneficiaries, namely Antyodaya Anna Yojana (AAY; poorest of the poor), Below Poverty Line (BPL) and Above Poverty Line (APL). Since its inception the PDS has been criticized for its wastage of grains and corruption. In particular, it is commonly held that much of the grain which is supplied to the System is appropriated by bureaucrats and employees rather than reaching the designated beneficiaries. Recent research has investigated the hypothesis that embezzlement in the PDS has been aggravated by growing APL allocations since the year 2000 because this group of households is likely to have a lower demand for the modest-quality grains and be less aware of its entitlement, making it less likely for bureaucrats and employees to be held accountable for the embezzlement of APL allotments. In this paper I investigate econometrically how leakage in the PDS, which I define as the proportion of grain supplied to the System not reaching beneficiaries, responds to variation in the fraction of grains dedicated to APL households. For twenty major states during the years 2004 to 2012, I combine administrative data on grains supplied to the PDS by state and year with state and year-wise consumption of PDS grains, which I calculate from six waves of India's National Sample Survey. Using panel data estimation techniques, I find that the APL quota on the supply side is an important predictor of leakage. My point estimates imply that the increase in the APL share in total grains supplied by the central government of about 25 percentage points has increased leakage by more than ten percentage points, which is about a third of total leakage. I also make an effort to take into account grains supplied by individual states rather than the center, a shortcoming of previous research, which leads to the conclusion that, since 2004, leakage in the PDS has actually increased and not declined as commonly claimed.

“Corruption is the enemy of development, and of good governance. It must be got rid of. Both the government and the people at large must come together to achieve this national objective.”

_Pratibha Patil, 12th President of India

1 Introduction

Nowadays India is one of the fastest growing economies in the world but contradicting to rising figures in GDP the nutrition situation has worsened (Deaton & Dreze, 2009). Estimates of the World Bank (2016) stating that in 2011 about 21,3 percent of the Indian population lived from less than $1,90 per day demonstrate that poverty has to be considered an alarming incident. With regard to nutrition, in 2009 three quarters of the population lived in households with a per-capita intake of less than the amount of calories perceived as necessary (Deaton & Dreze, 2009). Further figures stated by Jain (2016) are striking: about 46 percent of all Indian children as well as 35,6 percent of all women living in India are malnourished. Given that Indians make up three quarters of the South Asian population the immense scale of the problem becomes suffocating (Von Grebmer et al., 2015). There are still people in India who die due to starvation; a fact, that is unacceptable for a civilized society in the 21st century (Government of India, 2002). In fighting India’s notorious hunger issues several measures have been taken. However, none of them seems to solve the problem for good.

One of these measures implemented, the so called Public Distribution System (PDS), is meant to procure subsidized food to the population, especially to the poor. Food subsidy schemes are a common way to increase low-income families’ access to basic food staples in developing countries (Austin, 1981). For instance, in Indonesia the OPK program provides income support in form of subsidized rice (Olken, 2006). Moreover, Sri Lanka’s government committed about 21 percent of its total budget in food supply to the population in 1972, mostly in form of free or subsidized rice (Austin, 1981). The distribution of food under the PDS also makes up a significant part of government subsidies in India and it plays a major role in ensuring food security for the poor (Jain, 2016). Corruption and general inefficiencies in the system are obstacles that need to be overcome. In a broader context this study focuses on the delivery system of public spending which is important when understanding its impact on the poor in developing countries (Reinikka & Svensson, 2004).

In this paper I contribute to filling the knowledge gap of where the Public Distribution

System is most vulnerable to corruption, namely the diversion of foodgrains or leakages. Leakage means the proportion of foodgrains that is meant to be distributed but is not consumed by the eligible beneficiaries. According to recent literature there seemed to have been progress in the functioning of the PDS but still large proportions of food get diverted. The central research question of this paper is if there is more evidence that the “above poverty line” (APL) quota is the main source of leakages. The APL quota is the amount of foodgrains that is taken off from the central pool of the Food Corporation of India (FCI) by the states to be distributed via the PDS to households being classified as “above poverty line”.

As Drèze and Khera (2015) discuss this hypothesis and also apply a cross-section analysis I try to strengthen their finding applying a panel analysis. I do not use the APL quota as its total amount but as its share in the total amount of grain taken off for distribution under the PDS from the central pool of foodgrains. By fitting leakages and APL quotas into a panel over twenty states and a period of six respectively nine years it was possible to observe how these variables relate to each other. Through a fixed-effect regression I find that the APL quota has a significant impact on the leakage. The estimates suggest that an one percent increase in the share of the APL quota in total offtake implies half a percent increase in the leakage. In the context of how leakages and the APL quota changed between the beginning and the end of the time observed the average leakage could have been reduced by 10 percent in addition, if the APL quota on average would not have been extended.

The calculations for state-wise leakages were conducted similar to Reetika Khera’s (2011b) method matching data of the National Sample Survey (NSS) on PDS consumption with official data on offtake published by the Department of Food and Public Distribution, India. However, I also address the problem that the official offtake does not exactly equal the total amount of PDS grains available for consumption as states take action themselves and top up the offtake from the central FCI pool by procuring foodgrains locally. Hence the leakage as calculated by Khera (2011b) is not the complete leakage. This problem was already discussed by Khera (2011b) but she only corrected the leakage for the case of Chhattisgarh in one year. In this paper I complement the offtake of four heterogeneous states, namely Andhra Pradesh, Tamil Nadu, Orissa and Madhya Pradesh with data of PDS grains procured by the states. Even though there are more states procuring PDS grains locally only for these states relevant data was available. For these calculations I used data on decentralized procurement in the four states which were published by the particular Departments of Food and Civil Supplies of each state. Thus it was possible to calculate the real leakages.

It turns out that omitting PDS grains procured by the state introduce non-minor measurement errors in calculating leakages. When estimating real leakages, the findings of foregone literature stating that PDS leakages have generally decreased recently become unstable. The whole picture changes as it turns out that in the four states average leakage decreased by 24 percent while average real leakage increased by 14 percent between 2004 and 2012. This finding is striking and emphasizes the importance of not neglecting actions on state level when talking about leakages. Even though in my main estimation I do use the leakages omitting the state engagement a formal analysis shows that the results are also valid for "real leakages".

Generally this paper suggests that the APL quota is a major source of leakages. Furthermore the locally procured grains are not. So the rise in real leakages can not be accounted for by the extension of the input of foodgrains but by the extended share of foodgrains taken off under the APL quota.

The remainder of this paper is structured as follows. In the subsequent section background information on the system and the content of foregone research on the PDS as well as the main findings are discussed. Section 2 also focuses on the literature of Jean Drèze and Reetika Khera as this paper tries to tie in with their work. The third section deals with the data used and the methodology applied. In the fourth section the problem of omitting decentralized procurement in the leakages is concerned. A description of the econometrical approach, a discussion and a theoretical analysis of a bias problem that may arise in the estimations is provided in section five. The sixth section provides results for all estimations. The last section concludes.

2 Background

The Public Distribution System in India was introduced around World War II as a war-time rationing measure (Kumari & Kumari, 2015). During the 1950s and 1960s, a time stamped by serious food crises, it was expanded mainly to protect urban consumers and fight the upward pressure on food prices (Radharkrishna & Subbarao, 1997). Gradually the program was augmented to reach more and more beneficiaries. With the implementation of the Revamped PDS (RPDS) in 1992 2,496 blocks (meaning district subdivisions) in also hard-to-reach areas were covered under the scheme.

Under the Targeted Public Distribution System (TPDS), which was launched in 1997 the government attempted to target the subsidy more effectively to ensure that it would reach those who really needed it and therefore produced the highest benefit. The TPDS approach requires the states themselves to implement ways of how to identify poor households who are eligible for receiving subsidized food. Eligible households are given ration cards, which enable them to buy food at subsidized prices at Fair Price Shops (FPS). To get an idea of the dimension of the program one must face that there are 4.89 lakh (489000) Fair Price Shops operating to distribute millions of tons of food to people all throughout the country (Government of India, 2008). There are three main types of ration cards: The Below Poverty Line (BPL) card is supposed to be owned by people who live below the poverty line. The Antyodaya Anna Yojana (AAY) card is for those considered as the poorest of the poor. Hence they are households living below the poverty line as well. Households possessing this type of card face even lower prices than BPL cardholders. Furthermore there are households who possess an Above Poverty Line (APL) card. A quota for APL households was intended to be a transitory allocation of food grains in excess of the requirement of Below Poverty Line (BPL) (Government of India, 2001a). This threefolding classification is specified by the government. Nonetheless, there are differences among the states with respect to what kind of ration cards are available as well as how they are distributed. Furthermore the issue of defining a poverty line leaves some space for interpretation (Drèze and Khera, 2013).

Given the importance and the scope of the PDS it is important to note that the PDS is far from ensuring food security in most parts of the country. Food security exists if three conditions are sufficiently met: namely food availabilty, food accessibility and food affordability. With India being one of the largest food grain producers in the world food availability is not the major problem. The green revolution helped the country to pratically eliminate the need for food imports (Jain, 2016). However, the food distribution is much more of a problem.

To pursue economic growth the government has taken measures in the last decades which negatively affected the poor population of India. The main answer on how to handle this issue has often been the PDS as a safety net to rescue those who suffer from the economic reforms (Mooij, 1994). This even more stresses the inevitability of a functioning system as politicians seem to rely on the PDS for correcting undesired side effects produced by their policies.

Several studies that examined the performance of the PDS pointed out problems which detain it from being the safety net for the hungry masses that it is supposed to be. As mentioned above the implementation of the TPDS was supposed to correct the errors that could be accounted for by the universal coverage of the PDS. According to Nawani (1994) the main weakness of the PDS even was its universality. With the old program it was possible for everyone to purchase foodgrains at subsidized prices. Interestingly Himanshu & Sen (2011) doubt that there have been any improvements in the system after it was made targeted. In the system inherited inclusion and especially exclusion errors hinder the TPDS from being effective. They find that in 2004/2005 among the richest 20 percent of the population approximately 11 percent purchased rice or wheat from the PDS while only 35 per cent of the poorest 20 per cent did so. These findings suggest that targeting the distribution to the poor is not completely successful. More evidence for bad targeting is given by a case study in Rajasthan from Khera (2008), estimating that only 44,3 per cent of the poor population is covered by the PDS whereas 23,5 per cent of the non-poor population is covered. A similar study measuring inclusion and exclusion errors of the PDS in Andhra Pradesh and Maharashtra was made by Ramaswami & Dutta (2011). The authors also calculate the implicit subsidy to consumers by PDS and interpret it as an income transfer. This is done by taking the difference between the market price of grain and the price of grain charged at the FPS. When relating this transfer to the general household expenditure they find that the PDS does a much better job in Andhra Pradesh than in Maharashtra. Similar to this approach Drèze & Khera (2013) try to elicit the effect the PDS has on poverty statistics. They add the implicit subsidy to the Mean Per Capita Expenditure (MPCE) of households to see how households' poverty statuses are affected. They find that the PDS induced reduction of rural poverty at the all-India level in 2009/10 was around 11 percent based on the head-count ratio and 18 percent based on the poverty-gap index. Another concern uttered by foregone literature is that even though people have access to the PDS the supply under the program is not sufficient. A case study in rural Orissa for example showed that generally the organization of the FPS and the system itself was perceived as satisfying. Nevertheless, almost half of all BPL households and over 80 percent of APL households had to spend extra money to cover their nutritional basic needs. This can be accounted for by the system's ignorance against family size and simply inferior quality of the distributed foodgrains (Panigranhi & Pathak, 2015). It becomes clear that even if the system works per se it is not guaranteeing proper food security. Moreover FPS often do not have predictable opening hours or they run out of food even before all eligible households demanded their entitlements (Khera, 2011a). These problems of hard accessibility of the PDS impose extra cost to the consumer and therefore implicitly lower the actual subsidy. A further major issue is the one of leakages. A substantial proportion of the grain, which is meant to reach eligible families under the PDS ends up being sold in the open market by corrupt intermediaries (Drèze & Khera, 2011). The focus of this paper is on leakages in the PDS and how they can be explained.

Drèze and Khera (2015) discuss that the biggest source of continuing leakages is the APL quota. They compare leakages in the agricultural years 2004/2005 and 2011/2012 and find that they reduced by about 12 percentage points. The result of a field study which was conducted in 2011 shows that BPL households on average received 84 percent of their entitlements (Drèze and Khera, 2011). Therefore one could argue that the reduction in leakages Drèze and Khera (2015) measure can be accounted mostly to the BPL quota where little diversion takes place. Since the total offtake from the central pool is differentiated between APL, BPL and AAY quota they assume that the grains that vanish in corruption can be traced back to the quota under which they were taken from the central pool of the FCI. In the data of the 68th NSS round it is also possible to differentiate between purchases of PDS grains by APL and BPL households. Drèze and Khera (2015) exploit this attribute of the 68th NSS round to separately estimate leakages for both quotas in 2011/2012 and find that the leakage is 67 percent for the APL quota and 30 percent for the BPL quota.

This leads to the assumption that the APL quota is more prone to corruption which can be caused by a number of issues. Among the states there is no uniform procedure to identify those who are eligible to hold an APL card which leads to the fact that in West Bengal 30 percent of the APL population were falsely excluded from the program (Bhattacharyya & Runa, 2008). As the APL quota serves as a transitory allocation only for excess amount foodgrains (Government of India, 2001a) the quota varied a lot from year to year and so did the entitlements for APL households (Drèze & Khera, 2015). Therefore there are no specific entitlements for APL households, and no clear allocation norms (Drèze & Khera, 2011). This lack of clear entitlements is a possible reason why the PDS works better for the BPL households than the APL households (Khera, 2011a). Furthermore in the case of West Bengal for example people in APL households seldomly bought any grains from the ration shops (Bhattacharyya & Runa, 2008). The problem of corruption due to lack of information was also observed in a case study in Uganda concerning public expenditure on schools. As little information about government spending was available to the public it was possible for local officials and politicians to take advantage of the system. Consequently publishing the information turned out to be an effective measure against corruption (Reinikka & Svensson, 2004). Hubbard (2007) later put this in relative terms as he found that there were also other changes in policy that were likely to reduce corruption. Still he states that information does play an important role in the political economy of corruption. Especially in the PDS there is evidence that more transparency, which can be achieved in many ways, leads to a better functioning of the PDS. This was investigated by Puri (2012) for the case of Chhattisgarh. Providing information about the system is also supportive of giving the people a reason to believe that the PDS provides something good for them and to strengthen their stake in it. This is a strong weapon against corruption (Drèze and Khera, 2011). When relating these issues to the APL quota under the PDS it seems obvious that foodgrains distributed under the APL quota depict a good target for corruption.

3 Data and variables

Achieving a quantitative measure of the extent of corruption in developing countries is a topic already dealt with by Olken (2005) in a study about a food subsidy scheme in Indonesia comparable to the PDS in India. He compares government administrative records on the amount of subsidized rice with household surveys which elicit if households have actually received rice. Assuming every household receives its full entitlements he aggregates the total consumption of subsidized rice and then obtains what proportion of the administrative records it makes up. This is comparable to calculating leakages as done in this paper.

To estimate the PDS leakages in several states I apply a method similar to what Khera (2011b) did. With the data of six rounds of the National Sample Survey it was possible to compute the monthly average per-capita consumption of PDS grain in each state for six years. The term PDS grain here refers to the sum of rice and wheat. Both items are taken together since rice and wheat almost have the same nutritional value. One kilo of rice contains 3460 kcal and one kilo of wheat 3410 kcal respectively (Government of India, 2012).

My procedure of calculating per-capita consumption slightly differs from Khera's (2011b). Her results, which can be seen in Tables 1A and 1B in her paper show the estimated per-capita purchase of PDS rice and wheat. The calculation underlying these results is simply dividing the average monthly purchase per household in a state in either rural or urban sector by the average household size in that sector in that state. Furthermore Khera (2011b) estimates an average per-capita purchase of PDS grain for whole India in the rural or urban sector in Tables 1A and 1B by simply taking the mean of all states. This is a misleading approach since not all states have the same population size and so at national level one should weight the states differently. My calculations are more precise. Calculating the total consumption of PDS grains in a year in a state can be reproduced by following:

$$total\,consumption_{it} = \frac{1}{n_i}\sum_{h=1}^{n_i}\left(\frac{average\,household\,consumption_{hit}}{householdsize_{hit}}\right)*\left(\frac{365}{30}\right)*Census\,population_{it}$$

where i denotes the state, t the survey year, h the household and n_i is the number of surveyed households in a state.

The reference period in all treated NSS rounds is 30 days. So the results roughly refer to monthly per-capita purchase. For my purpose annual per-capita purchase is needed. Simply multiplying the monthly figures with 12 gives a good estimate of the average over one year (Deaton, 1997). However to be more precise I multiplied these figures with (*365/30*). Information about population were taken from the Census of India. The first five rounds I looked at, which were 61st to 66th (excluding 65th round) were carried out for the survey years from 2004/2005 to 2009/2010 (excluding 2008/2009 due to limited data access). One survey year describes a time period from July in the first year to June in the following year. Regarding population figures for these rounds I made use of the Population Projection Report 2001 from the Census of India (Government of India, 2001b). The document gives population projections for the years 2001 to 2026. Here I followed Khera (2011b) and dealt with the population projection as on March in the second half of the survey year. For example the population figures I used with the 61st round were the projections as on March 2005. For the 68th NSS round, the latest one I looked at, carried out between July 2011 and June 2012, the data from the 2001 Census of India was already outdated as there was a new Census published in 2011. For the 68th round I therefore calculated with the real population figures from 2011 (Government of India, 2011). As they differed a lot from the projections made in 2001 this promised to give more valid results. After applying these calculations we know the total amount of PDS grains consumed in each state in each of the six survey years. The results are visualized in figures 1 and 2.

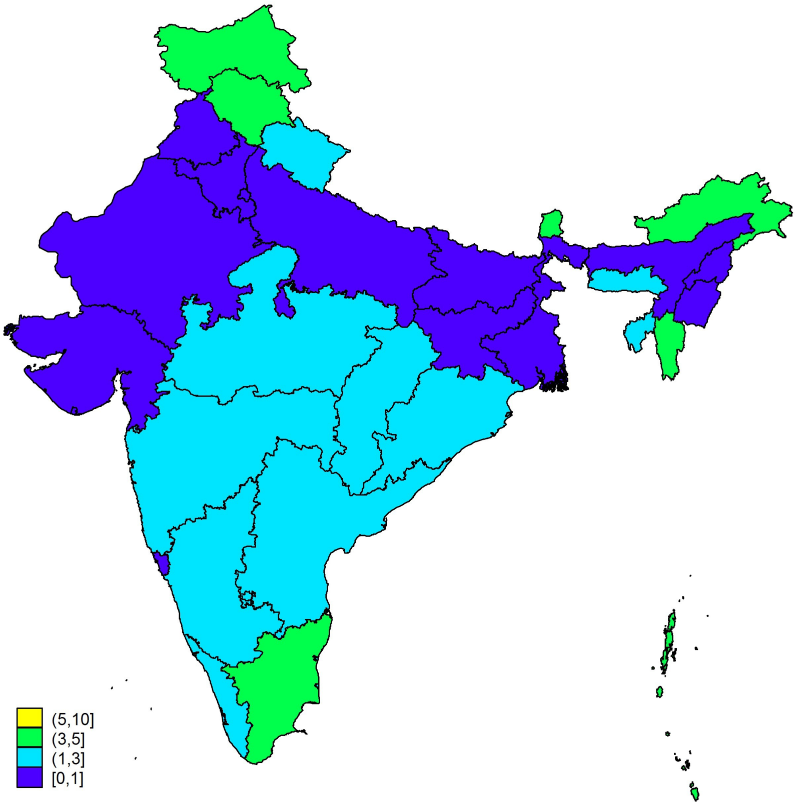

Figure 1: Average monthly per-capita consumption (kg) of PDS grains 2004/2005

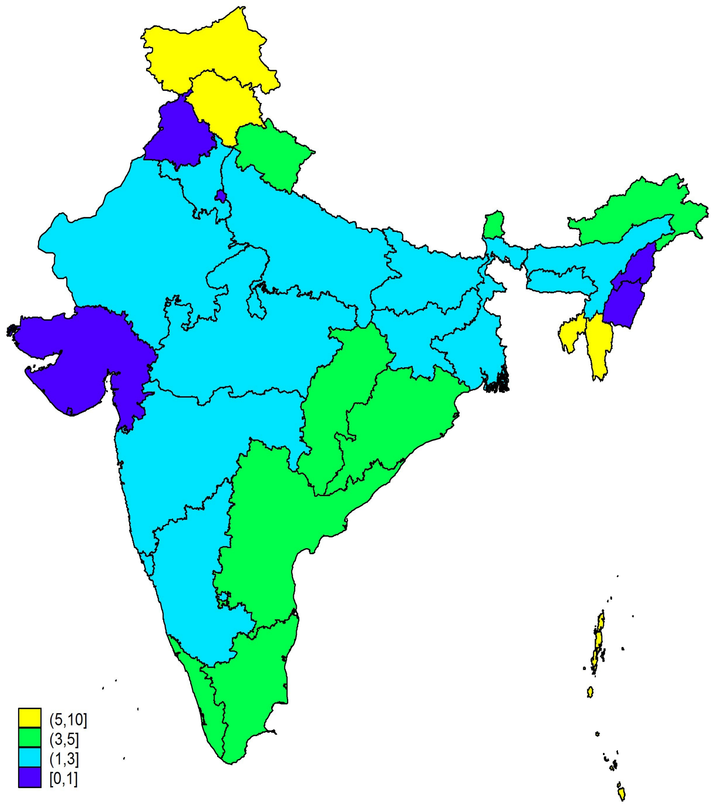

Figure 2: Average monthly per-capita consumption (kg) of PDS grains 2011/2012

Speaking generally it is safe to say that the overall consumption of PDS grains has increased. This could be triggered by several reasons such as rising poverty, rising food prices on commercial markets etc.. However, price changes and general consumption patterns are not part of this study. But important to note is that increased consumption does not necessarily mean an improvement in the functioning of the system. Figures 1 and 2 illustrate average monthly per-capita consumption of PDS grains throughout the states and Union Territories (UT) of India in 2004/2005 (61st NSS round) and 2011/2012 (68th NSS round) respectively. It can be seen that there has been an upward trend in average PDS grain consumption. In 2004/2005 in no state or UT the average per capita consumption of PDS grains was as high as 5 kg and a non-neglible part consumed not more than one kg (dark blue) of PDS grain on average per month. Seven years later the picture already looks different as only five states have an average consumption between zero and one and four states achieved an average consumption of over 5 kg per-capita per month. Also the rest of India is generally in more light colors implying higher levels of consumption. This is just to give an overview of how much people actually get out of the PDS and how it changed over the years. As already indicated this improvements cannot be directly interpreted as an improvement in the functioning of the PDS. Engagement on the state-level, namely schemes like the DPS did augment the procurement of foodgrains distributed under PDS. The consumption could simply be due to a virulent increase on the supply side. Whether leakages are reduced or not can not be concluded from these figures.

The term leakage refers to the proportion of PDS grains which is diverted, meaning that it appears in the official offtake data but is not consumed by the population. To measure the leakage in a certain state in a certain survey year I conducted the calculation as follows:

$$leakage_{it} = 1 - \frac{total\,consumption_{it}}{offtake_{it}}$$

where *i* denotes the state and *t* denotes the survey round.

Offtake refers to the official total offtake of "Rice & Wheat" as stated in the Monthly Foodgrain Bulletin for the financial year corresponding to the survey year.[1] So the supply-side data (offtake) is for the time period from April to March and the demand-side data (NSS) is for the time period from July to June. As Drèze & Khera (2015) state synchronizing the data

1 Data access on http/::www.dfpd.nic.in and then to Food Grain Bulletin

to the same time period only makes little difference there are no time adjustments made here. This paper focuses on leakages at state level only, so it will not be differentiated between the rural and the urban sector. Moreover I only look at the major states that Khera (2011b) also observes.[2] Very small states or UTs are left out of the main panel.

	N	mean	sd	min	max
Apl	120	0.290	0.201	0.00198	0.836
Leakage	120	0.364	0.304	-0.651	0.942

Table 1: Summary Statistics for *leakage* and *apl* in 20 states over six years

Another important variable for my purpose is *apl* which gives the offtake of grains under the APL quota as a percentage of total offtake for a certain state in a certain financial year. So $apl = \frac{APL}{offtake}$. Table 1 describes *apl* and *leakage.*[3] It is noticeable that the minimum of *leakage* is negative, a problem which will be further discussed in section 4. The variation of *apl* over the years, which sufficiency is important for the remainder of the analysis is visualized by figure 3. Table 2 gives the means of *apl* in 2004/2005 and 2011/2012.

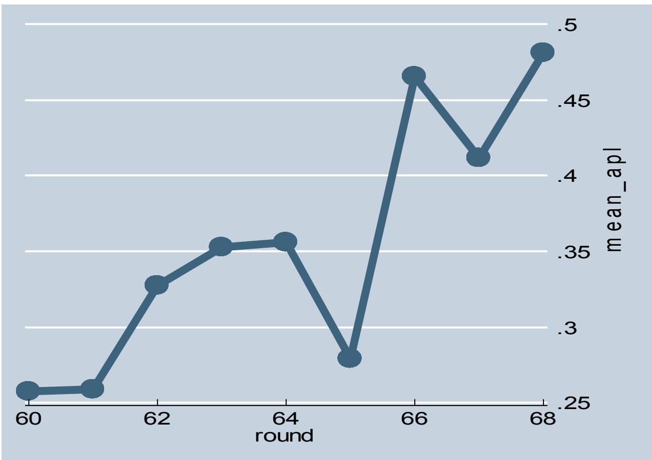

Figure 3: Variation of overall mean *apl* between 2003 and 2012

2 The observed states are: Andhra Pradesh, Assam, Bihar, Chhatthisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal

3 For Summary Statistics for the other quotas see Appendix A-1

	N	mean	sd	min	max
Apl					
2004/2005	20	0.215	0.176	0.00198	0.512
2011/2012	20	0.403	0.176	0.0526	0.752

Table 2: Mean *apl* in 2004/2005 and 2011/2012

It is important to emphasize that the consumption data derived from the NSS might suffer from measurement error, and in particular under-reporting. As mentioned above the reference period in all rounds was 30 days. Thus, people had to recall their consumption of PDS grains in the 30 days preceding the survey. Deaton (1997) states that in household surveys already a recall period of even two weeks will result in downward biased estimates of consumption. Therefore one must consider the possibility of errors in the calculations. Furthermore concerning the NSS data explicitly Deaton and Drèze (2009) assume that there is underestimation in consumption. Taking this into account, the leakage as estimated above is likely to be overestimated because there is an error in measurement causing an upward bias of the estimate. Nevertheless the empirical approach using fixed-effects in the subsequent analysis should take care of this under-reporting complication.

4 Real leakages

There are three measures that can be taken at the state-level to improve the efficiency of the PDS. The state governments can increase the coverage of the PDS by redistributing the quotas, meaning less entitlements for the individual household but therefore reaching more households. Grains under the APL quota can also be redistributed to the eventually more needy BPL households. Furthermore the states can simply top up the amount of grain which they are entitled for by the government and procure foodgrains for PDS locally (Khera, 2011b). What is important from this insight is that the amount of foodgrain by the central government is not necessarily the ultimate amount distributed. One source of local procurement is the so called Decentralized Procurement Scheme (DPS) under which the states purchase, store and procure foodgrains themselves and distribute them under TPDS (Government of India, 2004). This is a source of PDS foodgrains different from the official offtake, which is only the amount of foodgrain taken by the states from the central pool of the

FCI. I will refer to the amount of foodgrains procured by the DPS as a topup on the offtake. Therefore the total consumption derived from the NSS data does include consumption of PDS grain procured under DPS (topup) and consumption of PDS grain from the central pool (offtake). Taking only the official offtake could lead to wrongly calculated leakages. A problem which Khera (2011b) and Himanshu & Sen (2011) discuss but do not fix. To be accurate one has to include local procurement as well. It is likely that the grains procured under DPS are better targeted and less likely to be diverted than those coming from the central pool. To go one step further I assume that all grains procured under DPS are actually reaching the consumers. This is a critical assumption of this analysis. But as local procurement implies that the grain does not have to be transported a long distance there are shorter chains of supply and so less chances for middlemen or other officials to divert the grain. Thus, when fixing the problem in the leakage definition total consumption just stays the same. However, the actual total amount of foodgrains available for consumption is the offtake (from FCI) plus the individual state's topup. *Leakage* is therefore omitting the commitment at the state level. The *real leakag*e takes into account the topup.

$$real\ leakage_{it} = 1 - \frac{total\ consumption_{it}}{offtake_{it} + topup_{it}}$$

This furthermore explains how it is possible for total PDS foodgrain consumption to exceed the offtake and therefore leading to negative estimated leakages as seen in Table 1. Major states which adopted this scheme at least in some districts are Andhra Pradesh, Bihar, Chhatthisgarh, Guarat, Karnataka, Kerala, Madya Pradesh, Orissa, Tamil Nadu, Punjab, Rajasthan, Uttrakhand and West Bengal (Government of India, 2016).

For the time analyzed in this paper useful information about decentralized procurement was only available in four states, namely for Orissa, Madhya Pradesh, Andhra Pradesh and Tamil Nadu. Thus, it was only possible to calculate an estimate of the real leakage for these states. As there might be a lack of information there is also evidence that some states only applied the scheme after time observed in this paper, as for example Kerala (Ramabhadran Pillai, 2015). For Orissa the Odisha State Civil Supplies Corporation Ltd. (OSCSC) has published information about yearwise achieved procurement of rice under DPS from 2003 to 2012.[4] In Madhya Pradesh the Madhya Pradesh State Civil Supplies Corporation Ltd. shares

4 For information go to http://www.oscsc.in/Doc/decentralised_paddy_procurement_operations.pdf

information about the decentralized procurement of wheat which is finally distributed through Fair Price Shops from 2008 onwards.[5] Note in this case that in the analysis the amount of decentrally procured foodgrains will be equal to zero in the rounds before 2008/2009. For data of decentralized procurement of rice in Andhra Pradesh I used information published by the corresponding Corporation for Civil Supplies, which is available for all years of interest.[6] Finally in Tamil Nadu the Tamil Nadu Civil Supplies Corporation (TNCSC) shares information about rice procurement after the introduction of DPS from 2002 to 2011.[7] Note here that for the last round of the analysis 2011/2012 I used the targeted amount for the season.[8]

	N	mean	sd	min	max
Leakage					
2004/2005	4	0.277	0.330	-0.111	0.681
2011/2012	4	0.0308	0.141	-0.0842	0.236
Real Leakage					
2004/2005	4	0.356	0.242	0.182	0.699
2011/2012	4	0.492	0.142	0.363	0.667

Table 3: Average *leakage* and *real leakage* for 2004/2005 and 2011/2012 in topup states

Summary statistics for leakage and real leakage in the four states are provided in Table 3. It is observable that there is a big difference in the means of both estimates. Including the topup amount of grain increases the leakage estimate in 2004/2005 by about 8 percent. In addition to that it is interesting that when looking at row 3 and 4 real leakage did not diminish but increase. This observation will be discussed further in subsequent sections.

It is important to note that selection bias in this analysis are unlikely. The four states at hand are neither only role-model states nor just basket cases. Actually they are very heterogeneous in terms of governance. In a paper by Mundle et al. (2012) the states of India are ranked by the quality of their governance. Each of the four topup states appear in a different quintile of the ranking. Out of 17 states Andhra Pradesh ranks first, Tamil Nadu fourth, Orissa eleventh and Madhya Pradesh ranks fourteenth. Furthermore Orissa and Madhya Pradesh are more viewed as less developed (Mundle et al., 2012) whereas Tamil Nadu and Andhra Pradesh are more advanced states (Mundle et al., 2016). Moreover the differences in demographical characteristics are

5 For information go to http://www.mpscsc.mp.gov.in/page.php?pagelink=Procurement
6 Information from Powerpoint presentation retrieved from http://www.powershow.com/view4/5078af-YjNmM/Decentralized_Procurement_powerpoint_ppt_presentation
7 For information go to http://www.tncsc.tn.gov.in and then “Procurement of Paddy“
8 For summary statistics of topup relative to offtake see Appendix A-2

striking. According to the Census of India in 2011 less than 20 percent of Orissa's population was living in urban areas. In Madhya Pradesh the urban population made up between 25 and 30 percent. In Andhra Pradesh between 30 and 35 percent and in Tamil Nadu at least 35 percent of the population lived in urban areas (Government of India, 2011). So the four states can be viewed as representative for all states of India.

5 Econometric approach

In this study I went further to find out whether the APL quota is the major force in keeping the leakages high. A panel-data approach was applied in which I measured the influence of *apl (*APL quota as a share in the total offtake) on the *leakage*. The panel variable are 20 states of India and the time variable are the survey years in which the 61st, 62nd, 63rd ,64th, 66th and 68th rounds of the National Sample Survey were carried out. Due to limited data access I could not include rounds 65 and 67. The main estimation of this paper is modeled as follows:

$$leakage_{it} = \alpha_i + \gamma_t + \beta_1 \, apl_{it} + u_{it} \qquad (1)$$

The subscript *i* denotes the cross-sections, which are the 20 major states so *i*= (1,2,3...,20). The subscript *t* is an index for the time dimension and denotes the survey rounds I looked at, so *t*= (61, 62, 63, 64, 66, 68). $Leakage_{it}$ gives the leakage of PDS grain for a certain state in a certain survey year. β_1 is the coefficient for the regressor *apl* which estimates the effect of an increase in the share of the APL quota in total offtake on the leakage. The α_i stands for unobserved components which are state-fixed, so they vary over i only. These can be understood as certain qualities of the states that do not change over time. The γ_t stands for time fixed-effects that vary only over t. The u_{it} stands for idiosyncratic errors that vary over i and over t. If β_1 turns ot to be significantly greater than zero this implies that an increase in the share of APL offtake in total offtake also increases the proportion of grain which gets diverted.

It is a logical argument that people are not consuming the quantities of PDS foodgrains in the same period of time they are registered to be taken off by the states simply because the distribution takes time. There will be a delay between offtake and consumption which can be misleading when interpreting the leakage in a certain period of time. To control for this incident I extended the model by including a lagged variable for the APL quota. Having this, we can check whether the quotas of a foregone year influence the leakage of the current year.

$$leakage_{it} = \alpha_i + \gamma_t + \beta_1 apl_{it} + \beta_2 apl_{it-1} + u_{it} \quad (1a)$$

At this point I take a closer look at the model specification again. As I asssume PDS topup grains to be displayed in total consumption it becomes clear that the topup has a direct negative influence on the leakage. As there is not sufficient information about topups for all states I have to treat it as an unobserved variable when regressing leakage on the APL quota. In order to get a consistent estimate for β_1 I need to investigate whether the topup is uncorrelated with the APL quota or not. If there is a correlation, technically the unobserved variables included in the idiosyncratic error-term would influence the independent variable included in the model. Thus, the estimated coefficient for the independent variable would be biased. Whether this is the case or not is a valid question here as a state government might either redistribute the APL quota to BPL households or just add more grains via DPS. My concern is that if the APL quota of a state is extended the state has no incentive to procure topups because it just uses the additional grains targeted for APL households to meet the needs of the more needy population. This would imply that an increase in the APL quota lead to lower topups. Lower topups would then lead to higher leakages. The latter is conditional on the assumption that the topups are definitely displayed in the consumption data. So finally the estimate for β_1 would be biased. In the following subsection I will analyse the asymptotic properties of this problem to check if there will be interfere when estimating model (1). I already introduced the variables *offtake*, *topup*, *leakage*, *real leakage* and *apl.* To put the problem formally I need to introduce the following variables:

The APL quota as a share in the total grain available for consumption (so *offtake* plus *topup)* is called *apls,* so:

$$apls_{it} = \frac{APL_{it}}{offtake_{it} + topup_{it}} \quad \text{(note difference to} \quad apl_{it} = \frac{APL_{it}}{offtake_{it}} \quad)$$

The topup as a share in the total grain available for consumption (so *offtake* plus *topup)* is called *tps,* so :

$$tps_{it} = \frac{topup_{it}}{offtake_{it} + topup_{it}}$$

The topup related to the offtake is called *tpo,* so :

$$tpo_{it}=\frac{topup_{it}}{offtake_{it}}$$

Consider the data generating process:

$$real\ leakage=a+b*apls+d*tps+\nu \qquad [A]$$

We are interested in *b* and possibly *d*.

[A] can be shown to be equivalent to

$$leakage=a+b*apl+(a-1+d)*tpo+(1+tpo)*\nu \qquad [B]$$

Consider the following estimating equations:

When data on *topup* is missing:

$$leakage_{it}=\alpha_i+\gamma_t+\beta apl_{it}+u_{it} \qquad (1)$$

When data on *topup* is available:

$$leakage_{it}=\alpha_i+\gamma_t+\beta apl_{it}+\delta tpo_{it}+u_{it} \qquad (2)$$

$$real\ leakage_{it}=\alpha_i+\gamma_t+\beta apls_{it}+\delta tps_{it}+u_{it} \qquad (3)$$

Clearly (3) will deliver unbiased estimates of *b* and *d* in [A] because:

$$plim\,\hat{\beta}=b \quad , \quad plim\,\hat{\delta}=d$$

Estimating (2) will give:

$$plim\,\hat{\beta}=b \quad , \quad plim\,\hat{\delta}=(a-1+d) \quad , \quad plim\,\hat{\alpha}=a$$

so also *d* can be retrieved.

Estimation of (1) will suffer from an omitted variable bias and we have

$$plim\,\hat{\beta}=b+\beta_{tpo,apl}(a-1+d) \qquad (*)$$

where $\beta_{tpo,apl}$ denotes the slope coefficient from the regression:

$$tpo_{it}=\alpha_i+\gamma_t+\beta_{tpo,apl}apl_{it}+u_{it} \qquad (4)$$

Hence there is a bias problem and its extent depends on $\beta_{tpo,apl}$, *a* and *d*.

6 Results

Note first that for all estimations I used state-clustered standard errors. This is taking into account correlation of variables within a state over the years due to unobserved characteristics of the state. As a correlation seemed possible this promised to get more robust estimates. Furthermore based on first-order asymptotic analysis there are no costs of being completely robust to any kind of within-group correlation if the panel consists of a large group of cross-sections and relatively few time periods. This is the case as we have 20 states as cross-sections and only six rounds of NSS as time periods.

Table 4 gives the main results. The first two columns concern all 20 states. Running a fixed-effect regression following baseline model (1) it turns out that *apl* has a significant positive effect on the leakage. This can be seen in column 1. Consider that here positive implies that the leakage is increasing which is rather bad. The coefficient for *apl* taken from column 1 can be interpreted such as that an one percent increase in the share of the APL quota in the total offtake triggers a half percent increase in the leakage. This can be interpreted as the main finding of this paper as it displays exactly what has been attempted to show. To put it differently one can state that seeing the mean leakage has reduced by 24 percentage points and the APL quota as a share in the total offtake on average has risen by 20 percentage points the leakage could have even been reduced by 10 percentage points in addition if the APL quota would not have been increased. Furthermore it turns out that including a lagged variable in column 2 only decreases the point estimate by less than 6 percentage points and persists to be significant. Column 3 and 4 refer to the 16 major states for which no data of decentralized procurement was available. Here it is observable that the point estimate is almost equal to the one in column 1. This is supportive for the assumption Drèze & Khera (2011) made that the APL quota is partly responsible for leakages. Note that in this case still the leakage is calculated omitting the topup grain by the DPS for some states.

Columns 5 and 6 only concern the four topup states. Here the point estimates also suggest a positive effect of the APL quota on the leakage. Even though in the fifth column the effect of the APL quota is not significant this can also be accounted to the small dataset underlying. Still the effect is similar to the other, significant estimates.

To see whether estimation of the baseline model is biased one can compare the two coefficients for apl in column 1 and column 6 which refer to β in equations (1) and (2). It is observable that both coefficients are positive, non-minor and significant on the 5 percent level. There is a difference in the magnitude of 0,73 which can be suggestive that the topup is influencing the APL quota. Again this can also be accounted to the different data underlying the estimation. The finding that *tpo* has a significant negative influence on *leakage* is not surprising as leakage is omitting the topup. As mentioned above I assume the topup to be well targeted and therefore actually reaching the consumer. So following the calculation of *leakage* it is obvious that when topup increases the numerator gets bigger but the denominator (*offtake*) stays the same. Therefore *leakage* generally becomes smaller.

	(1)	(2)	(3)	(4)	(5)	(6)
	leakage	leakage	leakage	leakage	leakage	leakage
apl	0.503**	0.441**	0.506**	0.508**	0.797	1.235**
	(0.178)	(0.177)	(0.209)	(0.202)	(0.502)	(0.231)
apl_{t-1}		0.126		-0.00573		
		(0.223)		(0.213)		
tpo						-0.387*
						(0.124)
Round FE	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y
Observations	120	120	96	96	24	24
R-squared	0.740	0.741	0.714	0.714	0.788	0.898

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

Table 4: Main Results. Fixed-effect regressions.

Furthermore it is to note that in the regressions displayed in the first four columns of Table 4 a serial correlation of the idiosyncratic residuals (u_{it}) is interfering the efficiency of the estimators. This can be checked for by applying the Wooldridge test for autocorrelation in panel data. As the test-statistics do reject the Null-hypothesis that there is no first order autocorrelation one has to consider the estimators as not the most efficient ones. Nevertheless they are consistent. Table 5 presents the results of the regression of real leakage which is supposed to give unbiased estimates of β and δ for sure. One should now compare the β with the one from column 1 in Table 4 to see how far the main estimation is from the certainly unbiased estimation. Namely how the effect of the APL quota changes when we take care of the topup as part of the PDS grain available. There is a difference in magnitude of about 0,58 and the coefficient for *apls* is not significant. Still I assume both estimates can be viewed as similar as both are non-minor and positive. Concerning the significance it is not a major problem because we are dealing with only four states. As standard errors become relatively large with small sample size and here we have only 24 observations the results are likely to be unstable.

	(1)
	Real leakage
apls	0.658
	(0.722)
tps	0.134
	(0.199)
Round FE	Y
State FE	Y
Observations	24
R-squared	0.846

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

Table 5: Fixed-effect **r**egression for topup states

Table 6 gives the results when estimating the effect of the APL quota on the topup. As discussed above this is an important question to find out whether the β from model 1 is biased. The coefficient for apl is the $\beta_{tpo,\ apl}$. Note in this case that for the estimation neither *leakage* nor *real leakage* are needed. Hence the consumption data derived from the NSS was not needed and the time of observation could be supplemented by the years that are missing in the main panel (namely the 2003/2004, 2008/2009 and 2010/2012). So to get more robust results I observed the top-ups and APL quotas in the four topup states from 2003 to 2012 in column 1 and only the years of the main panel in column 2.

For the bias problem I formulated that in the baseline model (1) one might estimate a biased coefficient because the asymptotic properties of the estimator tell that:

$$plim\,\hat{\beta} = b + \beta_{tpo,apl}(a - 1 + d) \qquad (*)$$

The results show that $\beta_{tpo,\ apl}$ is rather small and negative in the first column but positive in the second column. As both estimates are non-significant and the smaller estimate relies on larger data one can assume that $plim\,\hat{\beta} = b$. Therefore the estimated effect of *apl* on *leakage* can be considered unbiased and $\hat{\beta}$ a consistent estimate.

	(1) tpo	(2) tpo
apl	-0.177	1.131
	(0.961)	(1.423)
Round FE	Y	Y
State FE	Y	Y
Observations	36	24
R-squared	0.776	0.771

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

Table 6: Fixed-effect regression of *apl* on *tpo* in topup states over 9 years

7 Concluding Remarks

The main findings of the paper do support findings of recent literature in part but also add important aspects to the overall picture which need to be considered in future analysis. Firstly they suggest that corruption in the PDS happens largely under the APL quota. Setting up a panel of 20 states over 6 years allowed me to apply fixed effect regressions. Due to strong variations and an overall increase in the APL quota over the years this seemed a major obstacle in reducing PDS leakages.The point estimate for the effect of the APL quota on leakage is 0,503. So a one percentage point increase in the APL quota increases leakage by about half a percentage point. Given that the denominator of the APL quota and the leakage measure are the same, this also implies that, of every extra ton allocated to APL households, 503 kilos are diverted. It is interesting to compare this figure to the results of the cross-sectional analysis by Drèze and Khera (2015), who estimate that, on average across India's major states in 2011-2012 67% of the APL allocations are diverted. Combining the two figures it appears that the marginal rate is a little smaller than the average rate of leakage, albeit both are of a similar order of magnitude. Secondly it becomes clear that the engagement in the PDS at the state level is of special importance. Figures of how much grains have been procured locally for PDS via the DPS show that these topups make up a significant part of the total amount of grains available for consumption under PDS. In some cases the topups by the states even exceeded the offtake from the central pool. So ignoring this when estimating leakages - as done in foregone literature – could be heavily misleading. Generally there is a lack of sufficient information about the PDS foodgrains that are procured in the states and also distributed in the states. In this paper I used the information available in only four states. It is striking that when caring about the state topups the impression of falling leakages between 2004 and 2012 becomes invalid. At least in the four states the real leakages increased and not too little. Nevertheless this paper provides a formal analysis to check that the estimated effect of the APL quota is still meaningful. The four states are representative for the all-India level as they are heterogeneous in terms of governance and also demographic characteristics. So neither just role-model states nor simply basket cases. Anyway, having information on the top up grains in more states would certainly be helpful to back up the findings.

Concluding it looks like the real leakage increased over the years. This can be accounted to the overall extension in the share of the APL quota in total offtake. Furthermore the results show that the augmentation of the amount of locally procured PDS grain is unlikely to increase leakage. I find evidence that the PDS is improving in terms of consumption rates. Between the years 2004 and 2012 household data by the NSS suggests that per-capita consumption of PDS grains has risen significantly in almost every state. Still it is likely that this is only due to the increasing state engagement. The PDS is still not efficient as leakages remain high and high proportions get diverted.

As an outlook to further research one can formulate that there is more to the leakage than just the consumption from the NSS data and the official offtake data. Emphasis must be laid on what is really available for consumption under PDS. Furthermore my findings support that still the APL quota accounts for a lot of leakage and put the use of it into question.

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Appendix

	N	mean	sd	min	max
BPL	120	0.471	0.144	0.114	0.754
APL	120	0.290	0.201	0.00198	0.836
AAY	120	0.240	0.0910	0.0508	0.553

Table A-1: Summary Statistics for all three quotas as a share in the total offtake (2004/2005 to 2007/2008, 2009/2010 and 2011/2012)

	N	mean	sd	min	max
tpo					
Madhya Pradesh	9	0.362	0.489	0	1.296
Andhra Pradesh	9	0.243	0.237	0.00420	0.659
Tamil Nadu	9	0.443	0.163	0.133	0.703
Orissa	9	0.599	0.486	0.0187	1.249

Table A-2: Summary Statistics for tpo in topup states over 9 years (2003/2004 to 2011/2012)