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Policies for food security in India

an assessment of current policies and reform options

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Abstract

Ever since India's independence large-scale government interventions have been drastically shaping the landscape of the food grain sector. From a famine-prone country, India has become a large exporter and stockholder, with stable domestic prices and several nutrition programs. At the same time, 15 per cent of Indian population is still undernourished. The Indian government is currently implementing one of the world largest food aid programs - the National Food Security Act (NFSA) – in the course of which it experiences many challenges and needs rigorous analysis of the measures and tools of managing the system. Additionally, there is a strong international pressure on India to liberalize its policies in the food grain sector. The present dissertation studies various aspects of the food grain policies in India aiming to provide their comprehensive analysis.

We use econometric time-series techniques to ex-post evaluate the impacts of the policy measures on the market outcomes. Among other conclusions, we find a strong response of the wheat and rice production to the support prices whereas the rice consumption is mostly driven by the distribution of the subsidized grains. Due to protectionist trade policies, the grain export is so distorted that its volumes hardly correlate with the prices. We detect a clear upward trend in inflation adjusted fiscal costs, started in 2006-07, as a consequence of growing procurement, storage and distribution of wheat and rice.

We develop a dynamic partial equilibrium model with stochastic production shocks, based on the econometric results mentioned above. We produce mid-term simulations of different scenarios with possible policy measures to comply with the NFSA obligations based on the current, in-kind, system. We find that the high pressure on fiscal costs and public stocks, put by the NFSA, can be mitigated at the cost of higher and more volatile market prices. Our simulations indicate that a cash-based regime, alternative to the in-kind distribution, generates lower fiscal costs while the total stocks remain sufficient due to the increase of the private stocks. However, the higher market prices and volatility characterizing this scenario may negatively affect the producers, consumers, and the political stability.

Basing on household consumption data, by means of cross-sectional econometric techniques we analyze the consumption patterns of wheat and rice delivered through the Public Distribution System (PDS), targeting errors and reasons for leakage, self-selection and under-supply of staples. We find some serious targeting errors of the PDS: many poor households are not included in the system and migrant workers and female-led households are often not well covered. There is a negative self-selection of the richer households that results in cost savings, which would be lost under a cash-transfer scheme. We find that the leakage rates are in general very low for poor households and regions. Furthermore, we find that subsidizing increases the total consumption of wheat and rice. This increase, however, produces additional pressure on the prices that can have negative consequences for the poor excluded from the system because of the high targeting errors.

Zusammenfassung

Seit Indiens Unabhängigkeit haben umfangreiche Interventionen der Regierung den lokalen Getreidesektor stark beeinflusst. Indien hat sich von einem durch Hungersnöte gezeichneten Land zu einem der weltweit größten Exporteure, mit stabilen lokalen Preisen und mehreren Ernährungsprogrammen, entwickelt. Gleichzeitig gelten rund 15 Prozent der indischen Bevölkerung immer noch als unterernährt, trotz der großen Anzahl an Programmen gegen Armut, insbesondere Nahrungsmittel- und Ernährungsprogrammen. Die aktuelle Umsetzung des weltweit umfangreichsten Nahrungsmittelversorgungsprogrammes, dem *National Food Security Act* (NFSA), wird von vielen Hindernissen begleitet. Daher ist es notwendig potenzielle Maßnahmen, mit deren Hilfe man das System verwalten kann, intensiv zu analysieren. Desweitern ist Indien einem erhöhten internationalen Druck ausgesetzt ihre Agrar- und Handelspolitik zu liberalisieren, da das Land einen sehr großen Einfluss auf die Weltagrarmärkte hat. Diese Dissertation analysiert diverse Aspekte des indischen Nahrungsmittelsektors und der Getreidepolitik, und stellt somit weitreichende Analyse der Politik, den jeweiligen Interaktionen und Resultaten bereit.

Anhand einer ökonometrischen Zeitreihenanalyse untersuchen wir den Einfluss von politischen Maßnahmen auf die Märkte. Hier wird, unter anderem, herausgefunden, dass die Reis- und Weizenproduktion stark auf die vom Staat festgelegten, unterstützenden Preise reagieren, während der Reiskonsum hauptsächlich von der Austeilungsmenge von subventioniertem Getreide abhängt. Aufgrund Indiens protektionistischer Handelsregulationen sind die Exporte zu einem hohen Grad verzerrt und korrelieren daher kaum mit den Preisen. Seit 2006-07 gibt es folglich einen steigenden Trend in den inflationsbereinigten Fiskalkosten, begleitet von ansteigender Produktion, Lagerhaltung und Austeilungsmenge von subventioniertem Weizen und Reis.

Simulationsergebnisse eines *Dynamic Partial Equilibrium Models* mit stochastischen Produktionsschocks zeigen, dass der NFSA mittelfristig einen hohen Druck auf die Fiskalkosten und die öffentlichen Lagermengen ausübt. Unterschiedliche Managementstrategien führen zu *Trade-offs* zwischen den Marktpreisen, Fiskalkosten und der Gefahr von zu niedrigen Lagermengen. Ein Bargeld-basiertes Verfahren kann, verglichen mit einem Sachleistungssystem, die Fiskalkosten drosseln und dabei, aufgrund von stärkerer privater Lagerhaltung, aussreichend Lagermengen bereitstellen. Jedoch besteht in diesem Szenario die Möglichkeit, dass die hohen Marktpreise und Preisschwankungen einen negativen Einfluss auf Produzenten, Konsumenten, und die politische Stabilität haben.

Auf der Basis von Haushaltskonsumdaten, und anhand cross-sektionaler ökonometrischer Techniken, analysieren wir das Konsumverhalten von Weizen und Reis, welche durch Indiens *Public Distribution Systems* (PDS) zur Verfügung gestellt werden, die Erfassungsfehler des Systems, Gründe für Verlustraten sowie Selbst-Selektion und Unterversorgung mit Grundnahrungsmitteln. Die Resultate zeigen, dass das PDS hohe Erfassungsfehler aufweist: viele arme Haushalte sind nicht vom System erfasst worden, ebenso wie Wanderarbeiter und weiblich geführte Haushalte. Des Weiteren gibt es eine Selbst-Selektion reicher Haushalte, welche in Kosteneinsparungen resultiert. Diese würde in einem Bargeldtransfersystem verloren gehen. Ebenso finden wir, dass Verlustraten im Allgemeinen sehr niedrig sind für Arme und Regionen. Des Weiteren wird festgestellt, dass die Subventionen den Konsum von Weizen und Reis erhöhen. Dieser Anstieg übt jedoch zusätzlichen Druck auf Preise aus, was negative Konsequenzen für die armen Haushalte haben kann, die nicht vom System erfasst worden sind aufgrund der system-inhärenten hohen Erfassungsfehler.

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Table of Contents

List of Figures

List of Tables

Abbreviations

AAY	Antyodaya Anna Yojana Programme (Poorest of the Poor)
APL	Above Poverty Line
BPL	Below Poverty Line
CIP	Central Issue Price
DAC	Department of Agriculture & Cooperation
DFPD	Department of Food and Public Distribution
FCI	Food Corporation of India
GoI	Government of India
MIP	Minimum Issue Price
MOSPI	Ministry of Consumer Affairs, Food and Public Distribution
MPCE	Monthly Per Capita Expenditure
MSP	Minimum Support Price
NFSA	National Food Security Act
NSS	National Sample Survey
OMSS or OMSS (D)	Open Market Sale Scheme
OWS	Other Welfare Schemes
PDS	Public Distribution System
RBI	Reserve Bank of India
TPDS	Targeted Public Distribution System
WPI	Wholesale Price Index

1. Introduction[1]

> '*…it is imperative that we look at the entire system of food production, food procurement and the release and distribution of food. Trying to correct one segment of this complicated system is likely to end in failure.*' (Basu, 2011)

This dissertation explores the use of policies for food security in India, specifically, policies related to the Public Distribution System, procurement, and storage. India experiences persistent problems with undernourishment (United Nations, 2015), despite the large-scale food and nutrition interventions. Some of these interventions led to a WTO dispute (Brink, 2014). Further, India's trade policies significantly influence the world prices because of the high share of the Indian trade in the world markets (Anderson & Jensen, 2014). The current implementation by the Indian government of the world largest food aid program - the National Food Security Act (NFSA) - experiences many challenges and needs rigorous analysis of possible measures to manage the system. Additionally, there is a need to evaluate the alternative to the Targeted Public Distribution System (TPDS) regimes. While evaluating policy measures, this study focuses on food availability, including public and private stocks, food consumption, domestic and international market prices and fiscal cost.

1.1. Outline of the dissertation and research questions

In this chapter, we present a brief history of the transformation of the Indian food-grain sector and the government interventions since the 1940s, followed by the outline and the critique of the current policy framework. The aim is to set up a political economy perspective and understand the historical roots of the current system order to further analyze the problems and design the reforms.

[1] Fragments of this chapter were published as Saini, S., & Kozicka, M. (2014). Evolution and Critique of Buffer Stocking Policy of India. ICRIER Working Paper, 283(September) and Kozicka, M., Kalkuhl, M., Saini, S., & Brockhaus, J. (2015). Modelling Indian Wheat and Rice Sector Policies. ZEF-Discussion Papers on Development Policy, (197) and ICRIER Working Paper, 295(January).

In Chapter 2, the impacts of various food policies in India on market fundamentals are analyzed. This is a broad quantitative assessment based on time series econometric techniques. The research questions addressed here are:

- How do the major food-grain policies in India affect markets and fiscal costs?
- How can the major food-grain policies in India be modelled, i.e. are they endogenous or exogenous? Can they be represented by functional forms?

The study provides new insights into the scale and channels of impact of the government interventions on market fundamentals, in particular, on stocks, and links them to the fiscal costs. The study adds to the qualitative papers and quantitative analysis of the fragments of the food system in India (Gaiha & Kulkarni, 2005; Gulati & Sharma, 1990; Mythili, 2008; Umali-Deininger & Deininger, 2001).

In Chapter 3, a partial equilibrium model based on the results of Chapter 2, is used to simulate the impact of the implementation of the NFSA on market fundamentals and fiscal costs in the medium term – until 2020/21. These outcomes are compared across various policy strategies to comply with the NFSA obligations. Additionally, the policy regime change towards cash transfers in combination with deficiency payments is simulated. The research questions addressed here include:

- What are the implications of the implementation of the NFSA for prices, stocks and fiscal costs under different policy measures?
- How would prices, stocks and fiscal costs be affected by a regime change, i.e. by the implementation of cash transfers and deficiency payments instead of the physical grain procurement, storage and distribution?

This study extends the econometric analysis presented in Chapter 2 by simulating various policies with equilibrium price as well as analyzing counterfactual scenarios. The model is tailored to the Indian economy and relies on theoretical assumptions much less than the literature based on rational expectations models (like Gouel, 2013). It adds to the literature of simulation models by evaluating the NFSA implementation and comparing the NFSA with cash transfers. Moreover, the existing studies (Gouel, Gautam, & Martin, 2014; Jha, Srinivasan, & Landes, 2007) are extended by adding private stocks and taking

into account uncertainty coming from random production shocks. Further, it adds to the literature which calculates costs of the implementation of the NFSA (Kishore & Chakrabarti, 2015; Mishra, 2013; Pursell, 2014) by considering partial equilibrium effects.

Finally, Chapter 4 scales the focus down to a household level in order to analyze, using the National Sample Survey data, the consumption patterns of the Public Distribution System grains. The focus is on targeting errors and reasons for leakage, self-selection and under-supply of staples. Further, impact of the subsidy on market grain consumption is quantified.

The research questions addressed in this chapter are:

- How efficiently does the PDS cover the poor and the traditionally underprivileged (*e.g.* scheduled castes)?
- What is the scale of under-purchase in different card type groups?
- What are the reasons for it (supply constrains or demand reasons)?
- What is the impact of the Public Distribution System wheat and rice subsidy on total wheat and rice consumption?

The study provides a thorough quantitative analysis considering India as a whole. To our knowledge, this is the first empirical study of the various targeting errors and reasons for under-purchase on the all-India level. We add to the studies carried out on a smaller scale of selected states (Dhanaraj & Gade, 2012; R. Jha, Gaiha, Pandey, & Kaicker, 2013; Khera, 2011a). We also provide new insights into analysis of leakage from a food subsidy program (Drèze & Khera, 2015; Mehta & Jha, 2014). The results further contribute to the growing evidence that the PDS crowds in consumption of wheat and rice (Kaushal & Muchomba, 2013; Khera, 2011a; Shaw & Telidevara, 2014).

Chapter 5 draws the main findings together and proposes policy implications and further research.

This dissertation contributes to the discussion about the role of food policies in improving food security in India. Empirical grounding, comprehensible results and a political economy perspective distinguish this work. It provides a detailed and differentiated analysis that can be highly useful for improving the current system as well as for the design

of an alternative cash-based system. The relevance of our results has been recognized by Dr. Ashok V. Desai in his article published in the Telegraph (Desai, 2015) and cited by Sunil Jain in the Indian Express (Jain, 2015).

1.2. Evolution of Indian food-grain sector

Traces of the government intervention in providing relief to the needy in times of distress (famines, scarcities and crop failures) can be found in India already in the 15th century. The roots of the food grain policy with food grain reserve as its essential part dates back to the great Orissa famine of 1865-67 (Acharya, 1983). However, until about the first half of the 20th century, there were limited or no physical stocks of food grains maintained by the government. As a result, there were no government interventions in the market and prices of food grains were determined by the market forces. Markets, however, were functioning poorly. Sub-markets were weakly integrated and due to poor infrastructure, movement of grains from the surplus to the deficit areas was disrupted. Domestic demand was largely relying on imports. Consequently, domestic prices were characterized by high volatility. These factors combined with a high level of undernourishment and poverty resulted in frequent food crises (World Bank, 1999).

World War II affected food imports and the transportation system in the country, leading to the collapse of the free market system and a food crisis. Due to a drastic fall in production and a crippled grain market with restrictions on grain movements, more than two million people died of starvation in the Bengal Famine of 1942-43 (Padmanabhan, 1973). These events led to the creation of the Food Department (December 1942) at the central level. The period marked the beginning of the transition from reliance on the private sector to one establishing complete government monopoly in the procurement, storage and distribution of food grains.

The government introduced administrative controls, monopoly procurement and public distribution during 1943-47. The Public Distribution System (PDS), whose basic principles were laid in the 6th Price Control Conference held in September 1942, is regarded as one of the most stable elements of India's food policy. The central objective of the system in the beginning was stabilization of prices, and the focus of food distribution was the urban

and food deficit areas. The PDS has substantially helped protect the urban poor from a rapid rise in food grain prices.

The government purchased food grains from the markets at two prices. These were support prices and procurement prices, which differed in their levels and time of announcement. Support prices, declared before planting, were to provide strategic production incentives to producers and ensure stability in price and farm income around certain minimum levels. Procurement prices were declared for crops, mainly rice and wheat, for which the government had to undertake procurement to meet the PDS needs. These prices were announced at the beginning of each marketing season and maintained for the entire year. Such procurement was done from producers, traders and millers, more often on a voluntary basis but sometimes, with an element of compulsion.

While in the 1940s, the focus of buffer stocking operations was on the urban and food-deficit areas, in the 1950s, the focus on welfare led to the extension of these operations to the rural areas. The Constitution of India (1950) explicitly stated that the state "… shall regard the raising of the level of nutrition and the standard of living of its people, and the improvement of public health as among its primary duties". Likewise, after the adoption of planned development in the 1950s, the idea of economic growth with social justice (Article 47) became the guiding principle for India's economic policy formulation and the country adopted the so-called socialist pattern of society in 1955. The government introduced monopoly control over inter-state grain movements. State-zones were created and licensing was widespread to curb private trade. The Essential Commodities Act was passed in 1955, marking the increased regulation of the production, supply, distribution and trade of the essential commodities. Licenses and permits were used for this purpose.

In the mid-60s policy goals focused on price stabilization, elimination of hunger, and government involvement in grain markets to curb speculative trade. Both the Food Corporation of India (FCI) and Agriculture Prices Commission (APC) were set up in 1965 to secure a strategic and commanding position for the public sector in food grain trade. In order to create a stable environment for farmers to adopt new production techniques and inputs, government got involved in the food grain marketing of the country. These

intensified government interventions in the food sector brought about the beginning of the Green Revolution in India the 1960s. Since the 1970s, India has never been a big importer of wheat. This period marked the country's ability to link buffer stocks with local surplus production of food grains, unlike earlier when a buffer stock was created from imported grain only. It was during the Fourth Five-Year Plan that the creation of a food-grain buffer stock of adequate size as a central feature of food policy (figure 1) was introduced.

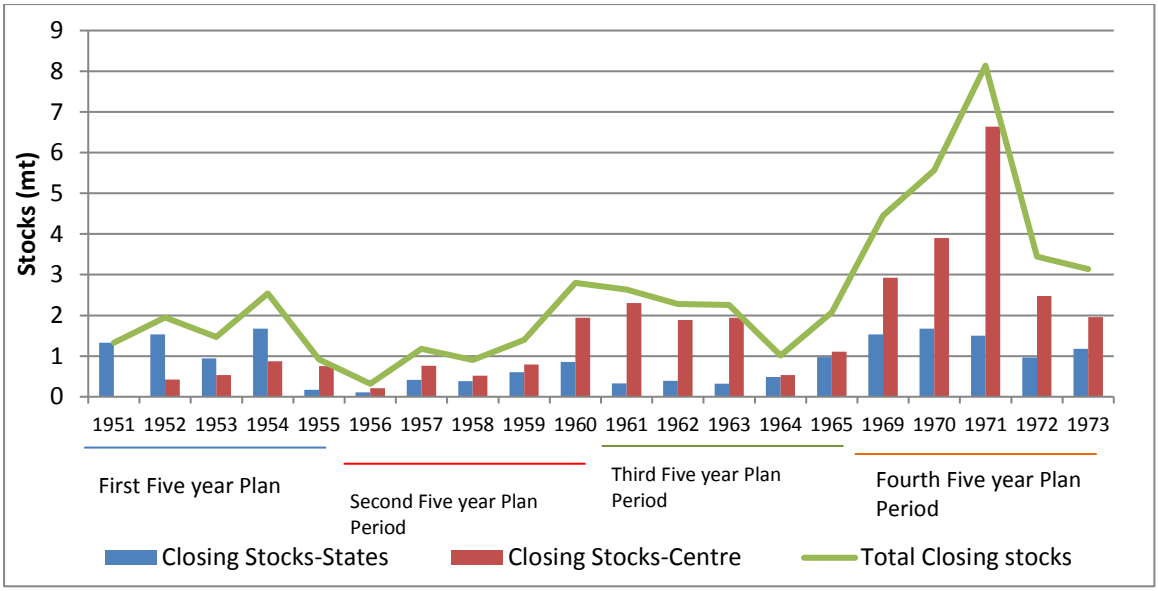

Figure 1 Stocks of food grains: 1951 to 1974

Source: (Chopra, 1981) Based on Bulletin on Food Statistics 1977; ESA, Ministry of Food and Agriculture, New Delhi, p.33. Reprinted in Chopra (1981 p.289)

As declaring procurement prices after sowing did not influence production decisions, the policy was revised and for the first time procurement prices were announced before the sowing period in 1978-79. This practice continues until now. Since the support prices also acted as procurement prices in the wake of an open-ended procurement drive, the distinction between support and procurement prices disappeared eventually. Until now, the government announces only the Minimum Support Price (MSP). The central government provides price support to paddy, wheat and coarse cereals through the Food Corporation of India (FCI) and state governments participating in the decentralized procurement program (DCP) and state agencies who buy all the offered-for-sale food grains, provided the grain conforms to prescribed specifications. As a policy, the procurement operations of the FCI are largely limited to rice and wheat. The procurement for both rice and wheat is open-ended, although there are indicative targets set before

each season. The producers of the grains have the option to sell their produce to the FCI/state agencies at the support prices or in the open market. Rice was collected by way of statutory levies on rice millers and rice dealers. The levy percentage varied between states. In October 2015, the levy program was discontinued.

The norms and composition of the FCI stocks are evaluated under two heads: operational and strategic. The government fixes the buffer stock norms, prescribing the minimum quantities of food grains (wheat and rice) to be maintained in the central pool at the beginning of each quarter, namely for January, April, July and October. FCI maintains stocks of grains in excess of what is required for meeting operational needs, and these stocks are called strategic stocks. These are maintained for ensuring price stability in the country and for meeting any exigent grain requirements.

As agricultural production had grown in the aftermath of the Green Revolution, the outreach of the PDS was extended to tribal blocks and areas with a high incidence of poverty in the 1970s and 1980s. Until 1992, the PDS was a general entitlement scheme for all consumers without any specific target. The 1991 hunger deaths in mostly the tribal areas in the country led to the formation of a Revamped PDS (RPDS), which propagated the adoption of an area approach, i.e. people living in the disadvantaged areas, mainly hilly, tribal, drought prone and desertified areas were identified and were designated to benefit from the RPDS. Both the PDS and RPDS were criticized for their failure to serve all the poor and the lack of transparency. Consequently, the Targeted Public Distribution system (TPDS) was introduced in June, 1997. Unlike the RPDS, which targeted “all in the poor areas”, the TPDS would target the “poor in all areas”. The new system identified the poor people across the country and provided them rationed quantities of essential commodities (mainly grain, sugar, kerosene etc.) at subsidized prices.

The Antyodaya Anna Yojana (AAY) program was launched in December, 2000, which was an extension of the TPDS and aimed to reduce hunger among the poorest segments of the below poverty line (BPL) population. As on December 31, 2013, 24.3 million families had been issued AAY cards by states/union territories (UTs).

The TPDS is operated under the joint responsibility of the Central and the State Governments. The Central Government, through the Food Corporation of India (FCI), is

responsible for procurement, storage, transportation and bulk allocation of food grains to the State Governments. The operational responsibility including allocation within the state, identification of eligible families, issue of the Ration Cards and supervision of the functioning of Fair Price Shops (FPSs) etc., belongs to the State Governments.

The Government of India makes allocations of food grains to three categories of beneficiaries under the TPDS, namely AAY, BPL (Below Poverty-Line) and APL (Above Poverty Line). Thirty-six per cent of the Indian population is identified as BPL. The entitlements differed between these three categories of beneficiaries. Since 2002, the scale of issue to the APL, BPL and AAY categories has been revised and made uniform at 35 kg/family/month for all. Grains under such schemes are released to the beneficiaries at highly subsidized rates called the Central Issue Price (CIP). Allocations are made to the BPL families at the subsidized rates of Rs. 4.15/kg for wheat and Rs. 5.65/kg for rice since July 25, 2000. Ever since the introduction of the AAY scheme in 2000, allocations to these families are made at the even more highly subsidized rates of Rs. 2/kg for wheat and Rs. 3/kg for rice. At the time the TPDS was introduced, the allocations to the APL families were made at the CIP, which was equal to the economic cost of the grains. However, the CIPs for the APL have been Rs. 6.10/kg for wheat and Rs. 7.95/kg for rice since July 7, 2002, which have been consistently lower than the associated economic costs. The CIPs have not been revised for the BPL and AAY families since July 25, 2000, and for APL since July 1, 2002.

The TPDS is one of many other food-related schemes run by the central government (center) and different states/Union Territories. The TPDS has the highest number of beneficiaries (243.7 million ration cards issued by 2014 (DFPD, 2014), with a very high level of grain distribution commitment (in 2012-13, close to 52 million tonnes of grains was allocated for distribution under TPDS). There are several other welfare schemes[2] run by both the center and the states, which differentiate and target beneficiaries based on their age, levels of nutrition deprivation, etc. Moreover, amongst others the entitlements

[2] Apart from meeting the grain needs under TPDS, the Central government also procures and distributes grains under other welfare schemes, like Mid-day meal scheme, Wheat-based Nutrition Scheme among others. There are in total 7 such schemes together addressed as Other Welfare Schemes (OWSs).

include cash, raw food grains, pre-cooked/hot-cooked meals and other essential commodities like pulses.

1.3. The National Food Security Act

In September 2013, the National Food Security Act (NFSA) was passed, which *i.a.* provides a legal right to highly subsidized food-grains for eligible households. The Act brought under its ambit many of the existing food-distributing welfare schemes run by the central government of the country, including TPDS. Under this, the three categories of beneficiaries are replaced by only two categories, namely AAY and priority. The latter is supposed to include the existing TPDS-BPL beneficiaries, unless they are found to have crossed the poverty threshold. The Act aims to provide food security to 67 per cent of the country's population (75 per cent of the rural population, and 50 per cent of the urban population) by distributing a fixed quantity of subsidized grain to them every month - with an entitlement of 5 kg per person per month of food grains. The AAY households will receive 35 kg per household per month. The NFSA freezes the issue prices at Rs. 2/kg for wheat and Rs. 3/kg for rice for all identified beneficiaries for three years (Gulati & Saini, 2014).

Implementation of the NFSA means that 61.2 million tonnes of cereals will be distributed through the PDS. As a result, buffer stock norms need to be adjusted in order to feed increased distribution needs. As estimated by Gulati and Jain (2013), the new buffer norm for July 1 for rice and wheat jointly, needs to be increased to 46.7 mt from the current to 31.9 mt. Higher stock requirements and the legal entitlement to subsidized food grains under the NFSA, mean that upward deviations from new norms are very expensive (as even fulfilling the norms results in high costs) while falling below the norms implies the risk of being unable to meet requirements under the act.

Within the first year of its implementation, 11 Indian states/union territories (UTs) have implemented the Act. The remaining states were given several extensions and the current estimates suggest the full implementation by April 2016 (Das, 2015).

1.4.Conceptual framework

The Minimum Support Price (MSP) — the Indian government intervention in rice and wheat production— is announced before rice and wheat planting starts. Grains are unboundedly procured from farmers with the guaranteed MSP, which covers production costs and a "reasonable" margin for the farmers. The procured grain is stored as buffer stocks—consisting of operational and strategic stocks. Grain is distributed to the poor at the strongly subsidized Central Issue Price (CIP) through the Targeted Public Distribution system (TPDS) and Other Welfare Schemes (OWS). The stock norms indicate the need for the system to meet the requirement of the TPDS and OWS and to stabilize supply. Excessive stocks can be either released to the market through the Open Market Sales Scheme (OMSS) or exported, with exports and imports being concessional. OMSS tenders are floated for bulk orders and/or an over-the-counter sale is executed for smaller quantities for retail traders. An ad hoc Minimum Issue Price (MIP) is set for these sales. The MIP, to prevent resale, is higher than the current MSP and usually covers the acquisition cost of grains. Most of the operations are conducted by the Food Corporation of India (FCI), a parastatal agency. There are also trade regulations and private stock limitations used on an ad hoc basis to increase domestic availability, isolate domestic prices from international prices or boost public procurement.

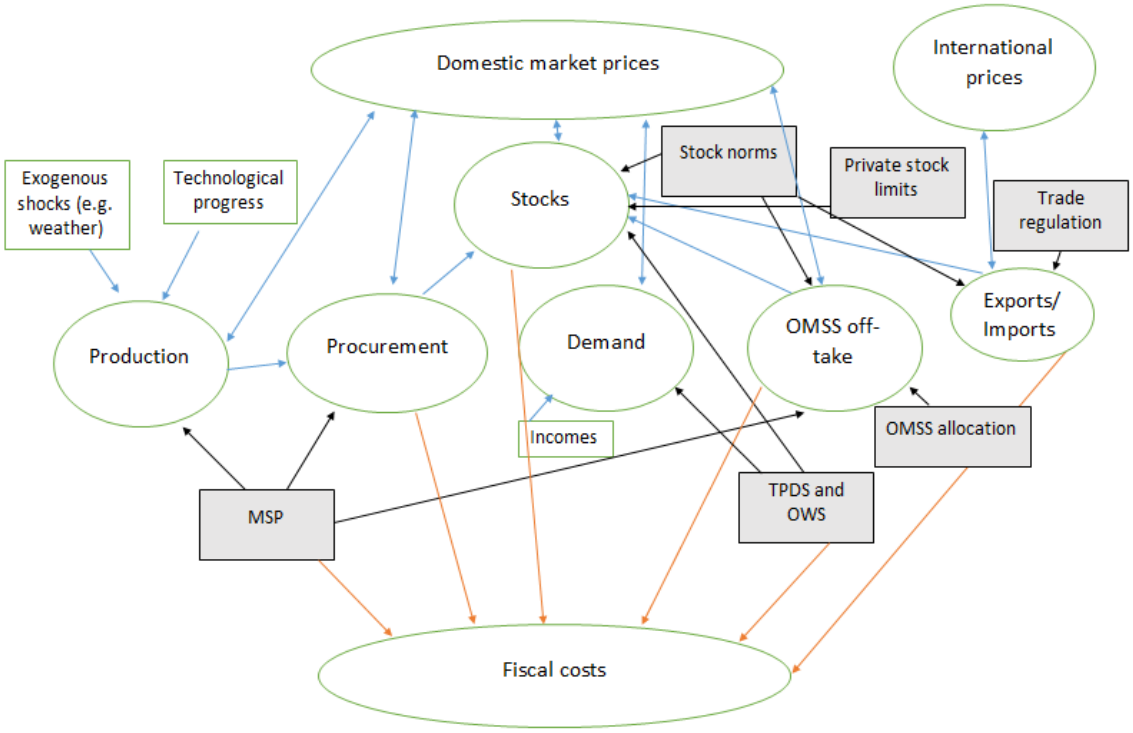

Figure 2 Modeling framework for the Indian Wheat and Rice Sector

Source: Own illustration

Note: The oval shapes indicate the endogenous variables in the system, the rectangular shapes are restricted for the exogenous variables and the grey shaded shapes refer to policy variables. The red arrows are related to the fiscal costs, the dark arrows symbolize the impact of exogenous policies of interest and the remaining interactions between the variables are represented by the blue arrows.

Figure 2 shows a graphical representation of our modelling approach to the Indian wheat and rice sector. The main variables of interest – prices, stocks and fiscal costs – are influenced by several endogenous and exogenous variables and directly as well as indirectly by policy measures.

Total production is shaped by expected output prices (Nerlove & Bessler, 2001), which is the current MSP and the upcoming marketing year market prices. Other exogenous factors, like weather, also play an important role in the quantity produced. International prices do not affect production decisions directly, but they influence domestic prices through the net exports, which further impact the total market availability. The net exports are decided by the interplay of the domestic and international prices combined with the trade regulations. Although it is not shown explicitly in figure 2, we distinguish between public and private exports, as public exports are more substantially driven by policy measures. Further, international prices respond to Indian net exports as India

contributes a significant amount to the global rice market. The public stocks, or rather changes in public stock levels, are shaped by inflows – that is, the public procurement; and outflows that include OMSS, TPDS and OWS[3] off-takes and exports. Private stock formation follow the competitive storage model, that is, stocks are driven by price expectations of the private stockholders (Williams & Wright, 1991). Additionally, the stock levels are affected by private stock limits. We consider private and public stocks separately, even though they are jointly represented in figure 2.

The part of marketable surplus sold to the government (that is, the public procurement) depends on the difference between the open market prices and the MSP. Additionally, it is affected by regulations, such as levy (Gulati & Sharma, 1990), infrastructure, and quality of institutions. Unfortunately, these exogenous factors are impossible to quantify or aggregate to the all-India level – for example access to the markets or corruption. As a result, in our model, procurement is a function of the production level (a proxy for the marketable surplus) and the difference between the MSP and the market price. OMSS off-takes depend on the exogenous policy variable - OMSS allocation, which defines the upper limit of the off-take. The actual level of off-take depends on the MIP and the market price, as the difference between these two determines the demand for the OMSS grains. Because MIP is always above the MSP, the current MSP affects the OMSS sales. All the domestic releases (OMSS and PDS) and procurement shape the market availability of wheat and rice, thereby affecting their market prices. Not only is consumption of wheat and rice dependent on their market prices and consumers' income levels, it is also affected by the quantity consumed from the PDS and the subsidy level (Deaton, 1981). Eventually, the fiscal costs are formed by the procurement level multiplied by the MSP plus some variable operational costs, costs of carrying the stock and distribution of the PDS grains. The revenue is generated from the sale of the PDS grains (that is, the CIP and the volume of the PDS distribution), and from the OMSS and public exports.

1.5.Critique of the system

The government's official food subsidy bill has been rising steadily from less than 0.4 per cent in the early 1990s to around 0.8 per cent of the GDP in recent years (figure 3). Apart

[3] TPDS and OWS will be jointly referred to as PDS.

from this direct cost borne by the government, there are additional costs, which arise from leakages, illegal diversion of food grains, and significant wastage due to poor storage and transport facilities (Shreedhar, Gupta, Pullabhotla, Ganesh-Kumar, & Gulati, 2012). Even though there is no consensus on the exact numbers of the leakage, the scale is undoubtedly high – even the lowest estimates report above 41% leakage in 2011-12 (Drèze & Khera, 2015; Gulati & Saini, 2015). The scale of storage losses is even less known. Different estimates quote aggregate losses (post-harvest annual loss of grain), starting from 16-17 million tonnes up to 55 million tonnes, which roughly means 7 per cent to 23 per cent of total production (Artiuch & Kornstein, 2012). FCI reports give not more than 0.4 per cent of the average stock level in the central pool in the corresponding years. Extreme inefficiency of the system was revealed by the Planning Commission report, which stated that Government of India (GoI) spent Rs. 3.65 for every 1 rupee of benefits received by beneficiaries (GoI, 2005).

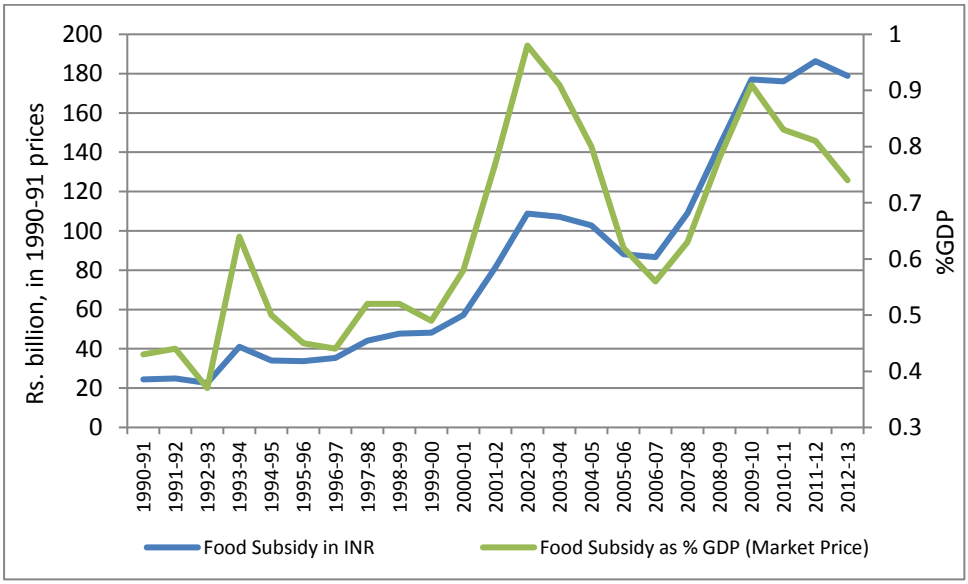

Figure 3 Food Subsidy as paid by the Government of India

Source: Planning Commission, GoI

Note: Real values obtained by adjusting for the Wholesale Price Index (December of the corresponding year value, Dec 1990=100)

Buffer stock of food grains, at any point in time, is determined by the interlinked factors: the carryover stock, the level of procurement by the central and by the state governments, the level of distribution, and the export and import volumes. As a result, stock levels are difficult to manage and they often significantly deviate from the stock norms and even exceed the storage capacity (figure 4).

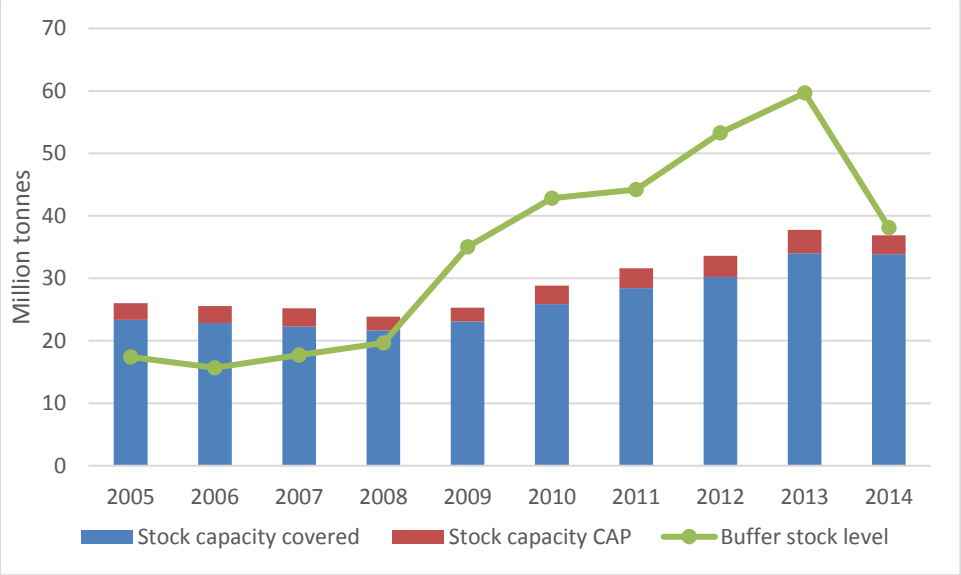

Figure 4 Buffer stocks of wheat and rice vs. stock capacity in India
Source: FCI

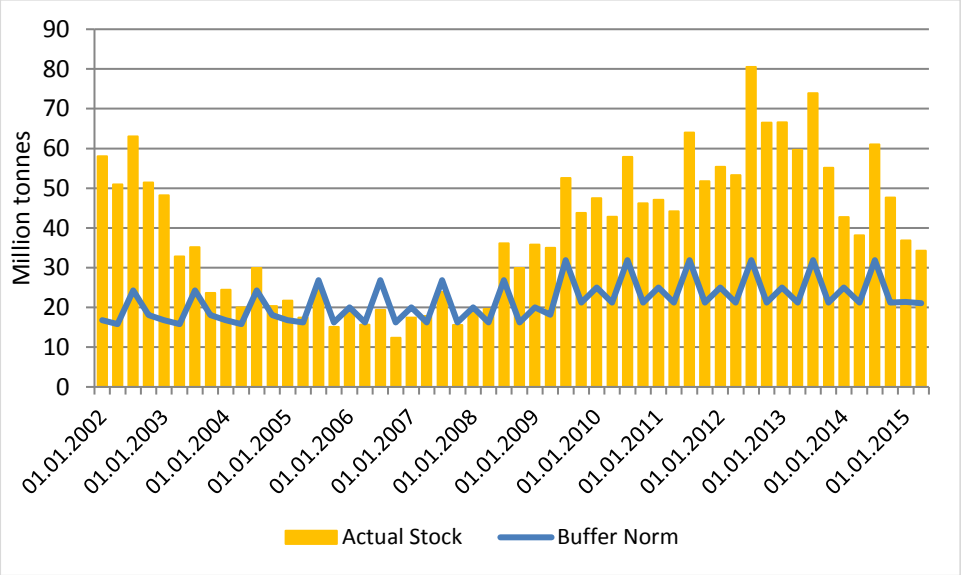

Figure 5 Buffer stocks of wheat and rice vs. stock norm in India
Source: FCI

The open-ended character of procurement, trade restrictions and high level of MSP led to a growing share of public procurement – close to 50 per cent of the marketed wheat and rice were procured by the government in the recent years. The absence of clear rules to release surplus stocks further resulted in mounting stocks (figure 5) and high food inflation (Gulati & Saini, 2013). The combination of high public stocks and limits to private stockholding under the Essential Commodities Act led to a marginalization of private stocks (Kozicka, Kalkuhl, Saini, & Brockhaus, 2015).

The current system is further criticized for skewing production towards wheat and rice (Banerjee, 2011; CACP, 2013), which hinders poverty alleviation (Birthal, Roy, & Negi, 2015), as well as not accounting for consumer preferences (Muralidharan, Niehaus, & Sukhtankar, 2011) and skewing consumption to wheat and rice away from cheaper and more nutritious coarse cereals (Gulati & Saini, 2013). Tying eligibility to a single FPS also limits effectiveness of TPDS in providing food security to migrant workers and their families.

Indian government is also actively involved in regulating international trade, for example by imposing selective export bans and zero import duties, which fuels international food price spikes and volatility (Anderson, Ivanic, & Martin, 2013; Anderson, 2013). In fact, this trade policy may also harm Indian farmers – the domestic price, especially of rice, has often been much lower than the international price, indicating a net taxation of Indian farmers and adding to the 'bill' of foregone benefits from trade (see also Anderson, 2013).

There is an international pressure on India to reform its food sector because of its impact on world market prices (Mitchell, 2008). The contribution of Indian export bans on rice and wheat to the world food price spikes during the 2007-2008 world food crises has been criticized by the international community. The recent prorogation of the implementation of the WTO Agreement on Agriculture (AoA), which limits support for farmers to 10 per cent of the value of production, is only a temporary solution and indicates the inevitable change of the political paradigm towards a more market-oriented approach (R. Kumar, Bagaria, & Santra, 2014).

Domestically, given the high cost generated by the PDS and the potential benefits of improving the food security and nutrition by better targeting, less leakage and a change in consumer behavior, there is a growing support from both policy makers and researchers (S. Jha & Ramaswami, 2010) of reforming the system in direction of a cash based schemes. The High Level Committee on re-structuring of Food Corporation of India set up on 20th August, 2014 made a clear recommendation to deeply restructure the system and among other reforms, to gradually roll-in cash transfers (S. Kumar, 2015). The Committee argues that the agricultural landscape in India has changed dramatically since the 60s when the FCI was created. The goal of self-sufficiency has been achieved and the

current food management system “has not been able to deliver on its objectives very efficiently”. The proposed reform aims at reaching many targets: benefiting larger number of farmers and better serving the economically vulnerable consumers in a financially sustainable manner; and optimizing stocking policies in order to efficiently and cost effectively feed PDS and stabilize grain markets. The former Chief Economic Advisor to India's Ministry of Finance and currently the World Bank's Chief Economist, Kaushik Basu in his paper on Foodgrain Management in India (Basu, 2010) criticized the current system for failing to provide support to neither the farmers not the consumers. He clearly speaks in favor of cash transfers or food coupons which would cut on leakage and inefficiencies.

2. Quantitative assessment of food-grain policy measures on market fundamentals[4]

This chapter attempts to unravel the major linkages between policies and markets for wheat and rice. It describes and analyses different fragments of the system to explain the endogenous components in figure 2. The policies in focus are procurement, storage and distribution (with market sales and exports) policies and the major variables of interest are stock levels, market prices and fiscal costs. As this model requires a consistent representation of macro-variables close to Indian reality, we focus on national aggregate variables from 1982 to 2013. Hence, our basic method of analysis will be a time-series analysis of the economy-wide variables indicated as ovals in figure 2.

2.1. Literature review

An analysis of the Indian rice and wheat sector policies has not received much attention in the last years. A few studies analyzed particular aspects or policies in isolation. For example, Jha et al. (2013) studied determinants of real income transfers through subsidized wheat, rice and sugar based on primary data collected in Andhra Pradesh, Maharashtra and Rajasthan. They found several inefficiencies and targeting errors of the TPDS and point at a high probability of exacerbation of these issues with introduction of the NFSA. Sharma (2012) focused on the cost of the system – the food subsidy as generated by the Food Corporation of India (FCI) after 1991. The results suggest that despite the growing cost of food subsidy, there have been improvements in the operational efficiency of the FCI. For example, share of administrative charges of procurement costs, and storage losses have declined during the last decade. An earlier study on FCI performance by Swaminathan (1999) also found that FCI improved its efficiency during the 1990s. By comparing wholesale market prices with economic costs of the FCI he found that in many states, the FCI was more competitive than the private sector. A broader policy analysis, evaluating the effects on production, productivity, accumulation of stocks, prices and exports, was conducted by Gaiha and Kulkarni (2005).

[4]Fragments of this chapter were published as Kozicka, M., Kalkuhl, M., Saini, S., & Brockhaus, J. (2015). Modelling Indian Wheat and Rice Sector Policies. ZEF-Discussion Papers on Development Policy, (197) and ICRIER Working Paper, 295(January).

This study is much more critical of governmental action. One of the findings by the authors was that agricultural subsidies hindered food grain productivity growth by constraining public investments in agriculture. They also found that minimum support prices (MSP) have a positive impact on procurement and stocks of wheat and rice. What is more, a higher MSP increases the wholesale price, which in turn leads to an increase in consumer prices. Umali-Deininger & Deininger (2001) studied a range of wheat and rice sector policies. They used aggregate and household level data to show that the system was costly and generated inefficiencies. The grain management costs grew between 1980 and 1999 much faster than the volume of operations probably due to rising bureaucracy, storage and transportation losses. Unpredictable market intervention and overregulation surprised the private sector. What is more, it was not beneficial to a majority of the poor. They proposed several reform options within the current system, that is, without any significant structural changes. An earlier study by Gulati and Sharma (1990) analyzed the impact of procurement price on open market prices, procurement and output. The authors found that procurement prices are the major factor driving market prices while the procurement volume was affected by the output level and the difference between procurement and market prices.

There are several studies that have looked at the demand and supply response to price changes. Mythili (2008) used dynamic panel data model to analyze the supply response of major crops before and after the reforms of the early 1990s. The study revealed that after 1990, production response to prices (farm-gate prices were taken into consideration) has increased and that farmers are more elastic in their non-acreage inputs. Most of the food grain demand analysis in India is based on household consumption estimates based on the National Sample Survey (NSS) data, collected by the Ministry of Statistics and Programme Implementation. The comprehensive study of wheat and rice demand and supply can be found in Ganesh-Kumar et al. (2012). The demand model was also estimated based on the NSS data. Production was modelled in two ways – as aggregate with the Cobb-Douglas production function and as a product of separately modelled yield and acreage. In both approaches, the ratio of own price to prices of competing crops was one of the explanatory variables.

Since food inflation has been persistently high in the last few years, there have been a few studies that analyzed the cause of rising food prices in the context of food price stabilizing policies. Dasgupta et al. (2011) conducted an econometric analysis of wheat price formation in India. The results suggest that the domestic price is only "moderately" affected by international prices; in addition, public stocks have virtually no impact on wheat prices in India. The authors conclude that "public stocks are rarely used effectively to stabilize wholesale market prices of wheat in India". Gulati and Saini (2013) found that the fiscal deficit, rising farm wages and international prices had a significant impact on food inflation in India.

The current chapter adds to the literature by providing a comprehensive overview of all the major policies of the food grain sector currently used in India, along with the quantitative assessment of their impacts on the markets and contribution to the fiscal costs.

2.2.Policies, their measures and outcomes

2.2.1. Prices

In order to understand what determines demand, supply and storage, we need to find out the prices paid to and received by different actors in the market. Regulated prices like the MSP, the MIP and the CIP are usually set by the center and differ only slightly at the state level.[5] They, however, influence market prices due to the high level of government involvement. The market prices include wholesale prices and retail prices. Regulated and market prices can be grouped as follows: the MSP, MIP and wholesale price as producer and trader prices and CIP and retail price as consumer prices.

Market prices differ a lot with their levels (price time series from selected markets can be found in Appendix 2) due to the state specific environment (like the efficiency of

[5]Unfortunately, these state-level differences are difficult to track, especially in a historical perspective. For example, bonuses to the MSP are sometimes used by local governments but data on them is rarely available. Even bigger issues are the institutional differences between states – like the almost universal coverage of the TPDS in Kerala, or extremely high level of leakages in Bihar. Furthermore, the procurement efficiency of the FCI/state level procurement agencies is not uniform in all states across the country. They function relatively better in a few states (Punjab, Haryana, parts of Andhra Pradesh and in recent years, also in Chattisgarh) but are mostly ineffective in others (Bihar, Orissa, etc.). As the purpose of this study is to assess the impact of central policies on the all India aggregate outcomes, considering these state-wise differences would bring too much complexity to the analysis and the model would lack transparency.

procurement or state-specific bonuses to the MSP and taxes), however they clearly show common trends. Acharya et al. (2012) found, for both wheat and rice, integration of prices across different levels of marketing – wholesale, retail and primary market, as well as spatial integration of markets – retail, wholesale and primary market prices across different geographical areas. This is important for analyzing the relationships between the variables, as production and consumption levels in different states vary significantly. For the purpose of our analysis, which deals with all-India yearly aggregates, we need to consider a weighted price average that reflects market forces and influences the decisions of different actors.

We, therefore, use commodity-specific wholesale price indices (wheat and rice components of the wholesale price index (WPI)), which capture the overall demand and supply conditions of the food market. Its components are trade-weighted average prices, collected from many markets and it is available on a monthly basis (see Appendix 3 for data sources). Based on this monthly index, we calculate average price dynamics for different periods, corresponding with the times when our endogenous variables are determined. For example, to analyze production determinants, we used averages for harvest months, planting months and marketing year, which are different for wheat and rice. Marketing year averages are also important for demand analysis.

The disadvantage of using the components of the WPI is that they do not provide the actual price levels, only the price dynamics. This is not an issue for the regression estimation; however, to analyze differences between regulated and open market prices, we needed to reproduce the wholesale price level. To do so, we calculated a production weighted average price of wheat and rice from major markets for the last four years. Next, using the respective WPI components, we reproduced the price levels backwards.[6] As a result, we obtained the monthly all-India wholesale price of wheat and rice. Then, for different purposes, different averages of these monthly prices were created. For production, the prices during the harvest, planting and marketing year were considered, which, in the case of rice, were weighted according to the production share in kharif and

[6] The WPI components are less volatile than market prices from major grain-producing states (see Appendix 1 for comparison of price averages).

rabi seasons[7]. For consumption, the marketing year average price was used. As the representative international price, the International Monetary Fund quoted prices were used. For wheat 'No.1 Hard Red Winter, ordinary protein, FOB Gulf of Mexico, US$ per metric ton' and for rice '5 per cent broken milled white rice, Thailand nominal price quote, US$ per metric ton', were used. Both were converted to rupees at the current exchange rate. In order to obtain real prices, all nominal prices are WPI deflated.

The comparison of the derived price time series is presented in figure 6 and figure 7. An interesting trend observed, both in the wheat and rice markets, is the narrowing gap between the MSP and wholesale prices. This came as a result of an aggressive procurement policy in response to the international price boom in 2007-08. At the same time, market prices remained stable in real terms. However, even though the gap between MSPs and the wholesale prices has narrowed, procurement prices remained clearly below market prices (with a one-year exception for wheat). This could suggest that MSP successfully protects the lower bound of the prices. Market price should be close to MSP at harvest in net producing states and rise with time and distance due to storage and transportation costs. However, the wholesale price used in this study is the average from different markets across India and so includes, for example, transportation costs. This is why even the harvest price has been usually well above MSP. In fact, in some states with ill-functioning procurement, the market price often drops below MSP (for example Patna prices in Appendix 2). This fact will be used in analyzing procurement level determinants in subsection 2.2.3.

It is also clear that domestic prices in India were successfully protected from international price fluctuations, avoiding the up and down swings in the mid-1990s and during and after the 2007-2008 food crisis. Domestic wheat prices, except for the few years when the world price spiked, were above international prices, whereas domestic rice prices for most of the time remained below international values. For both grains, however, the difference between the domestic and international price was high after the export ban in 2007-08. This could mean that trade policies, on the one hand, protected farmers from the international price fluctuations, but on the other, subdued domestic prices. As a result,

[7] Harvest months for wheat are March-May and for rice, October-December for the kharif season and March-June for the rabi season.

procurement was ample, and even excessive, with relatively low MSP. However, for the Indian farmers this policy measure meant foregone benefits from trade.

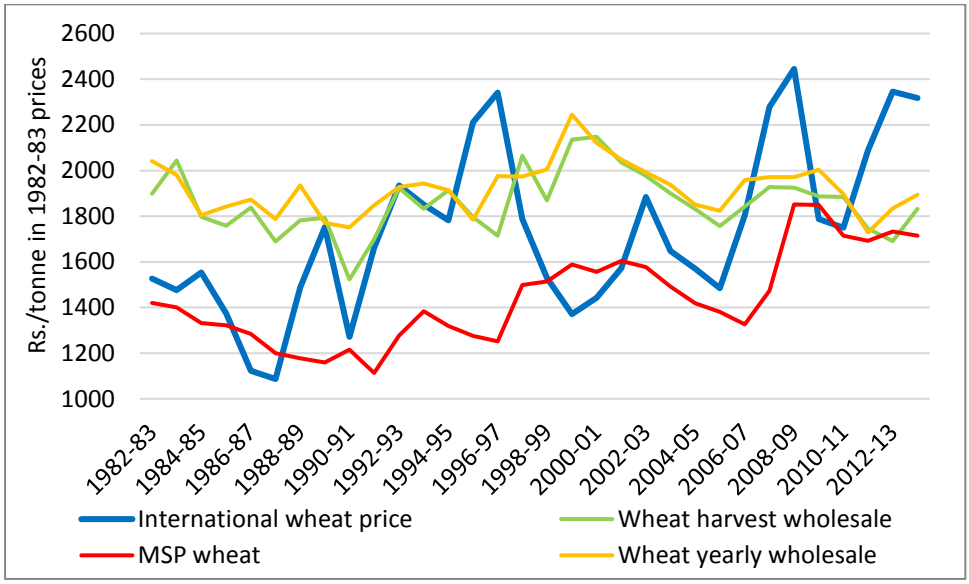

Figure 6 Wheat producer prices

Source: Own design based on data from RBI, DFPD, DAC, IMF and FED

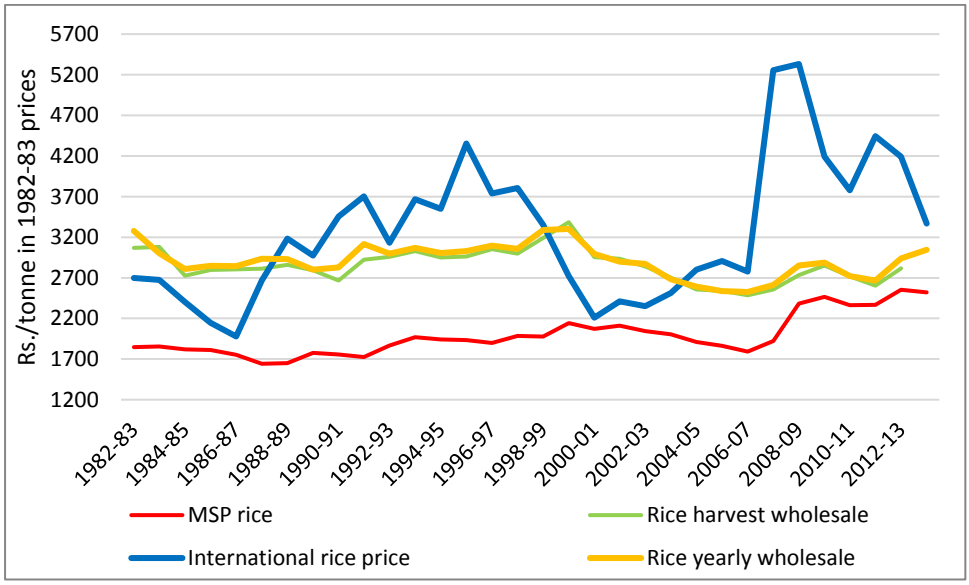

Figure 7 Rice producer prices

Source: Own design based on data from RBI, DFPD, DAC, IMF and FED

Note: For scaling factor, to convert paddy to rice, we used 0.66. International price is a corresponding marketing year average.

Wheat wholesale market price (both harvest time and yearly average) changes are only slightly correlated with MSP changes (table 1). For rice, all three prices, i.e., the MSP, and the two market averages are strongly correlated, which can be attributed to better functioning institutions (more efficient procurement, less leakage) in the 'rice' states than in the 'wheat' states (Khera, 2011a, 2011b). Besides, in the case of rice, a higher share of

marketed surplus is procured as compared to wheat. This means that the rice market is actually more regulated. In both cases, MSPs are positively but weakly correlated with respective international prices. This is probably because one of the factors considered for recommending the MSP by the Commission for Agricultural Costs and Prices is the international market situation (Saini & Kozicka, 2014). Domestic wholesale prices are weakly positively correlated in case of rice and weakly negatively, in case of wheat market. This is in line with findings of Acharya (2012) that there is no cointegration of international and domestic prices and there is no congruence between them.

	Wheat				Rice			
	MSP	**Yearly**	**Harvest**	**Int.**	**MSP**	**Yearly**	**Harvest**	**Int.**
MSP	1				1			
Yearly	0.36	1			0.82	1		
Harvest	0.32	0.58	1		0.79	0.94	1	
Int.	0.2	-0.35	-0.21	1	0.31	0.35	0.17	1

Table 1 Correlation matrix of different prices for wheat and rice
Note: First differences of nominal prices from 1982 till 2013 were used
Source: Own calculation based on MOSPI, DAC, DFPD

The CIP has been very low and it has changed very rarely; therefore, the actual retail price of subsidized grain differs quite significantly among states. The CIP has been kept constant in nominal terms for below poverty line (BPL) and above poverty line (APL) cardholders from July 2002 and for the group of the 'poorest of the poor' (AAY) from the beginning of 2001. As a result, the price in real terms has declined quite significantly.[8]

The dynamics of and changing relationships between prices, especially regulated and market prices, as well as our particular interest in the impact of policies on market outcomes resulted in our decision to estimate the independent system equations (presented in the section 3), rather than use a simultaneous equation model. This also allowed us to test for the relevance of price averages for different period in farmers' decision making. Endogeneity problems were solved with instrumental variables estimation techniques.

[8] More details can be found in the subsection 2.2.4.

2.2.2. Production

The government uses both input subsidies and output price support (MSP) to boost production. The MSP also serves as an instrument of income stabilization. The MSP for rice and wheat, "which along with other factors, takes into consideration the cost of various agricultural inputs and the reasonable margin for the farmers for their produce" (FCI web portal, 2015), is announced before each of the two sowing seasons – rabi and kharif.

In 1978-79, the MSP was for the first time announced before planting time. Earlier, the procurement price used to be announced before at harvest time. This change must have strongly influenced the way the MSP shaped farmers' price expectations. This is the major reason we start our estimation sample in 1982.

Wheat and rice usually do not compete for area; they are produced in different regions – wheat predominantly in the north and rice in the south.[9] Wheat, as compared to rice, is more often produced by commercial farmers, whereas rice is cultivated mostly by small-scale farmers.[10] There have been higher investments and a greater proportion of irrigated acreage under wheat – the proportion of irrigated acreage has risen from 81 per cent in 1990-1991 to above 91 per cent at present. By contrast, the irrigated acreage under rice has increased from 45.5 per cent to 58 per cent (DAC, Ministry of Agriculture). Hence, rice production is highly dependent on rainfall and is characterized by greater yield variability.

Public procurement plays a very important role in both sectors. Rice is procured directly from farmers in the form of paddy at the MSP (open-ended procurement) or from millers/traders (with obligatory levy[11] ranging from 30 per cent to 75 per cent depending on the state) at the 'levy' price, which is the MSP plus milling cost. Wheat is procured directly from producers at the MSP. The dominant share of the government, especially in recent years, can be traced by the procurement levels (see figure 8 and figure 9). For both crops, the share of public procurement in total production has been close to or even above

[9]For wheat the major competing crops are chickpea (gram), rapeseed and mustard and for rice, mostly sugarcane.

[10] Indian agriculture in general is characterized by high degree of fragmentation – 80 per cent of farms are small or marginal.

[11] This is an indirect taxation on rice millers/traders who are required to deliver rice to the government agencies at the prices derived from the minimum support price of paddy, before selling the remaining rice in the open market. The scheme was discontinued in October 2015.

30 per cent. But if one takes into consideration only marketed grain, the share increases to around 50 per cent, which means that about half of the grain sold by farmers go to the FCI.

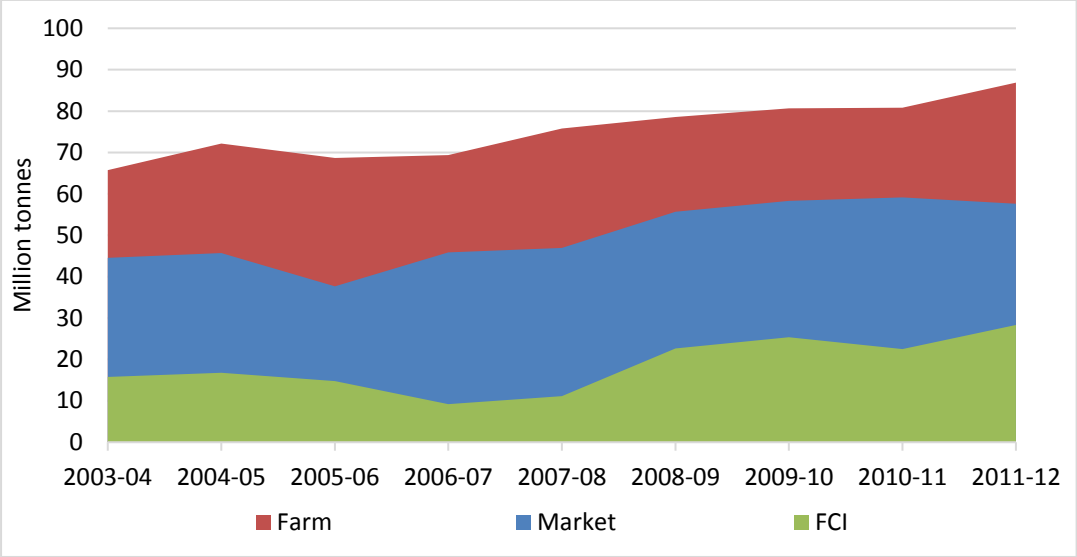

Figure 8 Wheat production, marketed surplus and procurement (as a part of production)
Source: Own design based on data from indiastat.com database

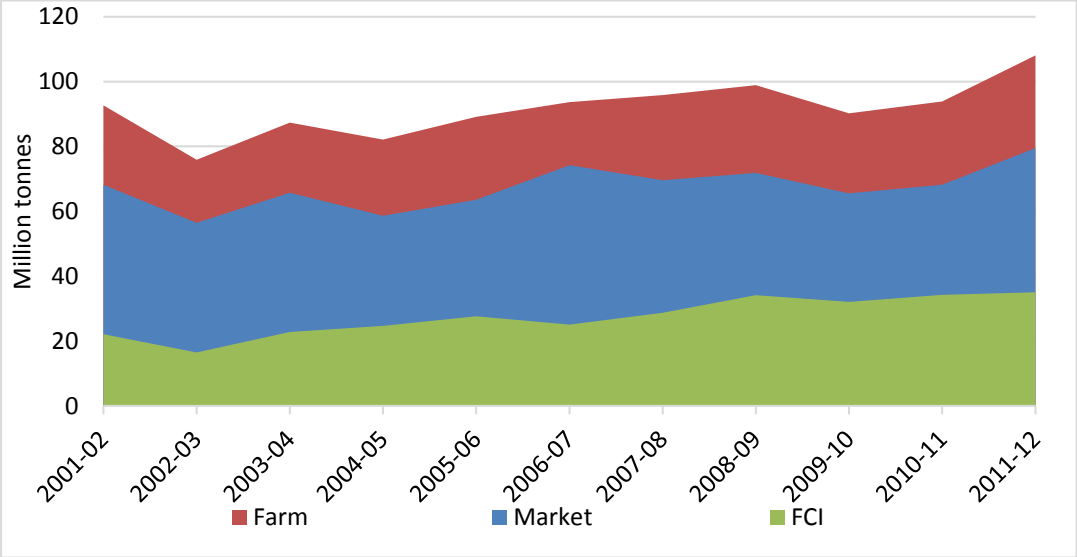

Figure 9 Rice production, marketed surplus and procurement (as a part of production)
Source: Own design based on indiastat.com database

This strong governmental involvement, as will be further discussed, has serious implications for determining production: not only has the MSP the largest impact on the production level, it has also wiped out the market impact on farmer's production decisions. Agricultural inputs are heavily subsidized and their nominal prices change very rarely; hence, input prices were not included in the production regression.

The general[12] equation for describing production is given by:

$$1 \qquad \ln Q_{t,i} = \alpha_0 + \gamma \ln Q_{t-1,i} + \alpha_1 \ln p_{t,i}^{MSP} + \alpha_2 \ln p_{t,i} + \alpha_3 \ln p_{t,j} + \alpha_4 \ln t + \alpha_5 R_t + \varepsilon_{t,i},$$

where $Q_{t,i}$ is yearly production quantity of the *i*-th crop (USDA data), p_i^{MSP} is a real MSP and $p_{t,i}$ is the market price of the *i*-th crop. All prices are WPI deflated. The contemporaneous MSP is considered because farmers know the MSP before planting and there is little uncertainty related to receiving this price. It is an exogenous variable as it is set by the policymakers before the planting time. As representative of the market price, lagged harvest time and planting time, as well as lagged marketing year price averages were taken into consideration. The lagged prices are exogenous variables – prices in year *t-1* are not affected by the production in year *t*. The lag structure of the market price reflects the assumption of naïve price expectation – the farmers expect the current year price to be the same as the previous year's price (harvest time and the yearly average prices) or alternatively, the price they observed at planting. Later, we econometrically test whether they really do. We also incorporated the Nerlovian (Nerlove, 1956) price expectation model with adaptive expectations by including lagged production as an explanatory variable. Besides, cross prices $p_{t,j}$ of the respective crops were used as explanatory variables – gram for wheat and maize for rice.[13] *t* is a trend variable, *R* is total yearly (calendar year) rainfall (IMD data[14]). Using the ordinary least square method and data for 1982-2012 gives the following results for different specifications:

	Dependent variable: log wheat production						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Log MSP	0.652***				0.635***	0.474***	0.652***
	(4.14)				(3.55)	(2.78)	(4.04)
Log trend	0.228***	0.329***	0.332***	0.295***	0.230***	0.124**	0.223***
	(12.02)	(8.7)	(9.87)	(8.01)	(12.88)	(2.45)	(11.80)
Lag log rain	0.348***	0.209	0.231	0.081	0.352***	0.408***	0.340***
	(3.23)	(1.65)	(1.62)	(0.52)	(3.31)	(4.76)	(3.11)

[12] This is the most general version of the equation, which combines all the nested specifications we estimated and discussed in tables 2 and 3. In the conceptual framework, we present only those specifications, which describe the phenomena the best according to our empirical analysis.
[13] Wheat and rice do not compete in production.
[14] http://www.imd.gov.in/

Lag log wholesale price (yearly)		0.298 (0.76)					
Lag log wholesale price (harvest time)			0.221 (0.8)				
Lag log wholesale price (planting time)				0.344 (0.99)	0.101 (0.43)		
Log cross price (gram price at the time wheat is planted)							0.037 (0.79)
Lag log wheat production						0.410* (2.01)	
_cons	-0.642 (-0.61)	0.924 (0.56)	0.992 (0.62)	1.799 (1.09)	-0.922 (-0.83)	-2.008** (-2.37)	-0.575 (-0.54)
N	31	30	30	31	31	31	31
R^2	0.95	0.9	0.9	0.89	0.95	0.96	0.95

Table 2 Regressions for wheat production

*Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with Newey-West standard error estimation. t-values are given in brackets. Error terms are stationary according to the ADF test.*

	Dependent variable: log rice production						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Log MSP	0.392***				0.413***	0.379**	0.364**
	(2.81)				(3.11)	(2.55)	(2.57)
Log trend	0.200***	0.253***	0.252***	0.239***	0.194***	0.187***	0.204***
	(10.25)	(9.37)	(9.47)	(9.64)	(9.9)	(6.37)	(9.60)
Lag log rain	0.498***	0.367**	0.367**	0.405**	0.501***	0.516**	0.498***
	(2.99)	(2.1)	(2.09)	(2.29)	(2.92)	(2.59)	(3.02)
Lag log wholesale price (yearly)		0.013 (0.09)					
Lag log wholesale price (harvest time)			-0.014 (-0.11)				

Lag log wholesale price (planting time)				0.073	-0.088		
				(0.48)	(-0.54)		
Log cross price (kharif planting maize price)							0.063
							(0.89)
Lag log rice production						0.061	
						(0.37)	
_cons	-0.657	1.099	1.179	0.694	-0.46	-0.987	-0.592
	(-0.48)	(0.74)	(0.82)	(0.46)	(-0.31)	(-0.52)	(-0.43)
N	30	29	29	30	30	30	30
R^2	0.91	0.88	0.88	0.87	0.91	0.91	0.91

Table 3 Regressions of rice production

*Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with Newey-West standard error estimation. t-values are given in brackets. Error terms are stationary according to the ADF test.*

Table 2 presents our estimates of the average price elasticities of wheat production in India. Column 1 shows estimates where wheat production is explained by the contemporaneous MSP, the lagged rainfall[15] and a time trend. Column 7 adds to this regression, the price (average at wheat planting period) of competing crop, gram (chickpea), which has an insignificant impact on wheat production. In both cases, the impact of the wheat MSP on wheat production is strong and significant, implying that on average, a one per cent increase in the MSP significantly increases wheat production in the corresponding marketing year by about 0.65 per cent. Columns 2-5 suggest that the wholesale market prices do not play a significant role in determining wheat production in India. Column 5 shows the regression with both prices – the MSP and the market price (wholesale price at planting – the one with the highest coefficient estimate and lowest standard error). When controlling for the MSP, market wholesale price seems to have little impact on the wheat production level – the estimated coefficient is quite low (0.1) and insignificant. An interesting result is reported in column 6, which expands the regression in column 1 with the autoregressive term, which could correspond with the Nerlovain adaptive price expectations. However, in this case, the price, MSP, is certain, so

[15] Rainfall variable represents total rainfall in a calendar year; whereas sowing of wheat crops harvested in a calendar year t starts in October of year t-1. This is why the lagged rainfall has been used in the wheat regression.

the autoregressive term represents the inertia of wheat production – for example farmers make crop specific investments, which prevent them from switching to competing crops very easily. The MSP coefficient estimate in this specification is significant and equal to 0.47, which can be interpreted as the short-term production response to the increase in the MSP. Lagged production has a positive and significant coefficient estimate equal to 0.41, which yields the long-term price elasticity (the long term response to a 1 per cent sustained increase in the MSP) of production, which is equal to 0.8. This specification has the highest R square of 0.96. In addition to the prices, wheat production is affected by rainfall and technological progress approximated by trend.

In the case of rice (table 3), production is explained by the MSP for rice, time trend and the rainfall (column 1). Quantitatively, the estimated coefficient implies that on average, a 1 per cent increase in the MSP results in a significant increase in production of about 0.4 per cent. The cross price of the competing crop (maize), however, turned out to be insignificant (column 7). The market price of rice does not show any significant influence on production (columns 2-5). Column 5 gives results of the regression with both prices – the MSP and the market price (average planting time wholesale price – the one with the highest coefficient estimate and lowest standard error). When controlling for MSP, the wholesale price seems to have little impact on the rice production level – the estimated coefficient is insignificant. Adding the autoregressive term to the specification 1, as reported in column 6, does not yield a major improvement – the lagged rice production is insignificant.

The price elasticity of rice production is smaller for rice than for wheat, which can be explained by the big share of small-scale farmers in rice production and the more commercial character of wheat production. The short-term price elasticity of production of 65 per cent and 39 per cent for wheat and rice respectively are high relative to estimates of market price elasticities in other countries. For example, in the FAPRI database,[16] the price elasticity of rice supply is usually close to 0.2, with the value of 0.25 in Bangladesh and 0.16 in China (0.11 for open-market price in India). The same database shows that price elasticities of wheat area response are slightly higher, averaging for example to 0.33 in Australia, 0.43 in Brazil and 0.09 in China (0.29 for open-market price

[16] http://www.fapri.iastate.edu/tools/elasticity.aspx

in India). The high MSP-elasticity in India might be explained by the low risk related to the MSP.

Gulati and Sharma (1990) used slightly different specifications of the output equation for Indian wheat and rice production. They used lagged output, lagged relative wholesale price, rainfall and irrigation to explain wheat and rice production in India. The estimation was based on data from 1969 to 1986, and hence, preceded the structural change in the 1990s. They found that market prices had a significant and strong impact, with a short-term (one-year) elasticity of 0.28 for wheat and 0.25 for rice. The long-term (three-year) elasticities were 0.83 for wheat and 0.72 for rice. Mythili (2008) found lower short-run price (relative price) elasticity of wheat and rice supply. In the post-reform period (1990-91 to 2004-05), the estimated short-run price elasticity of wheat supply was 0.17 and 0.16 (with two different specifications) and that of rice supply was 0.28 and 0.18 (ibid). In this study, the long-run supply response was also estimated, with the long run elasticity for wheat equal to 0.36 (0.29 with the alternative specification) and rice 0.7 (0.51 with the alternative specification). Neither of these studies used the MSP as an explanatory variable, as the authors focused on market prices.

2.2.3. Procurement

The share of wheat procurement in total production has been fluctuating between 11 and 40 per cent since the beginning of the 1980s, with a steep increase in the past few years (see figure 8). Rice procurement has been characterized by a more stable trend – from less than 11 per cent in 1982 to an average of 34 per cent in the last five years (see figure 9). These tendencies strongly coincide with the MSP changes, especially in relation to the market price (see figure 6 and figure 7).

The relationship between procurement and prices is modelled as follows:

2 $$\frac{D_{t,i}^{FCI}}{Q_{t,i}} = \alpha_0 + \alpha_1 \frac{D_{t-1,i}^{FCI}}{Q_{t-1,i}} + \alpha_2 \frac{p_{t,i}}{p_{t,i}^{MSP}} + \alpha_3 t,$$

where $D_{t,i}^{FCI}$ is the yearly procurement level of the *i*-th crop by the FCI and via decentralized procurement scheme[17] (DCP) in the marketing year, $Q_{t,i}$ is total production

[17]DCP was introduced in 1997-98 and is in place in 11 states. Under the scheme, states procure, store and distribute food grains through the TPDS. The surplus (in excess of the TPDS) is handed over to the FCI for the needs of the other (deficit) states.

and $p_{t,i}^{MSP}$ is is the MSP of the *i*-th crop, $p_{t,i}$ is the market price (marketing year average) of the respective crop. Thus, on the left hand side of the equation, there is the share of public procurement in total production and on the right hand side, there is the ratio of market price and the MSP and the trend. In order to control for the pre-existing procurement infrastructure, we add a lagged procurement share to the set of explanatory variables.

Public procurement has a high share in total marketed surplus and as a result might affect market prices. Due to consideration of the contemporaneous market price on the right hand side of the equation, there might be a problem of endogeneity in this specification. However, the procurement is always unlimited (open-ended) and the volume of procurement is decided by the fixed MSP level vis-à-vis the market price, which adjusts to the MSP. So the market price is affected by the MSP, not the procurement volume directly. The production might also influence the market price. However, it is plausible to assume that the share of procurement in the total production, which is the dependent variable, does not depend on the production volume due to the infrastructural rigidities.

Dependent variable: procurement share				
	Wheat 1	**Wheat 2**	**Rice 3**	**Rice 4**
Lag procurement share		0.41***		0.25***
		(2.99)		(2.81)
Ratio of market price (WPI) to MSP	-0.39 ***	-0.35***	-0.26 ***	-0.22***
	(-7.79)	(-7.45)	(-6.87)	(-6.27)
Time trend	-0.001	-0.002*	0.003***	0.002***
	(-1.50)	(-2.01)	(3.99)	(3.40)
Constant	0.77 ***	0.63***	0.56 ***	0.45***
	(9.67)	(7.26)	(8.73)	(7.15)
N	31	30	31	30
R^2	0.71	0.81	0.92	0.94

Table 4 Procurement regression estimates

*Note. *,**,*** indicates significance levels at 10, 5 and 1 per cent, respectively with the Newey-West standard error estimation. In brackets t-values are given. Error terms are stationary according to the ADF test.*

The rise of the MSP relative to the wholesale price by 1 per cent increases the share of procurement in the production by 0.35 – 0.39 per cent in the case of wheat and by 0.22 - 0.26 per cent in the case of rice; all the estimates are significant at the one per cent level (table 4). Consideration of the lagged dependent variable slightly decreases the

coefficient estimates, however the results are robust across the specifications. A significant upward trend in rice procurement might be because of decreasing transportation costs due to better infrastructure in rice growing areas, which raises the incentive of farmers to sell to the FCI.

Gulati and Sharma (1990) also estimated a similar procurement equation, allowing, however, for the additive impact of production level (as opposed to the multiplicative specification in our study). Their results indicate a strong procurement response to production, with elasticity equal to 1.37 for wheat and 1.1 for rice. The relative price elasticity (procurement to market price ratio) was estimated 0.85 for wheat and 0.59 for rice. However, these numbers cannot be compared with our estimates due to differences in the specification of the equation.

2.2.4. Demand and TPDS/OWS

Rice and wheat consumption comes from the three sources – own produce (only in the case of the rural households), received through the TPDS or other welfare schemes (OWS) and bought in the market. The contribution of individual sources to total consumption plays an important role in the analysis of demand and its determinants (price and income elasticities in particular).

There are 65.2 million BPL families in total[18] (including 24.3 million AAY families) (DFPD, 2013). They are entitled to 35 kg of food grains per family per month at a fixed price – the central issue price (CIP) plus a state-specific fee for BPL and APL recipients. The AAY price cannot be higher than the CIP (DFPD web portal). In practice, some states provide additional subsidy, distributing the grain at a price lower than CIP price (Saini & Kozicka, 2014). The allocation for APL families is based on the availability of food grains in the central pool and past off-take.[19]

The CIP has nominally declined after the introduction of the scheme and from the year 2002, or has remained unchanged, which means a significant drop in the real price (see figure 10 and figure 11). OWS comprises different schemes, such as the mid-day meal

[18]The requirement of food grains and subsidy requirements are decided on the basis of poverty estimates, based on a survey conducted by the Planning Commission in the year 1993-94 and year 2000 population estimates or the number of such families actually identified and ration cards issued to them by the state/UT governments, whichever is less (DFPD FAQ).

[19] These allocations have been changed under the NFSA, 2013.

scheme and wheat-based nutrition programs and the amount allocated does not usually exceed 10 per cent of that for the TPDS. Special additional allocations of food grains are also made, depending on grain availability (based on DFPD Food Grain Bulletins for different years).

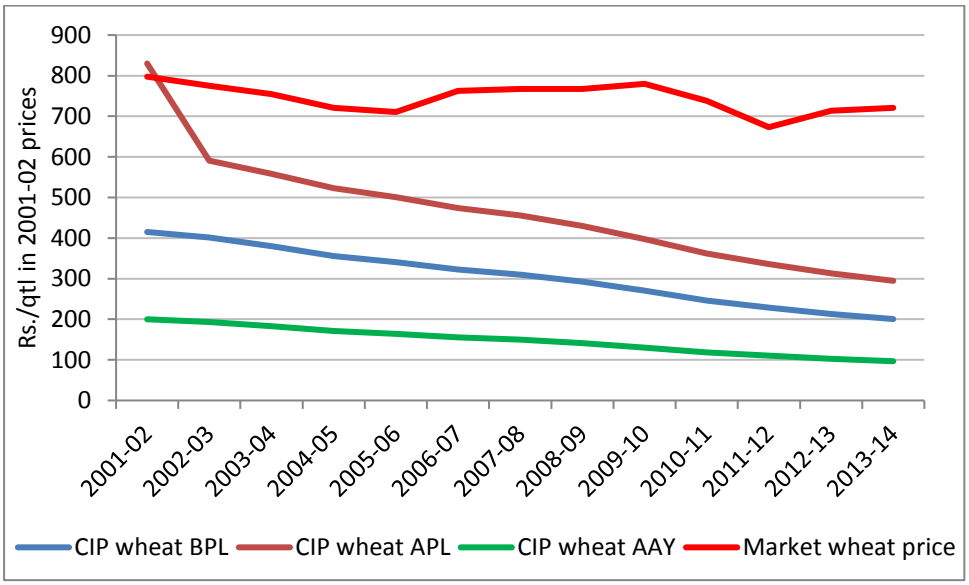

Figure 10 Wheat CIP and wholesale price
Source: Own design based on DFPD data

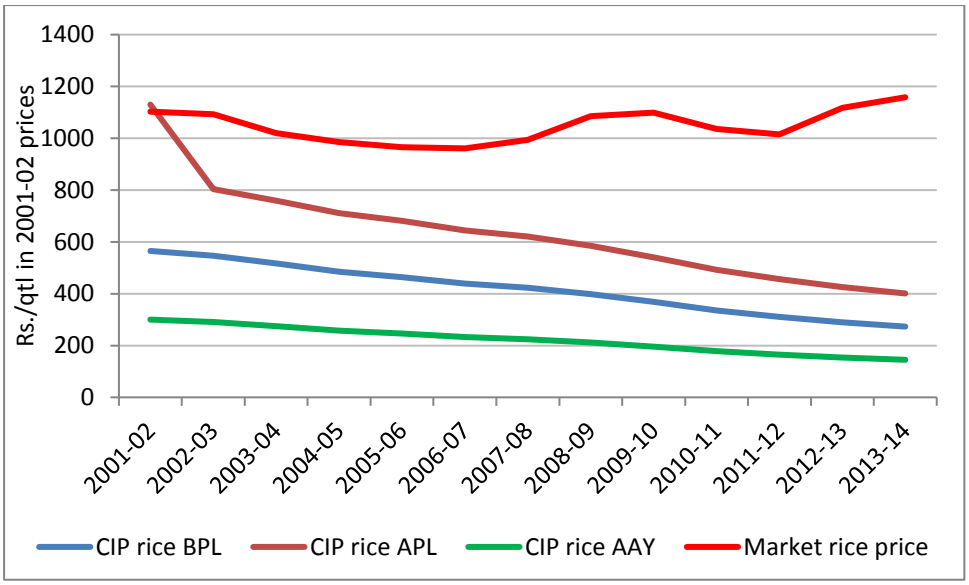

Figure 11 Rice CIP and wholesale price
Source: Own design based on DFPD data

Leakages[20] from the TPDS are a major challenge in estimating the 'market' consumption of wheat and rice. The 'leaked' grains are sold on the market at market price or exported to neighboring countries, *e.g.*, Bangladesh. 26 per cent of total rice and over 16 per cent

[20] Currently, the estimates for the leakage are close to 40% (Mukherjee, 2014).

of total wheat was consumed out of the Public Distribution System (PDS) supplies in India in 2011/12. These numbers have grown from 22 per cent (1.2 kg/capita/month) for rice and 12.3 per cent (0.5 kg/capita/month) for wheat in 2009-10 and from 13.1 per cent and 4.5 per cent respectively in 1999 (NSSA data). This can be attributed to lower leakages (Drèze & Khera, 2015) and increased TPDS allocations and off-take (figure 12). More details regarding the current subsidized wheat and rice consumption are discussed in Chapter 4.

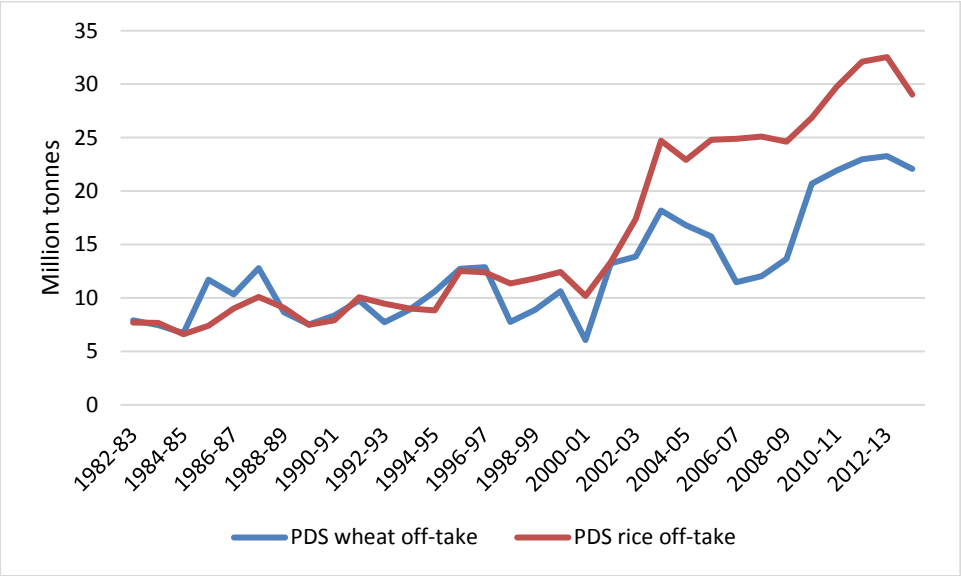

Figure 12 Off-take from public stocks for the TPDS and OWS
Source: Own design based on Food Grain Bulletin data, dfpd.nic.in

Twenty-five per cent and 37 per cent (1.2 kg and 1.5 kg per capita per month) of rice and wheat respectively of the total consumption of rural households came from home grown stock in 2009-10 and 30 per cent and 40 per cent in 2004-05, which was a drought year (NSS data). As discussed earlier in this paper, rice is mostly produced by small-holders, whereas wheat is a more commercial crop. This fact is reflected not only in the production function, but also in the quantity of grain retained on farm (and marketed surplus) in response to price changes.

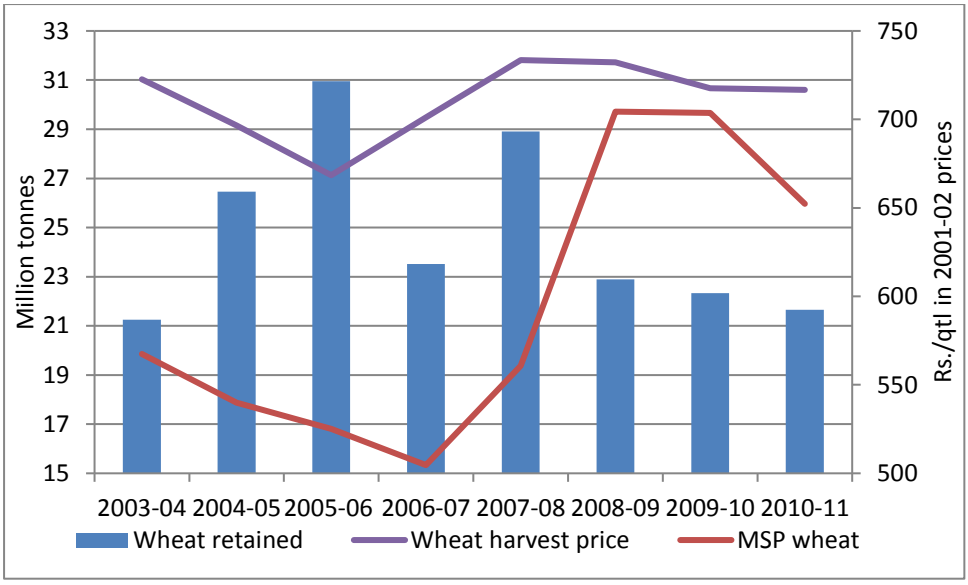

Figure 13 Wheat price and quantity retained on farm

Source: Own design based on http://agricoop.nic.in/agristatistics.htm and RBI data

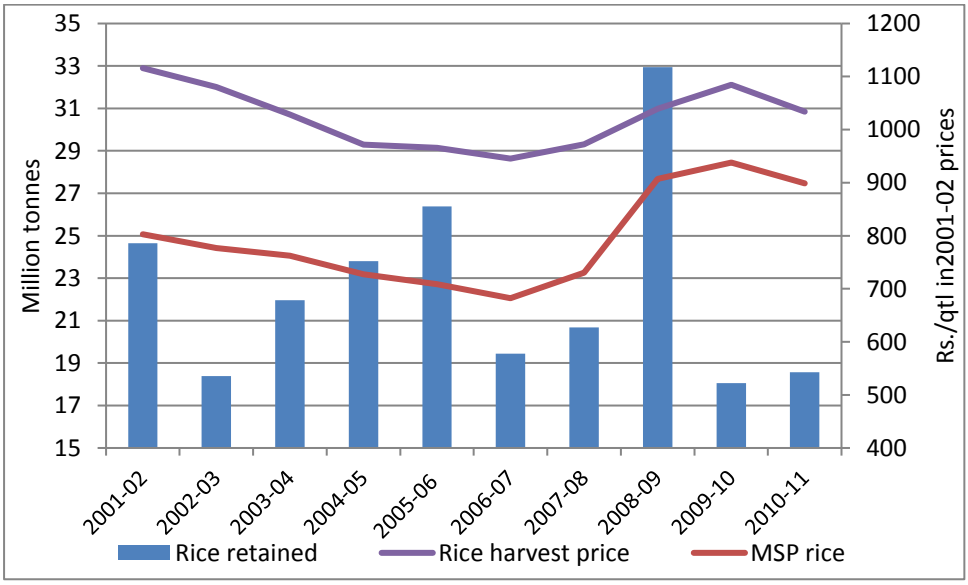

Figure 14 Rice price and quantity retained on farm

Source: Own design based on http://agricoop.nic.in/agristatistics.htm and RBI data

Wheat retained on farm reacts to prices more like a cash crop (figure 13) - it is sensitive to harvest time average wholesale price and the MSP – with the correlation equal to -0.54 in both cases. This might mean that farmers decide to sell more in times of high market prices during the harvest.

In the case of rice (figure 14), market prices do not seem to affect the amount consumed from own stock. Correlation with both prices (harvest and the MSP) is close to 0. This might be because rice is produced, for the most part, by poor smallholders, who produce mainly for own consumption and do not get affected by market price developments.

However, it is not clear then, why rice consumption from own stock fluctuates so much. If it was to cover the basic needs of the farmers, it should be rather stable in its volume. In reality, it varied significantly between 18 and 33 million tonnes. There are probably other factors influencing the consumption from own produce – for example, PDS supplies. However, with the available dataset (10 observations for rice and 8 for wheat), it is not possible to test this hypothesis.

The general equation for estimating demand is given by:

$$3 \qquad \ln D_{t,i}^{cap} = \alpha_0 + \alpha_1 \ln p_{t,i} + \alpha_2 \ln p_{t,i}^{cross} + \alpha_3 \ln PDS_{t,i}^{cap} + \alpha_4 \ln Income_t^{cap} + \alpha_5\, t,$$

where $D_{t,i}^{cap}$ is yearly (marketing year) per capita consumption for the *i*-th crop (based on the USDA data for domestic utilization), $p_{t,i}$ is yearly (marketing year) average of the own price of the *i*-th crop and $p_{t,i}^{cross}$ is price average of the other crop (cross price), both in real terms. $Income_t^{cap}$ is disposable income per capita and t is a time trend. The variable $PDS_{t,i}^{cap}$ is per capita off-take for the TPDS and OWS (PDS), which is treated in two different ways. Namely, there are two alternative specifications of the equation arising from the two alternative assumptions regarding the character of the substitution effect between the PDS and the market grains. First, it is assumed that grains from the PDS are imperfect substitutes for grain available in the market (due to the lower quality of the PDS grains sometimes and the greater difficulty in terms of access through fair price shops). In this case, the constant portion[21] of the PDS grain is subtracted from the total consumption (left hand side of the equation) and the total PDS off-take used as an explanatory variable. Second, it is assumed that grain from the PDS is a perfect substitute for grain available in the market. In this case, only the total consumption is considered and α_3 is set equal to zero.

Because the market price is endogenous to consumption, instrumental variable (two-stage least square estimation method) regressions were used in order to estimate

[21]This constant portion should represent the grain actually delivered through PDS and hence is equal to off-take minus leakage. In reality, the leakage portions fluctuate; however, this number is a controversial matter and differs significantly depending on the source of the data. Reliable estimates are based on the comparison of actually consumed grain from the PDS, based on the National Sample Survey results, and the off-take, as reported by the FCI (Khera, 2011b). However, the survey is not conducted yearly. In addition, the question on PDS consumption has been asked only in a few recent rounds; consequently, there are only three available observations. The amount of leaked grain used in this study is an average of these numbers, which is 25 per cent for rice and 61 per cent for wheat.

equation 3. MSP, rainfall and international prices (in years when there was no export ban) were used as instruments for the market price. First stage results are reported in Appendix 4.

Dependent variable: log wheat consumption			
	1	**2**	**3**
Log market price own	-0.880*	-1.069***	-0.820*
	(-1.68)	(-3.12)	(-1.84)
Log market price cross	0.613**	0.730***	0.712***
	(2.11)	(3.99)	(2.76)
Log PDS per capita off takes	-0.085	-0.104**	
	(-1.22)	(-1.97)	
Log income	-0.021		0.145***
	(-0.21)		(3.17)
Log time trend	0.139***	0.136***	
	(3.25)	(4.61)	
_cons	2.741***	-2.688***	3.010***
	(-3.52)	(-3.50)	(-3.74)
N	28	30	28
p-value of underidentification LM statistic	0.03	0.08	0.09
p-value of Hansen J statistic	0.08	0.43	0.53

Table 5 Regressions of wheat demand

*Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with robust standard error estimation. t-values are given in brackets. For column (1) and (2), PDS consumption is assumed to be an imperfect substitute (subtracted from the per-capita consumption); in column (3), PDS consumption is a perfect substitute.*

Dependent variable: log rice consumption			
	1	**2**	**3**
Log market price own	0.260	-0.112	0.311
	(1.14)	(-0.53)	(1.41)
Log market price cross	-0.170	0.02	-0.153
	(-0.72)	-0.09	(-0.70)
Log PDS per capita off takes	-0.222***	-0.332***	
	(-2.81)	(-7.71)	
Log income	-0.113		-0.010
	(-1.54)		(-0.42)
Log time trend	0.092***	0.043**	
	(2.78)	(2.09)	
_cons	-3.732***	-3.969***	-2.974**
	(-5.90)	(-5.87)	(-6.31)
N	29	30	29
p-value of underidentification LM statistic	0.08	0.12	0.11
p-value of Hansen J statistic	0.04	0.04	0.09

Table 6 Regressions of rice demand

*Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with robust standard error estimation. t-values are given in brackets. For column (1) and (2), PDS consumption is assumed to be an imperfect substitute (subtracted from the per-capita consumption); in column (3), PDS consumption is a perfect substitute.*

All wheat specifications have a p-value of underidentification LM statistic below 0.1, which means that at the 10 per cent significance level we can reject the null hypothesis (table 5). We can conclude that the models are identified. The first specification (column 1) has a p-value of Hansen J statistic below 0.1, which means that that the null hypothesis (instruments are valid instruments) can be rejected at 10 per cent significance level. This casts doubt on the validity of the instruments. However, in the specifications 2 and 3 (columns 2 and 3), we cannot reject the null hypothesis, that is, the instruments are valid. The rice model (table 6) only in specification 1 (column 1) is identified. Specifications 2 and 3 have the p-values of underidentification LM statistic above 0.1, so we cannot reject the null hypothesis. Also in all three specifications the p-values of Hansen J statistic are below 0.1, which means that the instruments in this model might not be valid. Consequently, the results of this model estimation must be treated with reserve and additional demand analysis is needed (provided in chapter 4).

In the case of wheat, market prices have a strong and significant impact on consumption (table 5): they are negative for own price and positive for the cross price (rice). Own price elasticity estimate is between -1.07 and -0.82 and cross price elasticity is between 0.61 and 0.73. It is not clear how PDS wheat affects total wheat consumption. According to the second specification (column 2, table 5), PDS wheat is an imperfect substitute for the open-market wheat – an increase in subsidized wheat delivery by 1 per cent decreases market consumption only by 0.1 per cent (column 1 suggests that it does not change market consumption at all). Hence, if we consider the amounts consumed from the both sources – very little actual consumption from PDS and consumption mainly from the market – the conclusion is that an increase in PDS wheat delivery results in increase in total wheat consumption (as on the left hand side of the equation, there is wheat consumption net of PDS consumption). What is more, the additional consumption will be almost equal to additional distribution. This small effect of PDS distribution on total consumption might be due to a few reasons. First, wheat distribution is quite small – around 60 per cent is leaked (GoI, 2005; Khera, 2011a). Second, the dependent variable is total wheat utilization, and hence, includes consumption for different purposes. A big

share of it is consumed in a ready-made form (like noodles) or outside homes (in canteens or restaurants). This part of consumption is not responsive to PDS deliveries. There might also be some positive impact of the income transfer effect (as discussed below) reflected in a higher total consumption of wheat.

In the case of rice, consumption seems to be mostly driven by a trend and PDS deliveries (table 6). The reason for this might be that PDS is functioning much better for rice. Since the beginning of the millennium, there has been much more rice than wheat allocated for the PDS (figure 12). Also, as discussed above, leakage of rice is much lower; therefore, much more rice is delivered effectively through the PDS. What is more, many 'rice consuming' states provide additional subsidy for TPDS rice. For example, BPL and AAY rice in AP, Karnataka, Kerala and Odisha is priced at only 1 Rs./kg. And Tamil Nadu has a unique universal PDS, delivering rice to everyone free of cost (DFPD, 2014, p. 54)[22]. This massive subsidization of rice might have led to the distorted price and income response of aggregate rice demand.

Kumar et al. (2011) and Ganesh-Kumar et al. (2012) analyzed price and expenditure elasticities of demand for several goods in India based on NSS household survey data. Their results are difficult to compare with those reported above as our dependent variable is total domestic utilization and, unlike NSS consumption data, includes grain bought in a processed form, consumed in canteens and restaurants and used for purposes other than consumption (e.g. feed). The average income elasticity for rice was found 0.024 and for wheat 0.075 in the former study and food expenditure elasticity was 0.21 for rice and -0.13 for wheat in the latter study. The own price elasticities were estimated in Kumar, Kumar, Parappurathu, & Raju (2011) at -0.247 for rice and -0.340 for wheat.

Income elasticity of wheat and rice demand are reported to be close to zero (0.024 and 0.075 for rice and wheat respectively) on average across all income groups in India (Kumar, Kumar, Parappurathu, & Raju, 2011). However, it is much higher for the poorest – equal to 0.182 for rice and 0.102 for wheat in the 25th income percentile (ibid). So if PDS is properly targeted, the major subsidy should be received by the poorest part of the

[22] Limited to 20 kg per household, and 35 kg in case of AAY cardholders (http://www.tncsc.tn.gov.in/html/pds.htm, accessed on Sep, 25th, 2014).

population and as a result, there might be a significant increase in wheat and rice consumption due to the income effect.

2.2.5. Stocks, OMSS and Exports

The public stock level ($X_{t,i}$ is end of year *t* stock level) is a result of the carryover stocks (less the deterioration rate, δ), the grain inflow from domestic procurement ($D_{t,i}^{FCI}$), imports and outflows to the TPDS/OWS, OMSS for domestic market (OMSS D) and net exports:

$$X_{t,i} = (1-\delta_i)X_{t-1,i} + D_{t,i}^{FCI} - OMSS_{t,i} - TPDS_{t,i} - NEX_{t,i}^{pub}. \quad (4)$$

However, fitting the data to the above equation is difficult because of the different reporting periods for different data. Procurement is reported for the marketing year, whereas all the off-take data is for the financial year. In the case of wheat, financial year (April to March) and marketing year (March to February) are almost identical, but for rice, the difference is quite significant, as its marketing year lasts from October to September. Stock levels are available on a monthly basis so we used the closing stocks of financial years.

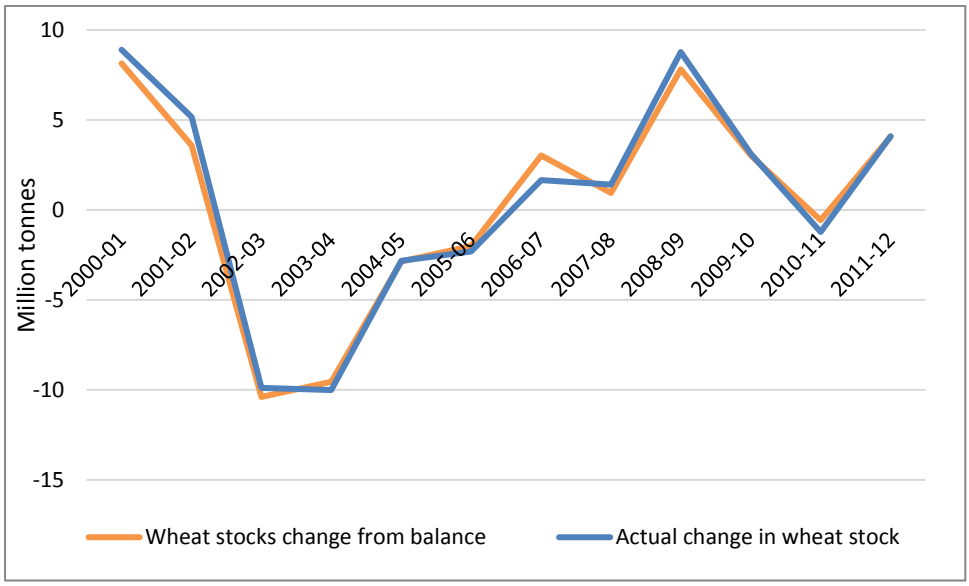

Figure 15 Wheat stock change as estimated from equation 4 and change in actual stock

Source: Own design based on FCI data

Note. Stock changes were calculated between financial year closing stocks, between March values of consecutive years.

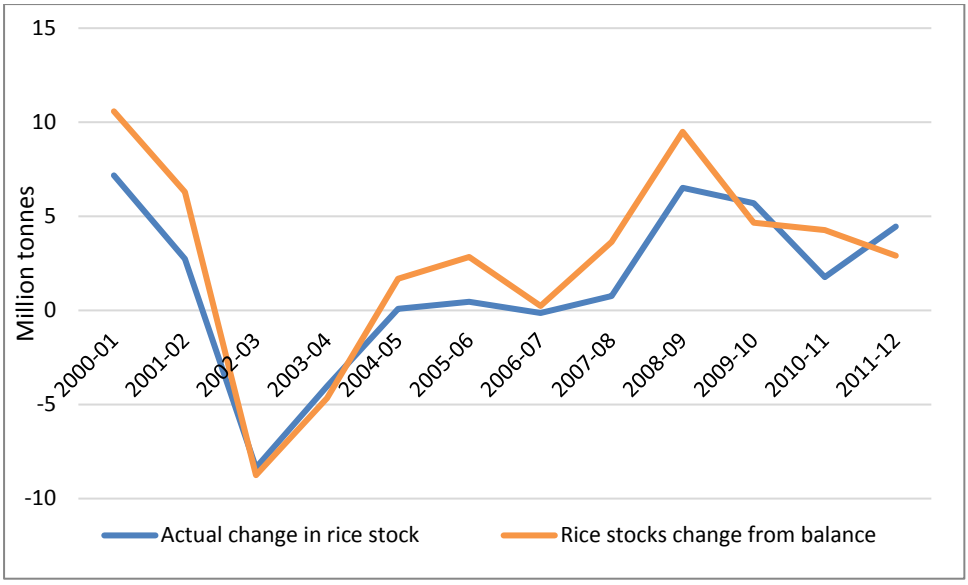

Figure 16 Rice stock change as estimated from equation 4 and change in actual stock

Source: Own design based on FCI data

Note. Stock changes were calculated between financial year closing stocks, between March values of consecutive years.

The calculated wheat stock change from grain flow (similar to the equation 4), $D_{t,i}^{FCI} - OMSS_{t,i} - TPDS_{t,i} - NEX_{t,i}^{pub}$, has been fluctuating around the difference between the ending stocks in consecutive financial years $X_{t,i} - X_{t-1,i}$ (figure 15). In the case of rice, the difference between the estimated and actual stock change is large (figure 16). This can be attributed partially to the discrepancy in the data reporting periods; however, this would only result in the time series interweaving with each other (one fluctuating around another). In reality, except for a few years, the estimated change from the grain flow balance stock change has been persistently above the actual change in stock. In principle, the former less the deterioration rate should be equal to the latter, as in equation 4. Therefore, the low actual stock change might be due to high losses. Based on equation 4, the average wheat stock deterioration rate from 2000-01 to 2012-13 is equal to 2 per cent and for rice, 10 per cent. However, this number should be interpreted as the average unexplained change in stock level between marketing seasons as the deviations were both positive and negative. Unfortunately, there is a lack of reliable estimates on storage losses in India to compare with. Different estimates quote aggregate losses (post-harvest annual loss of grain), starting from 16-17 million tons up to 55 million tons, which roughly means 7 per cent to 23 per cent of total production (Artiuch & Kornstein, 2012). FCI reports are much below any of these numbers – around 0.3 million tons for wheat and rice wasted in storage and transit in recent years (as reported on http://fciweb.nic.in/). Approximately

half of this amount was lost in storage, which gives not more than 0.4 per cent of the average stock level in the central pool in the corresponding years.

Buffer stock norms define the amount required to meet operational and strategic stock needs. The open-ended character of the procurement, relatively high MSP and trade limitations (e.g. temporary export bans) result in very high stock levels – periodically exceeding the norms.

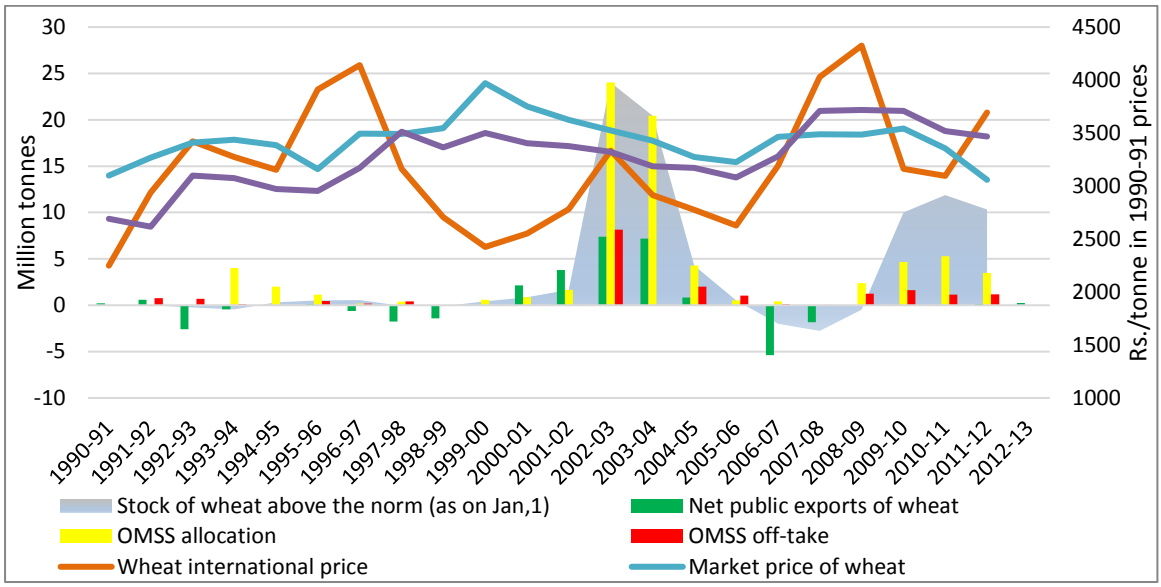

Figure 17 Wheat stocks, off-take and prices

Source: Own calculation based on from FCI, IMF and indiastat.com

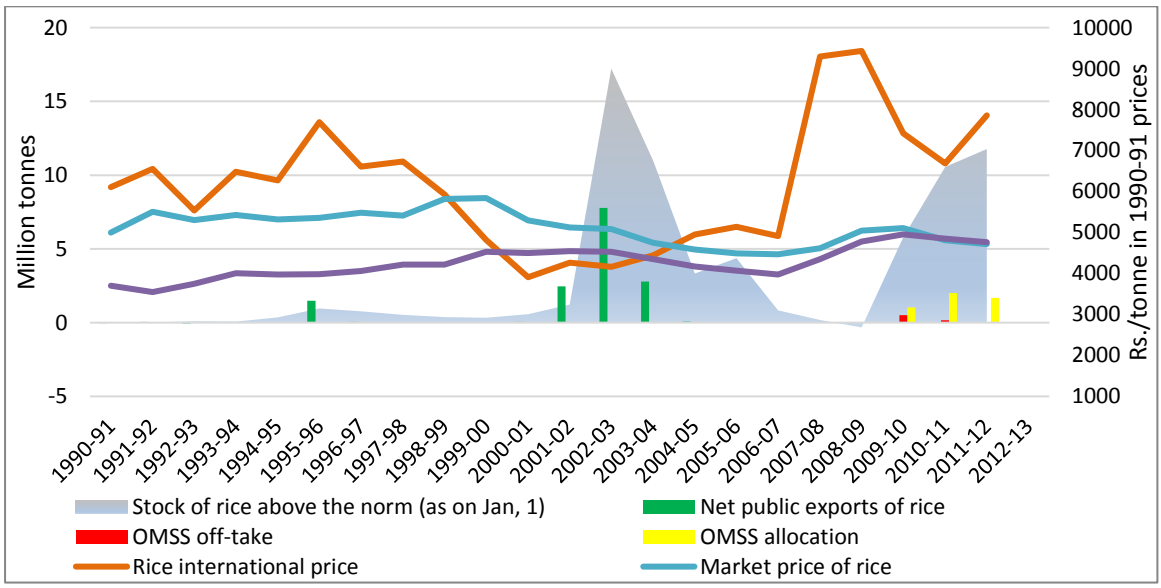

Figure 18 Rice stocks, off-take and prices

Source: Own calculation based on FCI data, IMF and indiastat.com

OMSS for wheat is mostly used to stabilize market supply and release stocks before the new harvest arrival (figure 17). For rice, the seasonality of supply is almost absent and the

OMSS was usually not used (figure 18). However, in the last years (from 2009-10), small amounts were allocated for the OMSS but they were mostly not absorbed by the market (the off-take was lower than the allocation).

Both OMSS and export allocations are *ad hoc* decisions. Although they are correlated with stock levels and stock norms, there are no rules for this. The issue price of grain – the minimum issue price (MIP) – is usually based on acquisition cost[23] from the previous marketing year (plus the freight), but sometimes, it is lower than that (however, it is never below the current MSP as it could lead to 'reselling' of grains by the traders). It is sold through tenders, so the actual price received is close to the market price. The amount actually released through these channels is not a simple outcome of difference between the market price and the CIP as there are several limitations – sometimes the quality of the released grains is low (because of poor storage facilities[24] and grain is being stored for a few years); there are also logistical limitations (Thukral & Bhardwaj, 2013).

The difference between the minimum issue price (MIP) and international market price could work in favor of exports, especially for rice. Prolonged export restrictions resulted in a much lower domestic rice price in comparison with the international price (figure 18). Export off-take has been used sometimes in order to balance the stock level (often in the form of humanitarian aid (non-commercial)); however, this has apparently not been enough in the recent years – despite the huge stock pile-up starting from 2008-2009, there were hardly any exports and attempts to release through the OMSS were rather unsuccessful.

2.2.6. Trade

International trade, like other activities within the wheat and rice sectors, is heavily controlled by government and there are several regulations on private exporters, including frequent export bans, tariffs and minimum export prices (figures 19 and 20). Before the early 1990s, India had a closed economy. Exports of common rice were banned until 1994 and the country was dependent on import of wheat – importing a few millions

[23]Acquisition cost consists of cost of grain, statutory taxes, storage and interest charges, etc., at acquisition stage.

[24]Stock level is often above not only the stock norms, but also the storage capacity, which results in storing grain in the open (Bhardwaj, 2012).

of tonnes yearly. This is why we mostly restrict our analysis of wheat and rice exports to the period after 1990.

It is difficult to estimate actual public exports – the reported numbers by FCI for public exports are in some cases higher than total exports from India of these commodities.[25] The reason for high public export values might be because they include issue of grain stocks for export to private parties, and these might have been partly released on the domestic market. The large share of public trade in total trade affects the calculation of the price elasticity of exports – public exports include food relief allocations, World Food Program contributions and other non-market based operations.

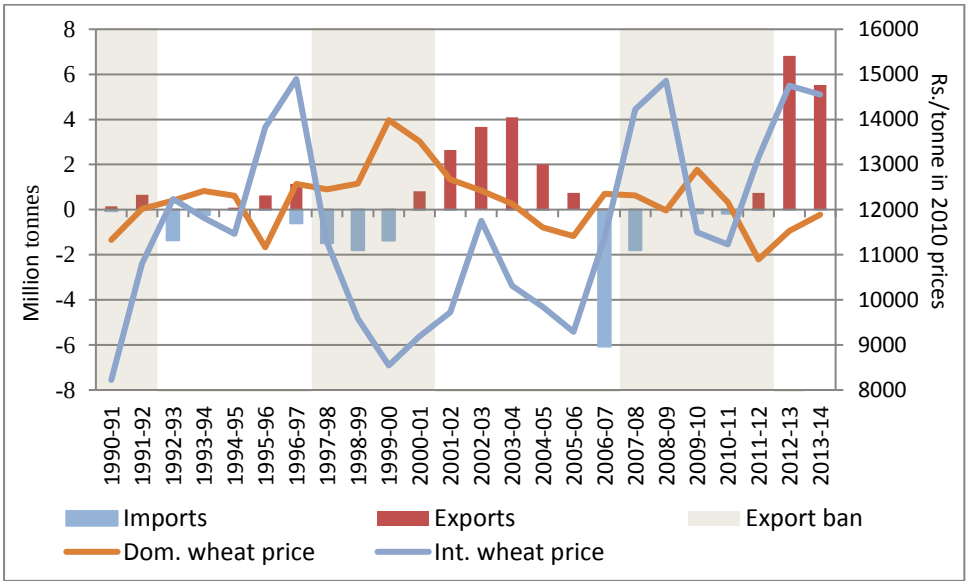

Figure 19 Total wheat trade in India

Source: Own calculation based on FCI data, DGCIS and IMF

[25] This would result in negative values for private exports when estimated as the difference between total (as reported by Directorate General of Commercial Intelligence and Statistics) and the FCI off-take for exports.

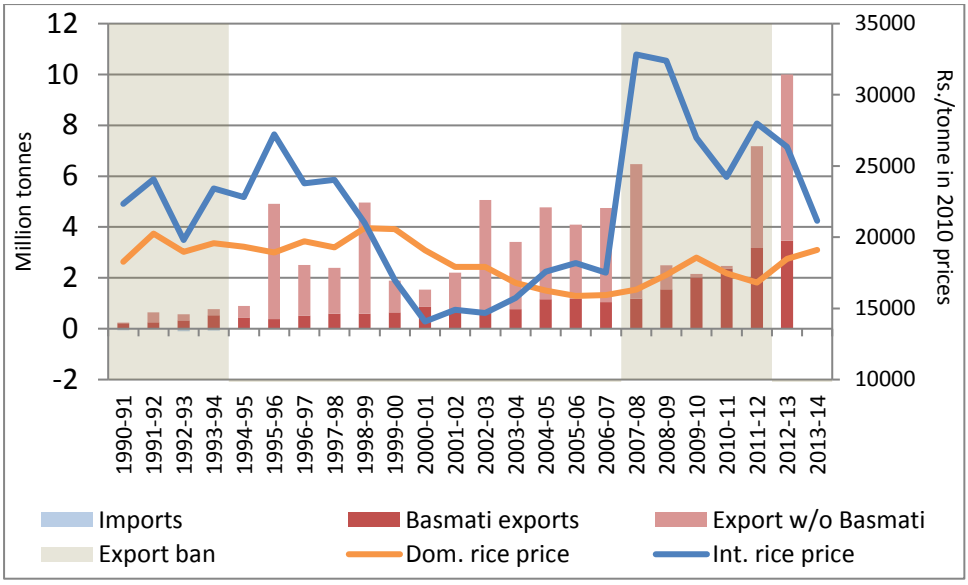

Figure 20 Total rice trade in India

Source: Own calculation based on FCI data, DGCIS and IMF

As a result, the relationship between export volume and the ratio of domestic to international price has become positive, which means that a rise in domestic price with respect to the international price can be associated with higher exports. The estimation results of the regression of wheat and rice exports (as a share of production) on the ratio of domestic to international prices and export bans confirms this hypothesis.

The following regressions were estimated:

$$\frac{Exp_{t,i}}{Q_{t,i}} = \alpha_0 + \alpha_2 B_{t,i} + \alpha_3 \frac{p_{t-1,i}}{p^{int}_{t-1,i}} + \alpha_3 t \quad (6)$$

where $Exp_{t,i}$ is total volume of exported in a financial year, $Q_{t,i}$ is production of the respective grain, $B_{t,i}$ is an export ban dummy, $\frac{p_{t-1,i}}{p^{int}_{t-1,i}}$ is a lagged price ratio – domestic wholesale to international, converted to Rs., t is a time trend. The lagged price ratios are due to the delay in the realization of export contracts and price expectation formation (in this way, we assume naïve price expectations). The estimation results are presented in table 7 below.

Dependent variable (as a share of total production)	**Net wheat exports**	**Wheat exports**	**Net rice exports**	**Rice exports**
Export ban	-0.020 (-1.60)	-0.023** (-2.68)	-0.021** (-2.39)	-0.020** (-2.27)
Lagged ratio of market price to international price	0.065* (1.71)	0.049* (1.95)	-0.011 (-0.63)	-0.004 (-0.25)

Trend	0.002* (1.94)	0.001** (2.12)	0.002*** (3.15)	0.002*** (3.09)
_cons	-0.054* (-1.74)	-0.017 (-0.81)	0.023 (0.94)	0.016 (0.67)
N	31	31	31	31
R^2	0.26	0.48	0.70	0.67

Table 7 Foreign trade regression estimates

*Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with Newey-West standard error estimation. t-values are given in brackets. Most of the dependent variables, according to the ADF test, are non-stationary. However, inclusion of a trend variable in the explanatory variables resulted in stationary residuals.*

For both wheat and rice, export bans significantly influence export volume. Years with export bans have on average lower exports by more than two percentage points of production. The price ratio has a strong significant impact on wheat exports – increase in the domestic price relative to the international by 10 per cent can be associated with an increase in exports by 0.5 percentage points. The price ratio has no influence on rice exports. However, as discussed above, the direction of the impact of the price ratio is the reverse of what economic theory would suggest (Helpman & Krugman, 1989). An increase in the domestic price relative to the international price of wheat significantly increases the export volume of this crop. What is important is that neither of the regressions explains the variability of exports volume well – a maximum 48 per cent for wheat and 70 per cent for rice.

These results can be explained by the distortive character of trade policies in India. For example, in 2007-2009, rising international prices were not accompanied by increased exports and domestic prices for either wheat or rice. Skyrocketing international prices with stable domestic prices resulted in a widening gap between the two. However, due to the export bans, there were only basmati rice[26] exports and no wheat exports registered. This phenomenon indicates high market distortion, but can be explained by Indian trade policies. Whenever international prices rise, the government intervenes with export

[26] Export bans were only for non-basmati rice. In 2007 and 2011, there were also non-basmati exports registered despite the export bans in these years. There are a few reasons for this. First, the export ban periods were not identical with the financial years. In 2007, after the introduction of the export ban, existing export contracts could be executed and in 2011, the export ban was lifted before the end of the financial year for which export data is quoted. Second, there were some exemptions to the bans. For example, there were exports of non-Basmati rice under government-to-government contracts to Bangladesh, Bhutan and Sri Lanka (Dave, 2010).

restriction. This, in turn, leads to lower domestic prices, which drives the price ratio down with a simultaneous decrease in exports.[27] The opposite happens when high MSPs result in very high public stocks and relatively high domestic prices. The government's decision to release stocks for exports leads to higher exports with unchanged market availability (only the public stock level decreases) and market price. Consequently, we observe an increase both in the domestic market price and exports.

2.2.7. Fiscal costs

Analysis of the fiscal cost is based on data starting from 2001 because there were major changes in 1997, when the TPDS was introduced and in 2001, when the AAY group was defined and introduced.

Fiscal costs, as we define them in our framework, are based on the amount of wheat and rice handled by the FCI and states under the DCP within a fiscal year.[28] We use the cost and volume of procurement, storage and distribution as reported by the FCI. However, it is impossible to compare the estimated fiscal cost with the food subsidy incurred by the government. The food subsidy provided to FCI by the Ministry is in the form of consumer subsidy and buffer subsidy. For the quantity distributed, the difference between the acquisition cost and distribution cost incurred by FCI and the CIP realized is reimbursed as consumer subsidy. According to the instructions issued, three months[29] average sales quantity is treated as operational stock. Stock over and above the operational stock is treated as buffer stock. For buffer stocks, the cost of holding and maintenance of the stock (i.e. interest, storage etc.) is reimbursed in the form of buffer subsidy'(FCI, 2014). So the food subsidy is calculated for grains distributed, not handled (this does not capture the total cost of procurement in the current year, which is claimed only after the grain is released). As a result, the volume of grain for which the fiscal cost and food subsidy are calculated is different. For further simulation purposes, we need to endogenize the fiscal

[27]The same conclusions were reached in Dasgupta et al., 2011

[28]The exception is the amount of grain procured as it relates to the marketing year. In the case of wheat, the financial year (April to March) and marketing year (March to February) are almost identical, but for rice, the difference is quite significant, as its marketing year last from October to September. However, most of the rice is procured from October to March; so, within the financial year, the cost of residual procurement from the previous rice marketing year and the major part of the current rice marketing year is captured. As a result, the consequence for fiscal costs is negligible in the case of wheat while in the case of rice, this means small deviations of the estimated cost from the actual cost.

[29]The currently used definition of operational stock uses four months' off-take (CAG, 2013). Further, we will be using this definition in our estimates.

cost and for the clarity of the procedure, we need to define the cost of operating the system based on procurement, stock and distribution level within the same financial year. The per unit cost of these operations is approximated by the numbers reported by the FCI.

The formula for the fiscal costs is given below.

7 $$FC_t = \sum_i((c^p_{t,i} + p^{MSP}_{t,i})D^{FCI}_{t,i} + c^d_{t,i}PDS_{t,i} + k_t X_{t,i} - p^{PDS}_{t,i}PDS_{t,i} - p_{t,i}OMSS_{t,i} - p^{EX}_{t,i}NEX^{pub}_{t,i}),$$

where FC_t are yearly fiscal costs, $(c^p_{t,i} + p^{MSP}_{t,i})D^{FCI}_{t,i}$ are acquisition costs[30] (proportional to the procurement level) of the *i*-th crop, $c^d_{t,i}PDS_{t,i}$ are distribution costs[31] (proportional to the amount distributed through the PDS and OWS) of the *i*-th crop, $k_t X_{t,i}$ buffer carrying cost, $X_{t,i}$ is buffer stock (an average in the financial year stock in the central pool minus the operational stock) and $p^{PDS}_{t,i}PDS_{t,i} + p_{t,i}OMSS_{t,i} + p^{EX}_{t,i}NEX^{pub}_{t,i}$ are the revenues from sales with the average CIP and market price for OMSS and net exports. Most of the components of the equation come from FCI reports (see table 8).

Variable	FCI Category	Source	Unit
$c^p_{t,i}$	Procurement incidentals (as proportional to the procurement level)	FCI (can be also estimated as 21% of the MSP)	Rs./quintal, WPI deflated
$D^{FCI}_{t,i}$	Total procurement	FCI	Million tonnes
$p^{MSP}_{t,i}$	MSP	FCI	Rs./quintal, WPI deflated
c_1	Distribution cost	FCI	Rs./quintal, WPI deflated
$PDS_{t,i}$	TPDS and OWS off-take	FCI	Million tonnes
k_t	Annual rate of buffer carrying cost	FCI	Rs./quintal, WPI deflated
$X_{t,i}$	Buffer stock	Estimated based on reported monthly stock positions in the central pool	Million tonnes
$p^{PDS}_{t,i}$	CIP	Estimated CIP weighted by off-take for different categories (APL, BPL, AAY and OWS) average	Rs./quintal, WPI deflated
$p_{t,i}$	Market price	Price based on the WPI index	Rs./quintal, WPI deflated

[30]As incurred by the FCI. It consists of freight, interest, handling and storage charges, transit and storage losses and administrative overheads (FCI)

[31] As incurred by the FCI. It comprises freight handling expenses, storage charges for operational stock, interest charges, transit shortages, storage shortages, establishment charges and wage revision arrears. (FCI)

$OMSS_{t,i}$	OMSS off-take	FCI	Million tonnes
$p_{t,i}^{EX}$	Export price	Estimated as international price	Rs./quintal, WPI deflated, converted from the USD to the rupee using the then exchange rate
$NEX_{t,i}^{pub}$	Total net off-take for exports	FCI	Million tonnes

Table 8 Categories as included in the Fiscal Cost equation
Source: Own design

Acquisition costs consist of the two components – the MSP plus a bonus (pooled cost of grain)[32] and procurement incidentals. Procurement incidentals are the additional costs like statutory charges, transportation charges and labor charges. The rest of the cost – distribution costs and buffer carrying costs – are also approximated by the past cost per unit reported by the FCI, multiplied by the PDS off-take and stock levels.

Total grain cost (acquisition, distribution and buffer carrying cost) in real terms have risen in the last seven years when compared to the period 2000-2006, mostly due to higher acquisition costs. They rose by around 12 per cent in real terms between 2000-2006 and 2007-2013. Distribution costs and buffer carrying cost for both grains decreased in real terms, so the total grain cost increase was subdued to 4 per cent for wheat and 5.4 per cent for rice. After 2007-08, the total cost started rising dramatically (figure 21). This is due to both growing procurement levels and stock levels.

On the revenue side, there are three components – the OMSS, the TPDS with the OWS and net public exports. Both the OMSS allocation quantity and the MIP are *ad hoc* policy decisions, which are difficult to model.[33] However, the OMSS is sold through tenders, so we use the market price as a proxy for the price received for OMSS grains. Revenues from OMSS were estimated by multiplying (reported or estimated, if no reports available) quantity released by the market price. TPDS and OWS revenues were approximated by the off-take for different programs (income groups – APL, BPL, AAY) with the relevant CIP (both quantity and CIP as reported by the FCI). The difficulty is that there are usually additional allocations, such as for flood relief or festival allocations, sold at different prices. Consequently, the difference between the total PDS off-take and off-take for APL,

[32]The FCI definition of pooled cost of grain differs slightly – in their method, it is the weighted average cost of the opening stock at previous year's MSP and procurement of current year's crop at current year MSP.
[33] Even the authority making the decision has not been constant over time – sometimes it is the Ministry of Consumer Affairs, Food and Public Distribution and sometimes High-level Committee of the FCI (information obtained from the Ministry of Agriculture).

BPL and AAY is sold at different prices. It was assumed, that on average, this price was equal to the APL CIP. Finally, net export revenues were calculated based on the reported net export quantity and international price. However, this method will have an upward bias as a large share of public exports was in a form of humanitarian aid and the transportation cost of exports is not considered. In general, the estimate of revenue is based on several assumptions and is subject to errors. However, our goal is to produce a simple and transparent but detailed enough method for assessing the total cost of the implementation of the set of policy measures.

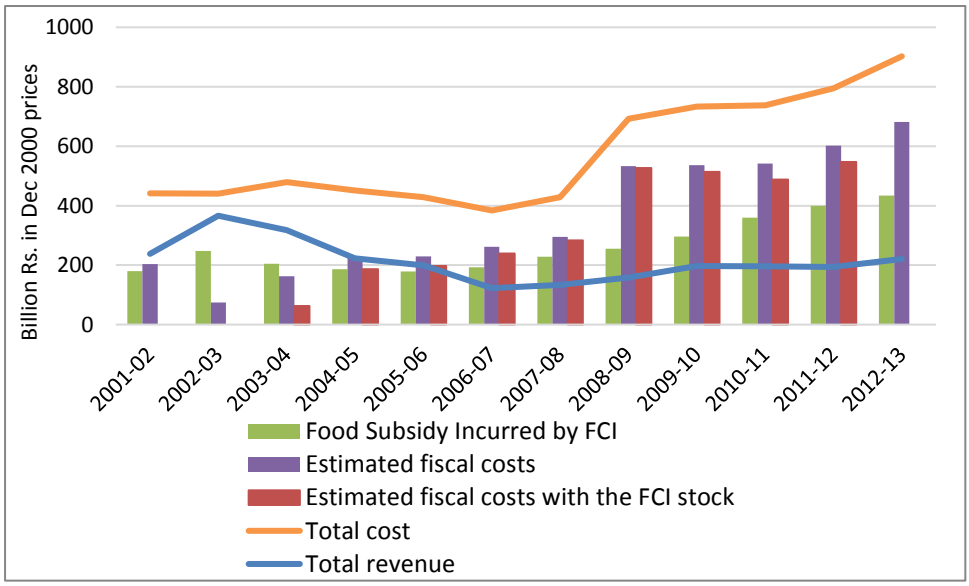

Figure 21 Fiscal cost and food subsidy
Source: Own calculation based on FCI data

The estimated fiscal cost (the difference between the total cost and total revenue) has risen dramatically in real terms from the financial year 2001-02 (even more as compared to the value in 2002-03, which seems to be an outlier though) – by 235 per cent until 2012-13 (figure 21). This number seems to be large as compared with the 80 per cent increase in the TPDS and OWS off-take in the same period. In 2001-02, the fiscal cost incurred per ton of distributed grain (wheat and rice on average) was Rs. 7654 and in 2012-13, it rose to Rs. 14204 (in Dec 2000 prices). In the same period, the average stock level in the central pool has increased by 35 per cent and procurement volume by 69 per cent. Food subsidy has also increased quite significantly – by 141 per cent in real terms.

The estimated total fiscal cost has been usually above the food subsidy incurred by the FCI (figure 21). Except for the years 2002-03 and 2003-04, the fiscal cost fluctuated

between 13 per cent and 109 per cent above the food subsidy. This difference can be explained by several factors. One is the way buffer stock carrying cost is accounted for by the FCI. The average buffer stock, as reported by the FCI in its annual reports, has been always much below our estimates based on the monthly stock levels as reported by the FCI (figure 22). The estimate of fiscal costs with the FCI reported buffer stock slightly decreased the figure; however, the difference is quite small (figure 21).

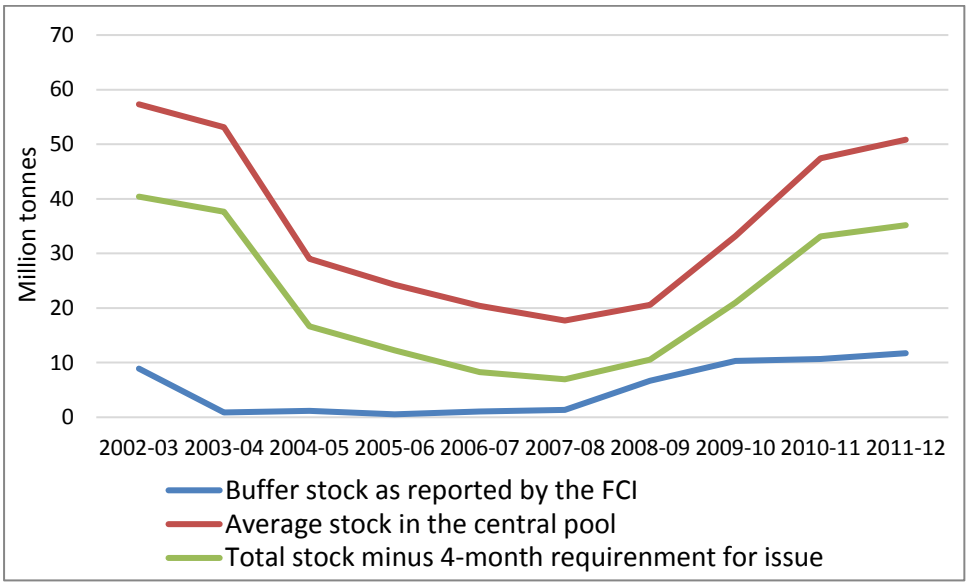

Figure 22 Stocks of wheat and rice

Source: Own calculation based on FCI data

Note: The FCI stock is own stock and held by the state governments under the DCP

Second, the food subsidy, as reported by the FCI, related to the grain released, not operated, as already discussed. The procurement levels were usually higher than the total off-take (figure 23), especially after 2006-07, which corresponds to rising difference between the estimated fiscal costs and claimed food subsidy. This might mean that the difference between the cost of procurement and revenue realized upon distribution is reported in the next year, when the stocks are released.

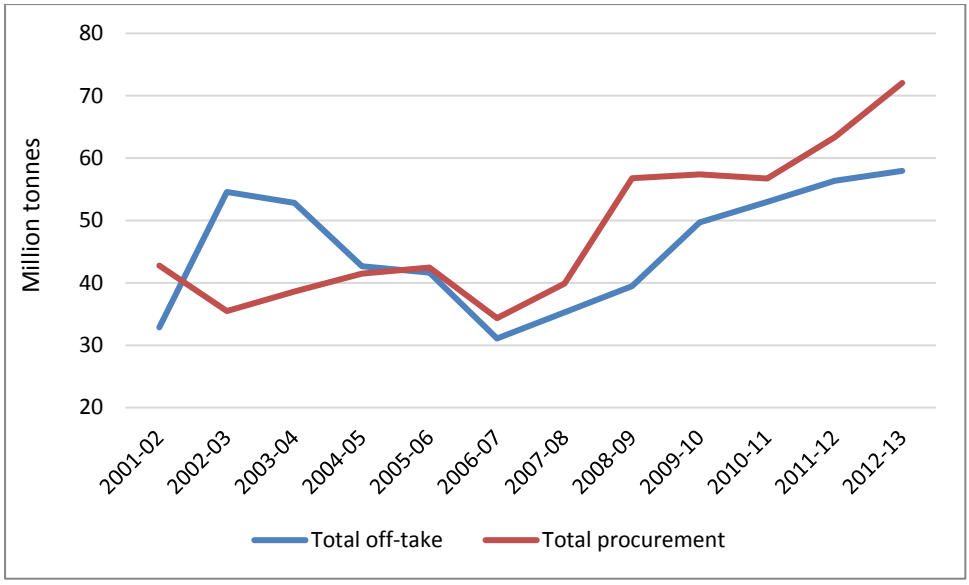

Figure 23 Wheat and rice procurement and total off-take*

Source: Own calculation based on FCI data

**For TPDS, OWS, relief and defence, OMSS and net exports*

Finally, the fiscal cost estimation method is based on many assumptions and should be used to analyze the dynamics and composition of the costs of operating the system rather than comparing it with the food subsidy.

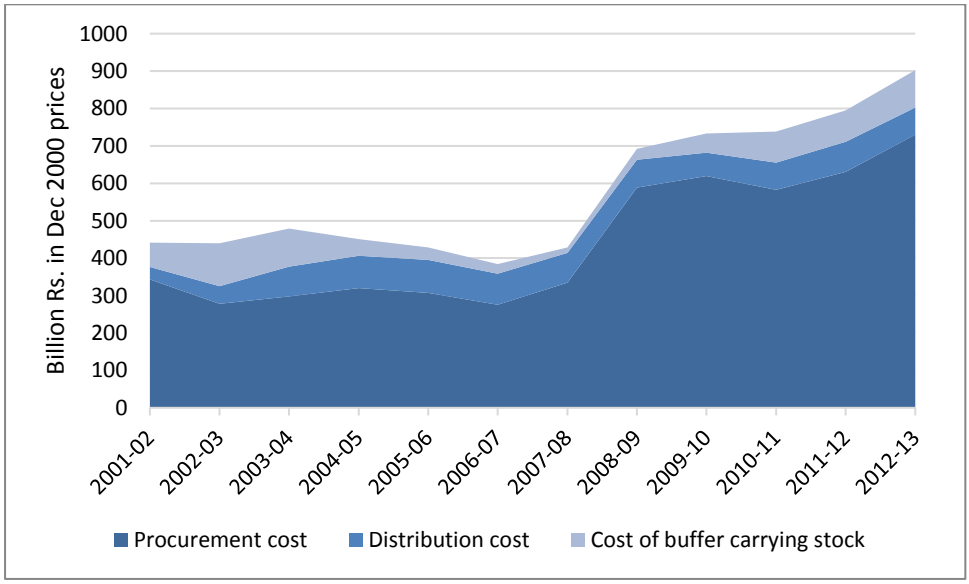

Figure 24 Composition of estimated expenditures

Source: Own calculation based on FCI data

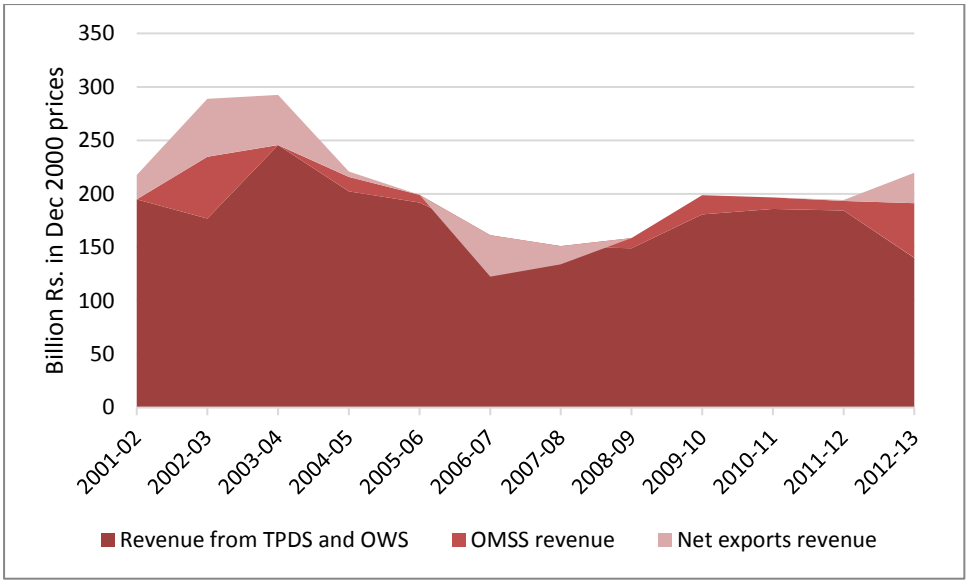

Figure 25 Composition of estimated revenues

Source: Own calculation based on FCI data

Note: In case net exports are negative, net export revenue also becomes negative, meaning net losses from trade.

The major component of fiscal cost (figure 24) is the cost of procurement, which consists of the MSP and acquisition costs. The considerable share in total costs, especially in recent years has been the cost of carrying the buffer stock. The rising trend in costs is mostly due to increasing volume of grain that is procured, distributed, and stored. On the revenue side (figure 25), a dominant role is played by revenues from the TPDS and OWS. Interestingly, it has declined in real terms, even though the volume of distribution has increased. This is because the CIP has been constant in nominal terms, which implies a sharp decline in its real value. Both export revenues (except for the beginning of the millennium) and OMSS revenues have usually had a negligible share in total revenue.

2.2.8. Seasonal dynamics of prices and stock inflows and outflows

The seasonality in the production of wheat, with one production season per year, and rice, with two seasons – the smaller rabi and the major kharif – finds reflection in the respective seasonal patterns in procurement (see figure 26 and 27). Most of the procurement is done around the major harvesting months. In the case of wheat, most of the grain is procured in two months – April and May. In the case of rice, the peak month is October; however, supplies come throughout the year, except for July and August. On the other hand, off-take under the TPDS and OMSS is steady throughout the year; as a result, stock levels are characterized by a pronounced seasonal pattern that reflects the seasonality of procurement. Another reason for fluctuations in the level of wheat stocks, not captured

in the figure 26, are OMSS releases, which usually happen, in case there are excessive stocks, before the arrival of the new harvest. As discussed before, OMSS does not apply in the case of rice.

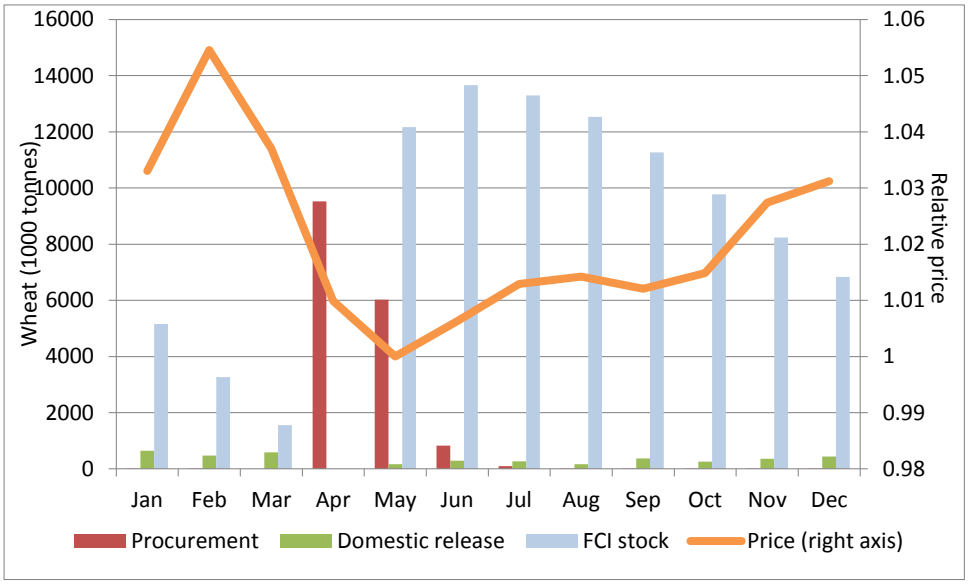

Figure 26 Seasonal pattern of wheat procurement, off-take, stocks and prices
Source: Own calculation based on the data from various DFPD Food Grain Bulletins

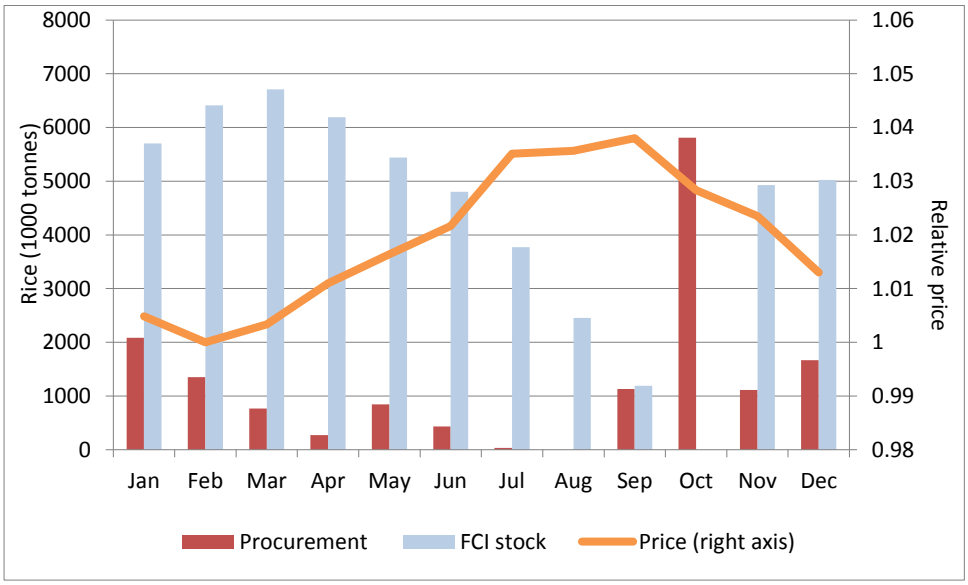

Figure 27 Seasonal pattern of rice procurement, off-take, stocks and prices
Note. Seasonal dynamics based on X12-Arima RSA3 filter using Demetra Plus software. For wheat and rice prices: Log-transformed monthly WPI prices for 1990 to 2013 have been used; FCI stocks from 2000 to 2012; domestic release (i.e. sum of off-take for TPDS, welfare schemes and OMSS open tender sales) for 2000 to 2006 (only wheat); procurement for 1998 to 2002. Differences in estimation spans stem from restricted data availability.
Source: Own calculation based on the data from various DFPD Food Grain Bulletins

The seasonality in procurement and stocks described above is reflected in the seasonal fluctuation in prices. Figures 26 and 27 show the normalized (to minimum value adjusted)

seasonal component. Along with the new harvest arrival that coincides with the lowest public stock level, market prices drop and later rise gradually through the year. Wheat prices before harvest are more than 5 per cent higher than after harvest; for rice, the gap is almost 4 per cent. However, these figures underestimate the seasonality as the underlying commodity WPI shows less fluctuation than the weighted average of wholesale market prices (see Appendix 1).

2.2.9. Summary and conclusions

The main findings of this chapter are as follows. Extensive market interventions resulted in a duality of the wheat and rice sectors with the coexistence of public and private sectors and dual prices, regulated and market prices. The regulated prices strongly influence real processes. Wheat and rice supply strongly and significantly respond to MSP. This result is robust with different specifications. In the case of wheat, price elasticity is higher, which might be due to the more commercial character of the crop. The price elasticities are high compared to acreage and yield elasticities for other countries, which can be explained by the low price risks due to minimum prices. Wholesale prices at planting or lagged harvest time prices are largely irrelevant.

The FCI procurement volume is driven by the production level and the difference between the MSP and the market price. For rice, there is also an upward trend in the proportion of procured grain to total production. Higher share of marketed surplus of rice is procured as compared to wheat. The gap between MSPs and the wholesale prices has narrowed in the last years.

The demand equation estimation turned out to be challenging due to the endogeneity of market price and because of the difficulty in accounting for the consumption from PDS (due do fluctuating and mostly unknown leakages from the PDS). Eventually, the instrumental variable regression was used to assess the impact of the market price on wheat and rice consumption. PDS grain was considered both as a perfect and imperfect substitute for market grain. The signs of the estimated price elasticities for wheat are significant and consistent with theory. For rice, they turned out to be insignificant. Rice consumption turned out to be determined mostly by the time trend and the PDS. The impact of the PDS on wheat consumption is ambiguous. This difference in influence of the PDS on consumption can be explained by the higher rice PDS off-take and lower leakage

and high additional subsidy (including universal public distribution) in some big rice consuming states.

Public stock analysis revealed that the average unexplained change in stock level between marketing seasons averaged 10 per cent for rice and 2 per cent for wheat. These unexplained changes might be linked to the storage losses. These numbers are difficult to compare with other studies' estimates of storage losses due to high variance in results and differences in methodology. OMSS allocations were usually made in case of wheat, rather than rice, due to higher seasonality of production and prices. The actual off-take for the OMSS was much below allocations.

Domestic prices in India were successfully protected from international price fluctuations, avoiding the up and down swings in the mid-1990s and during and after the 2007-2008 food crisis. Trade policies, on the one hand, protected farmers from the international price fluctuations, but on the other, subdued domestic prices. As a result, procurement was ample, and even excessive, with relatively low MSP. However, for the Indian farmers this policy measure meant foregone benefits from trade.

In general, rice market appears to be more regulated than the wheat market. This is visible in higher procurement levels, higher stocks and distribution, as well as more distorted demand.

The seasonal analysis of intra-year data revealed strong seasonality in procurement, in particular for wheat (less for rice). Off-take for the TPDS is non-seasonal. As a result, fluctuations in the stock level are characterized by strong seasonal patterns, which are accounted for in the buffer stock norms.

Starting from 2006-07, there has been a clear upward trend in inflation adjusted fiscal costs associated with procurement, storage and distribution of wheat and rice. There has been a strong rise in expenditures coming mostly from the rising procurement volume and the MSP. On the other hand, revenues have declined in real terms, due to lower real CIP and only marginal revenues from OMSS and exports. As a result, not only have total fiscal costs increased, fiscal costs relative to the amount of grains released through the PDS have also increased.

Limitations of our analysis lie in a high level of aggregation. As the aim of our study was to assess the outcomes of the central policies, we focused on the all-India aggregates. This framework neglects regional differences and state-specific environments. Further research should be carried out on the state level data. However, a time-series estimation shed light to important dynamics in the food sector in India and linked policy measures taken on the central level to their market outcomes. A comprehensive consideration of all major policies and their interplay gives a broad overview of the food grain sector and the forces that shape it. Further, the estimation of structural parameters can be used for partial equilibrium analysis, which implementation is discussed in Chapter 3.

3. Simulation of the NFSA implementation of vs. cash transfers – impacts on prices, stocks and fiscal costs[34]

‚…if we want to think about using cash transfers instead of the Public Distribution System, we have to consider all of the subsequent changes, what would happen to procurement and storage, and what would happen to the free market prices of grains.' (Deaton, 2015)

This chapter analyzes current and possible future reforms of the Indian food policies of the two most important staple grains, wheat and rice, within a two-commodity dynamic partial equilibrium model with stochastic shocks. Implementation of the National Food Security Act (NFSA) under several policy measures with the current regime as well as two scenarios with a regime change – implementation of cash transfers and deficiency payments. Implications for market fundamentals and fiscal costs were simulated in the medium term – are simulated until 2020/21.

3.1. Literature review and contributions

Contrary to econometric analyses, the current study allows considering equilibrium effects on prices, price variability and private grain stocks as endogenous market variables. Such an equilibrium model also allows analyzing counterfactual scenarios. At the same time, our model builds on the empirical analysis of the Indian food grain sector. Most of the functional forms and parameters were derived from the econometric time series analysis as discussed in Chapter 2. As a result, our model allows for simulations of counterfactual scenarios but it is well grounded in the real processes.

Several simulation models have been used to analyze the impact of various policies on rice and wheat. Krishna and Chhibber (1983) built a partial equilibrium model for the wheat sector to study the consequences of the dual price policy. The model was used to simulate output, government purchases and sales, imports, stocks and market prices of wheat under different scenarios. They showed a very high price sensitivity of wheat

[34] The earlier version of this chapter has been published as proceedings of the Ecomod2015 conference as Kozicka, M., Kalkuhl, M., & Brockhaus, J. (2015). Food Grain Policies in India and their Implications for Stocks and Fiscal Costs: A Partial Equilibrium Analysis. In Ecomod 2015. Boston. The revised version of this chapter has been accepted for a publication in the Journal of Agricultural Economics; currently scheduled to appear in Volume 68.1, January, 2017.

production and demand. The authors also found procurement responded strongly to production level changes. Schiff (1993) is another important study that examined the impact of dual pricing of wheat, rice and sugar for producers and consumers with a partial equilibrium model. The author distinguished three groups of actors affected by the pricing policy – the urban rich, the urban poor and the farmers and two trade regimes – free trade and closed economy. It was found that the effect of dual pricing has, under certain assumptions, a negative impact on prices and harms farmers, although it has a positive short-run impact on the urban poor. However, as the setup of Indian economy has changed a lot since the publication of these two papers, their results may not be applicable any more.

A series of more recent analysis of the sector policies within a partial equilibrium model was conducted by Jha and Srinivasan (for example Jha & Srinivasan, 1999). The authors published, jointly with Landes, a report (Jha, Srinivasan, & Landes, 2007) with extensive sector analysis and policy recommendations. They consider reduction in MSPs and alternatively, introduction of deficiency payments with the combination of decentralization. The authors recommended more liberal, market-oriented price policies with greater reliance on international markets. Our model extends their study with consideration of private stocks, new policy variables in the model, endogenous fiscal costs and different policy scenarios. Gouel, Gautam and Martin (2014) analyze welfare and cost implications of the current policies with a rational expectations trade-storage model for Indian wheat market. The authors found that significant cost savings through a combination of storage and trade costs could be made without any significant net loss in pure welfare through a less insulating trade policy implemented in conjunction with storage rules that are similar to, but above, competitive storage levels.

Explicit links of policies to the market fundamentals, consideration of both crops simultaneously and estimation of fiscal costs, implementation of endogenous international prices (large country case) as well as a solid empirical grounding in actual processes distinguishes the current setup and makes the study an important contribution to the above mentioned literature. Another extension we provide is a consideration of uncertainty coming from random production shocks, which is reported as variability of endogenous variables. A new reduced-form approach to model private storage based on

the competitive storage model is used. It does not require solving a rational expectations equilibrium by numerically estimating the value function. This approach allows to closely re-producing historical (private) storage data. Finally, we provide, to our best knowledge, the first broad assessment of implications of the NFSA in an equilibrium setup. We add to the literature (Kishore & Chakrabarti, 2015; Mishra, 2013; Pursell, 2014) which calculates costs of the implementation of the NFSA by considering partial equilibrium effects. A further important contribution is the simulation of consequences of alternative policy framework in India, namely cash transfers combined with deficiency payments.

3.2.Model description

Our model is a dynamic partial equilibrium model with two commodities, wheat and rice, and stochastic harvest shocks. They are indicated by a subscript $i \in \{w, r\}$. A subscript t denotes a year and $t \in \{2013, \dots, 2020\}$, which is a time span for simulations. All prices are in real terms, deflated by the wholesale price index (WPI).

Caveats of this framework are typical for partial equilibrium models – a bigger picture is neglected, for example there is no link to job market and other sectors.

3.2.1. Current policy framework

All functional forms, except for equations for private exports and international price, are based on the empirical ex-post analysis in chapter 2 and for private stocks, in Kozicka, Kalkuhl, Saini and Brockhaus (2015) and match the current policy framework – open-ended procurement with the MSP, distribution through the PDS and corresponding private and public stocks.

The exogenous variables are: PDS – volume and price, MSP, stock norms, population and GDP growth rates, inflation (WPI), trade regime, acquisition, distribution and storage costs. Endogenous variables in the partial equilibrium model are determined with the following equations:

Production

8 $$\ln Q_{t,i} = \alpha^{p}{}_{0} + \alpha^{p}{}_{1} \ln p_{t,i}^{MSP} + \alpha^{p}{}_{2} \ln t + \alpha^{p}{}_{3} R_t + \varepsilon_{t,i},$$

where $Q_{t,i}$ is a yearly production volume of the *i*-th crop, p_i^{MSP} is the real minimum support price, *t* is a trend variable, *R* is total yearly rainfall (in a calendar year), $\varepsilon_{t,i}$ is stochastic production shock.

Demand

9 $$\boldsymbol{ln\, D_{t,i}^{net\ cap} = \alpha^d{}_0 + \alpha^d{}_1 \ln p_{t,i} + \alpha^d{}_2 \ln p_{t,i}^{cross} + \alpha^d{}_3 \ln PDS_{t,i}^{cap} + \alpha^d{}_4 \ln t},$$

where $D_{t,i}^{net\ cap}$ is per capita yearly consumption of the *i*-th crop net of consumption through the PDS, $p_{t,i}$ is a yearly average of the own price of the *i*-th crop and $p_{t,i}^{cross}$ is the price average of the other crop (cross price), both in real terms, t is a time trend. The variable $PDS_{t,i}^{cap}$ is per capita off take under the PDS.

$PDS_{t,i}^{cap} = \frac{PDS_{t,i}}{Pop_t}$, where $PDS_{t,i}$ is a total off-take for PDS of the *i*-th crop in year *t* and Pop_t is a population of India in year *t*.

$D_{t,i}^{net\ cap} = \frac{D_{t,i}}{Pop_t} - \frac{\xi_i PDS_{t,i}}{Pop_t} = D_{t,i}^{cap} - \xi_i PDS_{t,i}^{cap}$ is a relationship between net per capita demand, per capita demand and total demand $D_{t,i}$. ξ_i is an average leakage from PDS.

Procurement

10 $$\frac{D_{t,i}^{FCI}}{Q_{t,i}} = \alpha^{pr}{}_0 + \alpha^{pr}{}_1 \frac{p_{t,i}}{p_{t,i}^{MSP}} + \alpha^{pr}{}_2 t,$$

where $D_{t,i}^{FCI}$ is the yearly procurement level of the *i*-th crop. Thus, on the left hand side of the equation, there is the share of public procurement in total production and on the right hand side, there is a ratio of market price to the MSP and the trend.

Private stocks

Private stocks are modeled using a reduced-form approach that proxies the dynamics of the competitive storage model with rational expectations equilibrium (Deaton & Laroque, 1992; Williams & Wright, 2005). Brockhaus and Kalkuhl (2015) showed how this model can be used to derive a reduced-form equation which can approximate speculative private storage behavior. If domestic supply in terms of harvest and last year's private and public carry-over stock are high, private stocks increase. Hence:

11 $$\frac{X_{t,i}^{priv}}{D_{t,i}^{trend}} = \alpha^s{}_0 + \alpha^s{}_1 \frac{S_{t,i}}{D_{t,i}^{trend}} + \alpha^s{}_2 \frac{X_{t,i}}{D_{t,i}^{trend}},$$

where $X_{t,i}^{priv}$ is the private stock of the *i*-th crop in the marketing year t, $D_{t,i}^{trend}$ is the consumption trend, approximated by a linear trend for simulations, $S_{t,i}$ is a total market supply calculated as $S_{t,i} = Q_{t,i} + X_{t-1,i}^{priv}$ and $X_{t,i}$ is the FCI stock (public stock).

Private exports

Private exports and imports, unless there are government interventions in the form of e.g export bans, are determined by the spatial arbitrage condition[35]:

12a $$\boldsymbol{Exp_{t,i}} \geq \mathbf{0} \perp -\boldsymbol{p_{t,i}^{int}} + \boldsymbol{p_{t,i}} + \boldsymbol{\theta_{ex}} + \boldsymbol{\omega_i} \geq \mathbf{0},$$

12b $$\boldsymbol{Imp_{t,i}} \geq \mathbf{0} \perp \boldsymbol{p_{t,i}^{int}} - \boldsymbol{p_{t,i}} + \boldsymbol{\theta_{im}} \geq \mathbf{0},$$

where $Exp_{t,i}$ and $Imp_{t,i}$ are the total volume of private export and import respectively in a financial year, $p_{t,i}^{int}$ is an international price converted to Rupees, in real terms (divided by Indian WPI), $p_{t,i}$ is a domestic price, θ_{ex} and θ_{im} are trade costs and ω_i is an export tariff.

Public exports

Public exports occur in times of an excessive stock (stock above the norm), when a certain share, τ, is released. When the stock is not sufficient to feed the PDS needs with a certain reserve, the required volume is imported. η defines the operational needs, for example $\eta = 0.25$ would mean a 3-month PDS requirement.

13 $$\boldsymbol{NExp^{pub}{}_{t,i}} = \mathbf{min}(\boldsymbol{X_{t,i}} - \boldsymbol{\eta PDS_{t,i}}, \boldsymbol{\tau}(\boldsymbol{X_{t,i}} - \boldsymbol{NX_{t,i}})),$$

where $NExp^{pub}{}_{t,i}$ is the total volume of net public export in a financial year, $X_{t,i} - NX_{t,i}$ is a public stock surplus (above the stock norm) and $PDS_{t,i}$ is a PDS off-take.

International price

[35] $\perp$ is used in the mixed complementarity condition means that the two inequalities on the both sides of the symbol are orthogonal, so if one equation holds as a strict inequality, the other side holds as a strict equality.

International price is determined endogenously as a deviation from a 'base' price, depending on the total net exports from India. The focus on impacts within India justifies the assumption that world market prices are stable apart from the influence of India's exports. Non-stable world prices would add an additional stochastic component which makes the results depended on the specific realization but would not change the expected values. Hence, we are not modelling the international prices but only the impact of the Indian policies on them.

14 $$\boldsymbol{p_{t,i}^{int}}=\boldsymbol{p_i^{int}}\left[\mathbf{1}-\boldsymbol{\gamma}(\boldsymbol{NExp^{pub}}_{\boldsymbol{t,i}}+\boldsymbol{NExp_{t,i}})\right],$$

where $p_{t,i}^{int}$ is international price in rupees, Indian WPI deflated, p_i^{int} is 'base' international price(international price without trade with India), γ is a sensitivity of international price to Indian net exports.

Open Market Sale Scheme (OMSS)

Similarly to public exports equation, stock off-takes via the OMSS, $OMSS_{t,i}$, are calculated as a share κ of excessive public stocks, whenever excess stocks are positive:

14 $$\boldsymbol{OMSS_{t,i}}=\boldsymbol{\kappa}\,\mathbf{max}(\mathbf{0},\boldsymbol{X_{t,i}}-\boldsymbol{NX_{t,i}}),$$

MIP

The Minimum Issue Price $MIP_{t,i}$, the price at which grains are sold through the OMSS, is determined by

15 $$\boldsymbol{MIP_{t,i}}=(\mathbf{1}+\boldsymbol{ec_i})\boldsymbol{MSP_{t,i}},$$

where ec_i is the 'economic cost' markup representing storage and transaction costs borne by the FCI.

Fiscal cost

The fiscal costs for the government are calculated as

16 $$\boldsymbol{FC_t}=\sum_{\boldsymbol{i}}(\boldsymbol{ac_{t,i}D_{t,i}^{FCI}}+\boldsymbol{c_{t,i}^{d}PDS_{t,i}}+\boldsymbol{k_t}\boldsymbol{X^{op}}_{\boldsymbol{t,i}}-\boldsymbol{p_{t,i}^{PDS}PDS_{t,i}}-\boldsymbol{MIP_{t,i}OMSS_{t,i}}-\boldsymbol{p_{t,i}^{EX}NExp^{pub}}),$$

where FC_t are yearly fiscal costs, $ac_{t,i}D_{t,i}^{FCI}$ are acquisition costs of the *i*-th crop, $c_{t,i}^{d}PDS_{t,i}$ are distribution costs, $k_t X^{op}{}_{t,i}$ is buffer carrying cost (where $X^{op}{}_{t,i}$ is the operational

stock, which is buffer stock of wheat and rice in the central pool minus four month off-take for PDS and OMSS) and $p_{t,i}^{PDS} PDS_{t,i} + MIP_{t,i} OMSS_{t,i} + p_{t,i}^{EX} NEX_{t,i}^{pub}$ are sales realizations (revenues) from sales from PDS, OMSS and net export off-take. Detailed specification of the components of the fiscal cost equation can be found in the table 8 (section 2.2.7).

The dynamic equilibrium model is closed by two identity equations:

Public stocks

17 $$\boldsymbol{X_{t,i} = (1 - \delta_i) X_{t-1,i} + D_{t,i}^{FCI} - OMSS_{t,i} - PDS_{t,i} - Nexp^{pub}_{t,i},}$$

where δ_i is the public stock deterioration rate.

Market clearing

18 $$\boldsymbol{Q_{t,i} + OMSS_{t,i} + PDS_{t,i} = D_{t,i} + Nexp_{t,i} + D_{t,i}^{FCI} + X_{t,i}^{priv} - (1 - \delta^{p}{}_{i}) X_{t-1,i}^{priv},}$$

where $\delta^{p}{}_{i}$ is the private stock deterioration rate.

3.2.2. Cash transfers and deficiency payments

An alternative to state procurement and food price subsidies are deficiency payments and cash transfers. They are considered to provide in principle similar social benefits by increasing real incomes of producers and consumers while reducing market distortions (Blackorby & Donaldson, 1988; Esmaeili, Karami, & Najafi, 2013).

A change from the PDS to cash transfers is modelled by adding the transfer to the disposable income in the demand equation and, on the government side, to fiscal costs while setting $PDS_{t,i} \equiv 0$.

19 $$\boldsymbol{ln\, D_{t,i}^{cap} = \alpha^{d}{}_{0} + \alpha^{d}{}_{1} \ln p_{t,i} + \alpha^{d}{}_{2} \ln p_{t,i}^{cross} + \alpha^{d}{}_{3} \ln(Income_{t}^{cap} + Cash_{t}^{cap}) + \alpha^{d}{}_{4} \ln t,}$$

where $D_{t,i}^{cap}$ is per capita yearly consumption of the *i*-th crop, and $Cash_t^{cap}$ is a yearly per capita cash transfer.

In case of cash transfers, there is no need for high public stocks. Stock norms are kept low, only to cover the emergency reserve. As a result and contrary to equation 10,

procurement happens only when stocks fall below the norms, which can be presented as $D_{t,i}^{FCI} = \max(0, NX_{t,i} - X_{t,i})$.

For the grain rotation, a fraction of the stock is released through the OMSS and the rest is exported. In order to provide support to the farmers and incentivize production, at times when market price falls below the support price (equal to the former MSP), farmers are offered deficiency payments. This is why the production function still has the MSP instead of the market price as the MSP is shaping the expectations of producers. The amount of payment is added to the fiscal costs.

Because our model is based on the empirics, it is useful mostly for short- and medium-term simulations. It needs to be noted that the introduction of cash based transfers and a significant reduction in public stock levels are a major change to the underlying assumptions of the data generating process that it naturally leads to a higher level of uncertainty attached to these scenarios.

3.3.Scenarios

Seven different scenarios projecting the exogenous variables and policy shifts over the next ten years until 2020-21 were simulated with the model. The baseline scenario assumes the implementation of the NFSA, which regulates the exogenous PDS distribution to 67 per cent of the Indian population with the rations defined by the Act and stock norms set to meet the new needs of the system. Management of the system is similar to the past – with growing MSP, small sales through the OMSS and exports. Other exogenous variables develop in a 'likely' way. Details are shown in table 9:

Variable	**Scenario**
MSP	2% yearly real growth
Rainfall (R)	Moving average of past 15 observations
Population (POP)	Growth at 1.3% per year (as in the last years)

PDS off-take	For 2013-14, as estimated for the NFSA obligations (based on DFPD (2014 p.27) estimates for the TPDS and own estimates for the OWS, total wheat and rice off-take is 59.97 million tonnes, with 33 million tonnes related to rice and 27 million tonnes to wheat), in the following years 1.3% yearly growth - the same as population growth
Real disposable income	In 2013-14, 4.8% growth , 2014-15, 5.7% growth, 6.5% growth from 2015-16 onwards (from the OECD GDP growth estimates and forecasts, WEO October 2014)
WPI	In 2014-15, 10%, equal to 6% from 2015-16 onwards (WEO (October 2014) projects declining CPI from 7.5% in 2015 to 6% in 2019)
Trade regime	No export bans
Acquisition costs, distribution cost, annual rate of buffer carrying cost	2% real yearly growth
Central issue price	Nominal as stated in the NFSA (2 Rs./kg for wheat and 3 Rs./kg for rice)

Table 9 Projection of exogenous variables in baseline scenario
Source: Own design

The alternative scenarios 1-4 assume implementation of the NFSA (in terms of distribution and stock norms) and different policy measures to fulfil its requirements. Scenarios 5 and 6 assume alternative policy framework with cash transfers and deficiency payments. They differ with the cash transfer coverage. Details are as follows:

Scenario 1 – varying MSP scenario: In this scenario price dynamics are set to meet the NFSA requirements with minimal procurement and stock levels. The MSPs are used to minimize the excessive stock levels (keep stocks close to the norms) and curb fiscal costs. As a result, the MSPs and acquisition costs change with a varying growth rate between 2013 and 2020: The wheat MSP grows on average by 1 per cent yearly in real terms and the rice MSP declines by 2/3 per cent annually in real terms (which means growth nominally) by 2016 and grows further on. As a result the average annual growth rate is close to 0 per cent. The rest is the same as in the baseline scenario.

Scenario 2 – aggressive OMSS: In this scenario OMSS is used to meet the NFSA requirements with ample level of procurement and high MSP growth rates. Stock levels

are kept close to the norms with high OMSS sales. MSP growth rates are set in real terms 2 per cent and 3 per cent for rice and wheat accordingly, the rest as in the baseline scenario.

Scenario 3 – export bans: In this scenario trade bans are used to meet the NFSA requirements with moderate MSPs. MSPs are set to grow with 1 per cent for rice and 2 per cent for wheat in real terms annually and in times of insufficient stocks (below the stock norms) export bans are introduced. The rest as in the baseline scenario

Scenario 4 – aggressive imports: In this scenario, farmers' support and procurement are minimized while imports are used to insure functioning of the NFSA. Therefore, MSPs are kept constant in real terms the Public distribution system supplies are supplemented with public imports. The rest is the same as in the baseline scenario.

Scenario 5 – cash transfer and deficiency payment: The idea of an alternative way to ensure food security is explored in this scenario. We assume that 67 per cent of the population receives the equivalent of the NFSA ration (5 kg of food-grains per person per month against Rs. 3/2 per kg for rice/wheat) in cash. The transfer is linked to the market price in the model (which is endogenous). In the model, market price is in the wholesale level, so we add 15 per cent markup to reproduce a consumer price. The emergency reserve is equal to 2 mt of wheat and 3 mt of rice. MSPs are kept constant in real terms. If market prices fall below the MSP, 30 per cent of produced grains receive the difference between the two prices. 30 per cent is close to the recent procurement levels – hence the deficiency payment policy would not create additional fiscal costs. Implementation of the deficiency payments with restricting the support to the 30 per cent of the production might cause several problems. First, if more than 30 per cent does not receive the price above the MSP, how the eligible farmers should be selected? The wealth/income criterion would serve the purpose of transferring income to the poor farmers. However, as a consequence, the response to the MSP changes might be different under the new policy regime because the non-poor farmers face higher price risks as compared to the open-ended procurement. For our modelling exercise, this might mean a structural change in the production function which corresponds to the current regime. However, it is plausible to assume that the volume of grains sold to the FCI (historically maximum 30 per cent of production) is the upper bound for the deficiency support.

Scenario 6 – cash transfer for 30 per cent and deficiency payment: In this scenario, in order to curb fiscal costs, we assume that only those below poverty line receive consumer transfers, however the ration is set exogenously and is much higher than in the scenario 5. This means that 30 per cent of the population receive Rs. 200 in 2013 prices, constant in real terms. Rs. 200 was an equivalent of 10.5 kg of wheat in New Delhi and 5.9 kg of rice in Chennai in January 2013 (FAO GIEWS retail price). To compare with, in a randomized control trial in Delhi, India in 2010-2011 offered Rs. 1000 in unconditional cash transfer per household (Gangopadhyay, Lensink, & Yadav, 2013). The rest is the same as in the scenario 5.

3.4.Calibration

Most of the functional forms and parameter values were estimated using national aggregates from 1982 until 2012. All parameters are reported in tables 10 and 11.

	Demand equation		
		Wheat	**Rice**
$\alpha^d{}_1$	Own price elasticity	-1.01	-0.11
$\alpha^d{}_2$	Cross price elasticity	0.7	0.02
$\alpha^d{}_3$	PDS elasticity	-0.07	-0.33
ξ_i	Average leakage from PDS	0.75	0.38
	Production equation		
$\alpha^p{}_1$	MSP elasticity	0.65	0.39
$\alpha^p{}_3$	Rainfall elasticity	0.35	0.5
	Procurement equation		
$\alpha^{pr}{}_1$	Price ratio parameter	-0.39	-0.26
	Private stocks equation		
$\alpha^s{}_1$	Supply parameter	0.34	0.34
$\alpha^s{}_2$	Public stock parameter	-0.62	-0.62
	Public exports equation		
η	PDS requirements parameter	0.3	0.3
τ	Excessive stock release parameter	0.1	0.1
	OMSS equation		
κ	Stock release parameter	0.2	0.2
	Trade specification		

p_i^{int} (Rs/t/WPI)	Base export price[a]	20	24
γ	India export response[a,b]	0.035	0.035
θ_{ex}, θ_{im}	Export/import costs[a]	2.4	2.4
ω_i	Export tariff[a]	0	2
	MIP equation		
ec_i	MSP markup[a]	0.45	0.45
	Public stock and identity equation		
$\delta^p{}_i$	Public stock deterioration rate	0.1	0.02
δ_i	Private stock deterioration rate [a]	0.02	0.02

Table 10 Estimated parameters - current policy framework

[a] *Calibrated*

[b] *Jha and Srinivasan (1999) quote IFPRI's IMPACT model, which gives the percentage decrease in world rice price due to 1 million tonnes of additional Indian rice exports as 4.7%. We use calibrated 3% response for both wheat and rice markets.*

Source: Own design. Parameters, if not calibrated, are based on estimations discussed in chapter 2.

Wheat demand is much more sensitive to market price changes than rice, whereas rice demand is more dependent on PDS distribution. This is probably because PDS functions much better for rice distribution – more rice is consumed form PDS than wheat, rice leakage is much smaller, and major rice consuming states provide additional subsidy and higher coverage than offered by the center. For example, rice in AP, Karnataka, Kerala and Odisha is priced for the poor at only Rs./kg 1. Tamil Nadu has a unique universal PDS, delivering rice to everyone free of cost (DFPD, 2014, p. 54)

Production strongly responds to MSP, which is probably because this price is high enough to cover the cost of production and there is very low risk attached to it.

		Wheat	**Rice**
	Demand equation – cash[b]		
$\alpha^d{}_1$	Own price elasticity	-0.7	-0.25
$\alpha^d{}_2$	Cross price elasticity	0.65	0.15
$\alpha^d{}_3$	Income elasticity	0.18	0.02

Table 11 Estimated parameters – policy change

[b] Wheat elasticities were estimated and rice taken from (P. Kumar et al., 2011)

3.5. Simulations

Our system of equations is written in the General Algebraic Modelling System (GAMS) programming language and solved with the Mixed Complementarity Problem (MCP) solver PATH. We further considered 1000 realizations of a random *iid* production shock $\varepsilon_{t,i}$ ~ N(0, 0.05) for each scenario simulation to analyze the role of uncertainty and the impact of policies on price volatility. The parameters of the distribution of $\varepsilon_{t,i}$ are based on historical realizations of the production shocks (discussed in section 2.2.2).

This number of simulations per scenario produces robust results. In a sample of 10 simulations (each including 1000 realizations of random shocks) for the MSP scenario, maximum difference of prices (domestic and international) between means for consecutive simulations was less than 0.5 per cent and for fiscal costs less than 0.7 per cent.

3.5.1. Model fit and selected baseline scenario results

The model reproduces past values of major endogenous variables quite well. Wheat demand tends to be underestimated, which might be the reason for underestimation of the market price. On the contrary, rice demand is slightly overestimated, the same as rice prices. Supply of both crops is precisely reproduced, as all the explanatory variables are exogenous for the historical phase, including supply shocks, and were introduced into the model[36].

In the baseline scenario, production grows along with the real MSP growth in the medium term. In 2020, total wheat and rice production reaches 208.8 mt. Total consumption grows due to population growth, higher PDS distribution, as outweighed by slightly rising market prices. In 2020, total wheat and rice consumption reaches 199.8 mt.

There are no export bans assumed in this scenario and, as a result, net private exports are between 0 mt and 0.2 mt for wheat and 4.8 mt and 7 mt for rice. The difference arises because Indian rice is more competitive internationally and we do assume no export subsidies. Wheat public net exports vary between -0.7 mt and 0.8 mt, whereas rice is exported at volumes between 0.9 mt and 1.4 mt. Also there are small off-takes for OMSS for both wheat and rice – below 1.6 mt of wheat and between 1.9 mt and 2.9 mt of rice.

[36] In Appendix 5 we present figures with means of the simulated values for consumption, production, prices, procurement and stocks along with their standard deviations in the projection period. We further compare them with the original time series – actual levels of the variables.

This is a result of a rule to release excessive stocks. Prices are rather stable and steadily grow in real terms, by 15 per cent for wheat and 9.1 per cent for rice between 2012 and 2020.

Despite the drop in 2013 in the case of wheat, procurement of both crops is in an upward trend, feeding the growing needs of the PDS under NFSA. The major difference between rice and wheat due to the NFSA is that PDS off-takes for rice remain close to the previous level (close to 33 mt), whereas for wheat it grows from 23 mt to 27 mt (in 2013, further it grows along with the population growth). This is reflected in decreasing wheat stocks (figure 28). Higher pressure on wheat PDS and equal growth of MSPs results in growing rice stocks and declining wheat stocks. Stock norms under NFSA are close to 10 mt for wheat and 11 mt for rice, as estimated by Gulati and Jain (2013). Figure 28 illustrates how sensitive the public stocks are to policy changes. A growing MSP for rice can lead to abundant stocks and, as it will be discussed further, to high fiscal costs, whereas wheat stocks even fall slightly below the norms. Finally, simulated private stock is less than 1 mt in the baseline scenario – mostly as a result of crowding out by high public stock. In terms of variability, most of the outcomes (production, procurement, prices and stocks) are more stable for wheat.

An alternative within the current policy framework is careful management of the MSP, which can minimize public stock levels and the fiscal cost. This is simulated under scenario 1.

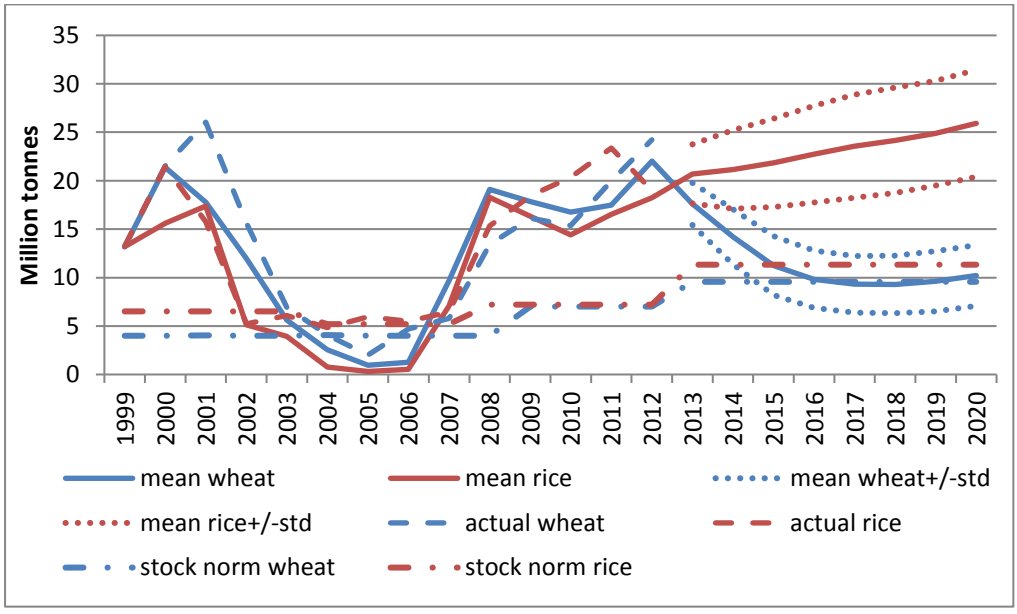

Figure 28 Ex-post and baseline scenario public stock simulation
Note: Mean +/- std means the mean realisation plus or minus its standard deviation based on 1000 simulations of a random production shock
Source: Own design

3.5.2. NFSA management policy measures

A comparison of the implications of the NFSA implementation in 2020 under different policies is reported in table 12. Different strategies to deliver the NFSA commitments have sometimes heterogeneous effects on wheat and rice markets, however some common tendencies can be outlined. High subsidies in baseline and OMSS scenarios result in the highest fiscal costs and lowest domestic prices. Fiscal cost related to wheat is 15 per cent higher under the most expensive OMSS scenario, as compared to the cheapest imports scenario. In case of rice, fiscal costs are the highest in the Baseline scenario and consistently the lowest in the Imports scenario with a difference of 21 per cent. MSP and Imports scenarios, on the contrary, lead to the highest domestic market prices and are the cheapest, with the MSP scenario yielding slightly higher fiscal costs among these two. Domestic prices in the Imports scenario are higher by 4 per cent for wheat and equal for rice, as compared to the OMSS scenario. Interestingly, the Trade ban scenario, so managing the system with export bans results in the lowest domestic price variability across simulations. This means that under this scenario, prices are the least affected by the domestic production shocks. The reported standard deviations in the table can be also interpreted as the level of uncertainty related to the realization of the variable. Price volatility over time is discussed in the section 3.5.4.

High reliance on trade in the Imports scenario results in large public imports and as a result relatively high international price levels and variability, especially in case of wheat. High international prices trigger private exports of 3.1 mt for wheat and 5.5 mt for rice. High private exports (over 6 mt) accompanied by small public exports of rice and no imports of wheat in OMSS scenario lead to the lowest and in the case of wheat, most stable, international prices. The international rice price under OMSS as compared to the MSP and Imports scenarios is lower by 12 per cent. This is a result of high production subsidy paid by the Indian government.

Under the NFSA the majority of consumers are covered with highly subsidized wheat and rice rations, with the poorest consumers receiving the substantial amount of 35 kg per

family. As a result, market prices affect the poor only partially. On the other hand, support for the producers varies between the scenarios, so in some variants, high market prices are desirable. Taking these circumstances under consideration, the best policy strategy under implementation of the NFSA is to minimize fiscal costs. This can be achieved through keeping MSPs low and relying more on imports to feed the public distribution system (Imports scenario). However, this strategy can result in very low public stock levels

		(1)MSP		(2)OMSS		(3)Trade bans		(4)Imports		Baseline	
		Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD
Wheat	Domestic Price	20.2	1.2	18.2	1.5	19.6	1.0	21.0	1.1	19.0	1.1
	International price	20.4	0.9	19.6	0.7	20.7	0.9	23.4	1.1	20.3	0.8
	Private net export	0.0	0.0	0.3	0.7	0.0	0.1	3.1	0.8	0.0	0.2
	Private stocks	1.3	1.5	0.3	0.7	1.1	1.1	3.4	1.5	0.6	0.9
	Public stock	10.2	3.6	13.1	2.6	8.6	2.5	1.6	1.6	10.2	3.1
	Public net export	-0.6	1.3	0.3	0.4	-1.0	1.3	-8.0	1.6	-0.5	1.2
	Fiscal cost	85.1	6.9	88.4	5.4	84.3	5.5	76.8	3.5	86.5	6.7
Rice	Domestic Price	24.8	2.7	21.2	2.8	23.0	1.9	24.9	2.7	21.7	2.1
	International price	31.5	2.7	27.8	2.8	30.2	2.7	31.5	2.7	28.3	2.1
	Private net export	5.9	1.2	6.2	1.9	4.3	1.6	5.5	1.2	4.8	1.3
	Private stocks	3.7	2.4	0.7	1.0	0.4	0.8	2.0	2.1	0.0	0.2
	Public stock	10.0	4.4	16.5	3.0	17.4	4.9	11.4	4.8	26.1	5.7
	Public net export	-2.1	2.6	0.5	0.4	0.6	0.6	-1.7	2.5	1.5	0.6
	Fiscal cost	137.1	12.2	148.6	11.7	144.1	13.8	131.2	12.6	159.0	15.5

Table 12 Simulation results – means and standard deviations (STD) in 2020 for the five scenarios

Note: Means and standard deviations are calculated for stochastic shocks realization; Rice prices are reported for milled rice (as opposed to paddy); fiscal costs are in Rs. Cr/WPI; All the aggregate volumes are reported in million tons (mt), prices are reported in Rs./kg in real terms (divided by WPI)

in case of wheat, slightly mitigated by higher private stocks. If insuring sufficient public stocks has a high priority – e.g. for political reasons but also due to the 'right to food' approach of the NFSA, the best strategy is to adjust the MSP to meet the stock norms (MSP scenario). However, setting the 'right' MSP level can be a very difficult task. The solution can be to renew the procurement price institution, i.e. keeping the MSP at the minimum and in case of insufficient procurement levels, introducing additional procurement with a higher price but only until the stock norms are achieved.

3.5.3. Cash transfers and deficiency payment scenarios

The introduction of cash transfers instead of physical food delivery and deficiency payments instead of procurement of wheat and rice has various implications for the food system. In table 13 we present a comparison of this alternative policy framework under

two different coverages with the MSP scenario. Results are slightly different for wheat and rice partly due to different coverage with these crops with the PDS and higher leakage in wheat distribution.

		(1) MSP		(5) Cash 67%		(6) Cash 30%	
		Mean	STD	Mean	STD	Mean	STD
Wheat	Production	96.8	4.9	87.9	4.5	87.9	4.4
	Consumption	96.4	2.8	90.2	3.1	90.2	3.2
	Domestic Price	18.2	1.5	23.5	2.4	23.4	2.6
	International price	19.6	0.7	21.6	1.8	21.6	1.9
	Private stocks	1.3	1.5	3.7	1.6	3.6	1.6
	Public stock	10.2	3.6	1.9	0.0	1.9	0.0
	Fiscal cost	85.1	6.9	61.9	6.8	63.8	0.1
Rice	Production	108.9	5.3	107.2	5.3	107.6	5.4
	Consumption	104.6	1.0	105.5	2.1	105.5	2.2
	Domestic Price	24.8	2.7	28.5	3.9	28.4	4.3
	International price	31.5	2.7	34.1	2.3	34.0	2.4
	Private stocks	3.7	2.4	9.4	1.9	9.5	2.0
	Public stock	10.0	4.4	3.0	0.0	3.0	0.0
	Fiscal cost	137.1	12.2	89.7	12.7	65.2	2.3

Table 13 Simulation results – means and standard deviations (STD) in 2020

Note: Means and standard deviations are calculated for stochastic shocks realization; Rice prices are reported for milled rice (as opposed to paddy); fiscal costs are in Rs. Cr/WPI; All the aggregate volumes are reported in million tons (mt), prices are reported in real terms (divided by WPI)

In both cash scenarios, production is lower than under the MSP scenario. This is an outcome of lower support prices. However, consumption is affected variously – for wheat it is lower and for rice, higher. Cash scenarios result in significantly higher domestic and international market prices and their variability except for the international rice price variability, which slightly declines under cash scenarios. This implies that international prices would be less affected by the Indian supply. Domestic market prices are higher by 14-29 per cent under cash scenarios. Again, the standard deviation was calculated across the production shock realizations, so it refers both to the uncertainty of the projection and the sensitivity of the price to production shocks. International prices are higher by 7.8 – 10.4 per cent in cash scenarios as compared to the MSP scenario. Public stocks are limited to emergency reserves in cash scenarios and, as a result, public stock levels go down to 1.9 mt for wheat and 3 mt for rice. This results in significantly higher private wheat stocks. In the Cash 67% scenario, fiscal costs for rice are reduced by over 27 per cent and, even more, 35 per cent for wheat.

Significant cost reduction can be achieved through delivering cash only to the poor, specifically to those, living below the poverty line. This is estimated to be 30 per cent of the population (according to the Rangaranjan report (Planning Commission, 2014). In this scenario, the cash transfer is increased to Rs. 200 per person per months, however fiscal costs are still dramatically lower - 42 per cent less than is the MSP scenario. However, in the Cash 30% scenario, between 2014 and 2020 market price of wheat grows by 29 per cent and of rice, by 14.4 per cent in real terms, which means a significant drop in wheat and rice quantity which can be bought for the transfer amount. The allowance is constant in real terms. On the other hand, the idea of delivering cash instead of in-kind transfers, assumes that the money can be spent on different goods and the average purchasing power of the transfer remains the same due to indexing it with inflation. Linking the transfer to the inflation of the poor would be a useful improvement of this policy measure. Finally, other problems related to cash transfers should be considered. As it was discussed by Birner and von Braun (2015), cash transfers are recommendable only in certain policy contexts.

3.5.4. Domestic price volatility

Excessive price volatility can have several negative implications for food security and macroeconomic stability (as discussed e.g. in Kalkuhl, Kornher, Kozicka, Boulanger, & Torero, 2013; von Braun & Tadesse, 2012). Food price instability can also have its political cost (Arezki & Brückner, 2011; Sidhir, 2004), which needs to be taken under consideration. In our simulation results, inter-annual price volatility differs quite significantly across scenarios, as presented in table 14.

The highest domestic wheat price volatility under the NFSA implementation is in the Imports scenario. In case of rice, the highest volatility is in the MSP scenario. Introduction of cash transfers and deficiency payments results in even higher domestic price volatility. Aggressive price stabilization policies have a significant impact in the model. The lowest domestic price volatilities are in the Baseline and the Trade bans scenarios.

	Wheat	**Rice**
(1) MSP	1.26	1.67
	(0.35)	(0.51)
(2) OMSS	1.15	1.48
	(0.35)	(0.45)

(3) Trade bans	0.99 (0.27)	1.24 (0.34)
(4) Imports	1.38 (0.37)	1.52 (0.49)
(5) Cash 67%	2.22 (0.56)	1.94 (0.66)
(6) Cash 30%	3.03 (0.77)	2.35 (0.85)
Baseline	0.97 (0.27)	1.17 (0.32)

Table 14 Simulation results – inter-annual domestic price volatility

Note: Price volatility was calculated as annual log returns standard deviation in the projection horizon, i.e. from 2013 to 2020. The means and standard deviations (in parenthesis) of 1000 simulations of each scenario are presented in the table.

3.5.5. Stocks and fiscal costs

The baseline scenario puts the highest pressure on the fiscal costs. High procurement, high stocks (37 mt) and large distribution with highly subsidized prices to a growing population causes the fiscal cost in our simulation to grow by 49 per cent in real terms between 2012 and 2020 (table 15). In terms of GDP share the number grows from 1.2 per cent to only 1.8 per cent, thanks to the growing economy. The OMSS scenario with slightly lower stock levels also results in very high fiscal cost. This is due to higher MSP levels and higher procurement, so effectively higher transfers for farmers. Relying on imports yields the lowest total stock level of 18 mt and the lowest fiscal cost of 1.5 per cent of GDP, among the NFSA scenarios. The Imports scenario has low fiscal cost because the MSPs are low, which results in low stocks. Only those grains which are necessary to feed the NFSA are imported if there are too low supplies in the domestic market. The MSP scenario results in total stock of 25 mt and still considerable cost of 1.6 per cent of GDP.

The Cash 67% scenario brings significant savings and shrinks fiscal costs to 1.1 per cent of the GDP. In addition, due to higher private stocks, total stock amounts to almost 18 mt. This means that stable food supplies are partially carried out by the private market.

The Cash 30% scenario is the 'cheapest' option causing the fiscal cost to decrease in real terms by 22 per cent. Under this scenario, fiscal costs amount to 0.9 per cent of GDP in 2020. Stock levels are similar to the Cash 67% scenario.

	Baseline	**(1) MSP**	**(2) OMSS**	**(3) Trade bans**	**(4) Imports**	**(5) Cash 67%**	**(6) Cash 30%**

Total stock (public+private)	36.9	25.3	30.5	27.6	18.3	17.9	18.0
Total fiscal cost (in % of GDP)	1.8	1.6	1.7	1.6	1.5	1.1	0.9
Total fiscal cost (nominal in Rs. Bln)	3002	2717	2898	2793	2543	1854	1577
Fiscal cost growth (% 2020 over 2012, in real terms)	48.5	34.3	43.3	38.1	25.8	-8.3	-22.0

Table 15 Simulation results –total stocks and fiscal costs in 2020

Note: According to our estimates (using the same methodology as in the table), fiscal cost in 2013 was equal to 1.2% of GDP.

GDP data source is OECD, assumed GDP growth rate equal to the baseline scenario.

3.6. Summary and conclusions

This chapter provides an empirically grounded dynamic partial equilibrium model for the Indian rice and wheat sectors. Most of the functional forms and their parameters were econometrically estimated using national time series data from 1982, discussed in the chapter 2. Discretionary policies, like OMSS and public exports, were approximated by simple rules, linking stock levels to PDS requirements and stock norms. The presented model differs from the existing literature in explicitly linking policies to the market fundamentals, including endogenous international prices and domestic public and private grain stocks, considering wheat and rice simultaneously, as well as estimating fiscal costs. We also provide the first assessment of the implications of the NFSA in a consistent equilibrium framework. Further, for the first time, different strategies to fulfil the requirements of the Act are compared and an alternative policy framework consisting of cash transfers and deficiency payments is evaluated.

The high degree of government involvement results in a high sensitivity of fiscal costs and public stock levels to policy measures. For example, small variations of the MSP strongly influence the production, procurement and stocks. Implementation of the NFSA under several policy measures within the current regime (procurement with MSP and distribution with PDS) as well as two scenarios with a regime change, namely cash transfers and deficiency payments were considered. Implications for market fundamentals and fiscal costs were simulated in the medium term – until 2020/21.

The NFSA puts a high pressure on fiscal costs and public stocks. Careful management of MSPs to keep public stocks close to the norms can reduce the fiscal costs but only to 1.6

per cent of the GDP. This policy measure, however, results in high and volatile domestic prices while international prices are not severely affected. In this scenario, a procurement price should be reintroduced in order to balance stock levels, i.e. the MSP is minimized subject to achieving the stock norms. On the contrary, relying on imports in the NFSA delivery elevates means and volatility of domestic and means of international prices; however this is the cheapest option among the NFSA scenarios. The major advantage would be the farmer's benefits from high prices while poor consumers are protected by PDS.

A policy reform, which introduces cash transfers instead of the PDS and deficiency payments instead of physical grain procurement, could bring considerable savings, decreasing the fiscal costs to 1.1 per cent of GDP in 2020. Even lower cost can be reached with cash transfers being targeted to the poor only. Fiscal cost then decreases to 0.9 per cent of GDP and yet total stocks are ample due to higher private stockholding. However, this scenario shows the highest domestic price variability, which can have negative effects on some producers and consumers. Price instability, thanks to indexed cash transfers, is countered by more stable incomes of the poor consumers. In this case, minimizing targeting errors play an important role. Impact of the price instability on producers is reduced through the deficiency payments. While poor farmers are protected by consumer transfers, deficiency payments' main goal is to incentivize production through reducing price risk faced by farmers (Haile, Kalkuhl, & von Braun, 2015). Food price instability can also have its political cost, which needs to be taken under consideration. However, the recent evidence suggests that the governments should be rather concerned about high food prices rather that food price volatility (Bellemare, 2014). Additionally, there are several problems, which should be taken care of under cash transfers. For example, payments should be linked to local prices to maintain the purchasing power of the transfers. Leakages can still prevail if people involved in the cash distribution are corrupt but with a very transparent cash transfer system leakages are likely to be reduced, particularly because those occurring at the fair price shops are impeded.

The limitations of our analysis are, as mentioned before, typical for partial equilibrium models – a bigger picture is neglected, for example there is no link to job market and other sectors. Additionally, the benefits of empirically grounded model become drawbacks in

case of a structural change, like a transition to the cash based system. As a consequence, the results should be interpreted carefully. Our analysis focuses on the domestic market and further research should be done to analyze impacts of supply and demand shocks on the world markets.

4. Consumption of wheat and rice – PDS vs. markets[37]

This chapter explores TPDS coverage and consumption of wheat and rice – both from the PDS and market using household level data from the 68th round of the National Sample Survey. It provides analysis of targeting errors and other malfunctions of the system. The reasons for no take-up or under-purchase of the PDS grains on all-India level are studied. Further, the substitution effect between the market and the PDS grains is analyzed.

4.1. Problem statement and literature review

In 2011/12 26 per cent of total rice and over 16 per cent of total wheat was consumed out of the Public Distribution System (PDS) supplies in India. Since April 2002, the scale of issue to all categories, APL, BPL and AAY, has been revised and made uniform at 35 kg per household per month for all (DFPD, 2013). However, the actual rations differ at the state level. Some states, like Tamil Nadu, offer per capita ration with an upper bound per household. Often the APL allocation is below the centrally guaranteed ration. The AAY quota of 35 kg per household is rather observed in all states (Balani, 2013). There are also sporadically additional allocations of food grains for different cardholder groups. As a result, the eligible consumers, especially the APL cardholders, are often unaware of their ration amount, which then can be used by the Fair Price Shop (FPS) owners to sell less to the card-holders and divert the difference to the black market (Dhanaraj & Gade, 2012; Khera, 2011a). Also the subsidy level differs across the states. The Consumer End Price (CEP) is decided by the state authorities and it is linked to the central issue price (CIP) which is set by the central government. CEP can be below the CIP if the state provides additional subsidy or it can be slightly above it, except the AAY group, containing commission.

The reasons behind the low take-up rates and low consumptions of the PDS grains are not fully understood. A few studies explore the problem locally, using household surveys. Jha et al. (2013) analyze the access issues related to the TPDS in three Indian states, Rajasthan, Andhra Pradesh, and Maharashtra. They found high transaction costs among the major

[37] A modified version of this chapter has been accepted for a publication as a FOODSECURE (www.foodsecure.eu) discussion paper.

under-purchase reasons. Dhanaraj and Gade (2012) study the performance of the Tamil Nadu model, which is a universal PDS that covers all households. The authors found high diversion rates due to the recipients' misinformation about their entitlement, which is set according to the household size. Low take-up was also due to non-availability of grains and to cheating during the weighting of grains. Consumers further complained about irregular opening timings and long queues, which can lead a demand driven under-purchase. Khera (2011a) studied the reasons of under-purchase in Rajasthan. Her findings point at supply constraints as the main diver of under-purchase, however she emphasizes that the demand side also plays an important role.

Mehta and Jha (2014) analyze drivers of pilferage in opaque food subsidy programs. In their theoretical model, pilferage of inferior goods can be lower or higher in poorer communities. This is because the poor have higher incentives to prevent leakage, however they usually have less power to do so. The authors found an evidence of the former effect dominating the latter in their case study from Philippines. Further, in theory, an impact of higher price subsidies on pilferage rates is also ambiguous. However, the authors did not find enough statistical evidence of either of the effects. Drèze and Khera (2015) further claim that leakage rates differ significantly between different ration card quotas, being the highest for APL cardholders due to the above mentioned misinformation.

In our study, we address the issue of under-purchase on all India level. We provide an in-depth analysis of the TPDS coverage and consumption, explaining who is coved by the PDS and identifying its major malfunctions. We further analyze the reasons for no take-up or under-purchase of the PDS grains on the all-India level. Specifically, our research questions are:

- How efficiently does the PDS cover poor and traditionally underprivileged (like scheduled castes members) people?
- What is the scale of under-purchase in different card type groups?
- What are the reasons for under-purchase? Is it due to supply constrains or demand reasons (consumer choices)?

Further, in the light of the 'cash versus in-kind transfer debate' in India[38], more evidence on the impact of the PDS on food consumption is needed. In general, the theory predicts that if the in-kind transfer is infra-marginal that is a household receiving less than it would consume solely from the market, the subsidy should be treated as a cash transfer. However, the evidence shows that this is not always true. What is even more puzzling is that the results are mixed across literature. Beatty and Tuttle (2014), for example, found that in response to the increase in in-kind benefits (from the Supplemental Nutrition Assistance Program), households increased their share of food expenditures. In case of India, a few studies found that there is no impact of the PDS subsidy on calorie consumption or nutrition, but it seems to skew grain consumption towards subsidized wheat and rice and away from coarse grains. Kaushal and Muchomba (2013), follow Kochar (2005) and use the exogenous increase in subsidy due to the transformation of the PDS into the TPDS to study its impact on nutrition. They found that higher food price subsidy shifted the consumption to the subsidized grains and sugar and away from coarse grains. However, the calorie, protein and fat consumption remained unchanged. Furthermore, no effect of the food price subsidy on nutrition (measured as calories, fat or protein intake) was found. Khera (2011a) similarly found that the wheat subsidy in Rajasthan affects the grain consumption (towards wheat, away from coarse grains) but does not affect the quantity of cereals consumed. Similar conclusions for the BPL cardholders were obtained by Shaw and Telidevara (2014).

On the other hand, there is still little known about the effect of cash transfers on nutrition and food security. Impact of conditional and unconditional cash transfers on child nutrition was found positive, for example by Agüero, Carter, and Woolard (2007) in South Africa and by Behrman and Hoddinott (2005) in Mexico. Manley, Gitter, and Slavchevska (2012) in their comprehensive literature review found that on average cash transfer programs have positive but insignificant impact on child nutrition. An important insight from this study is that cash transfers are much more effective in improving child nutrition in areas with less developed health infrastructure. Household nutrition and food security effects are also ambiguous. For example, Haushofer and Shapiro (2013), based on an

[38] There are several proponents and opponents of the introduction of cash transfers in India – both in academia and in political spheres. More details of the debate are presented in the policy implications section of the fifth chapter.

Randomized Control Trial (RCT) in Kenya, conclude that unconditional cash transfers improve consumption, food security and psychological well-being of the recipients. Hoddinott et al. (2013), who evaluate vouchers and cash transfers in four countries (Ecuador, Uganda, Niger, and Yemen), found that effectiveness in improving food security of different programs heavily depend on local conditions, including severity of food insecurity or thickness of markets. Additionally, they found no evidence that cash transfers are used for 'undesirable' goods (alcohol) consumption. The latter result of no significant impact or a significant negative impact of transfers on temptation goods was found to strongly dominate the literature by Evans and Popova (2014).

In our study, we focus on wheat and rice consumption and the subsidy's impact on market and total consumption of these grains on all-India level. This is a relevant question not only to analyze nutrition impact of the PDS on the transfer recipients, but in the light of the system's high targeting errors, the total demand shifts are also important for the poor who are not covered by the system. So in addition to the above listed research question, we aim to answer: How does PDS affect the total wheat and rice consumption? More specifically, are PDS grains substitutes for market grains? Are they imperfect substitutes? And if so, what is the rate of substitution?

Given the high cost generated by the PDS and the potential benefits of improving the food security and nutrition by better targeting, less leakage and a change in consumer behavior there are many proponents, both in academia and among policy-makers (Basu, 2010; S. Jha & Ramaswami, 2010) of switching to cash transfers. There were some failed attempts to introduce cash transfers on a local scale, for example in Puducherry. The program was called off mainly because of the operational problems, namely insufficient number of bank branches (Yadav, 2015).

With our results, we contribute to the discussion on how to improve the functioning of the PDS, in case the current system is preserved, and whether to switch to cash transfers.

4.2.Conceptual framework and methods

4.2.1. Consumption from the PDS

In our study, we consider a consumer who has a ration card, so can consume wheat and/or rice from two sources – the PDS and the market. The amount consumed from the PDS, q_s,

is constrained through the PDS entitlement, q_s^*, depending on both the state and ration card type. However, what is often observed (based on the NSS 68th round), $q_s = 0$ or $q_s < q_s^*$. So there are two types of problems besides the targeting error issue: eligible households do not use their ration cards at all (no PDS take-up) or eligible households consume PDS grains, but less than their ration.

In general, we distinguish between two types of reasons for under-purchase: demand or supply specific. The major difference in our analysis between the two is whether the quantity of wheat and rice consumed from the PDS is endogenous or exogenous, from a consumer perspective. Demand driven under-purchase also means that PDS grains are imperfect substitutes of the market grains. This in turn means that consumption form the PDS in not inframarginal, as market and PDS grains are perceived as different products. Similar argument is made by Suryanarayana (1995). He showed that implicit subsidy is significantly and positively correlated with the PDS dependence, which is due to the fact that the PDS grains are not inframarginal.

The demand driven, so voluntary, under-purchase might be due to high transaction costs or consumption habits/preference for other cereals, including inferior quality of the PDS grains. Additionally, there might be liquidity constraints preventing a household from purchasing the full ration[39]. However, the liquidity constraint is not likely to hold for the AAY and BPL households as the PDS grains ae distributed at extremely low prices, constituting a small share of their expenditures, which will be further discussed. The first reason, so under-purchase due to high transaction costs, would result in positive relation between PDS purchases and the difference between the market price and the subsidized price, which is the level of subsidy. The higher the food subsidy is, the stronger the incentive to consume from the PDS. Similarly, in the case of inferior quality of the PDS grains as compared to the market grains, price subsidy should have a positive impact on the quantity consumed from the PDS. In this case, PDS and market grains can be analyzed as imperfect substitutes. Finally, for the liquidity constrained, lower subsidized price should result in a higher amount purchased. PDS consumption would also depend on the

[39] PDS beneficiaries are often not allowed to purchase their ration in instalments.

household characteristics (preferences etc.), excluding regional characteristics if the under-purchase is demand driven.

If under-purchase is due to the supply causes, like diversion, the difference between the market price and the subsidized price should affect consumption from the PDS negatively – the higher the price difference is, the stronger the incentive for the middlemen (e.g. fair price shop operators) to cheat and sell the subsidized grains on the black market at the market price. In the areas with many poor people, the leakage rates might be lower because the poor have higher incentive to enforce the delivery. If regional characteristics are significant, it could be related to both, demand or supply side reasons.

Finally, an important question is whether there are differences in factors influencing a switch from $q_s = 0$ to $q_s > 0$ as compared to the incremental increase in q_s conditional on $q_s > 0$. Most of the above mentioned reasons for under-purchase can influence both – a complete dropout from the scheme, as well as the scale of under-purchase. High leakage may result in, for example non-deliveries to the local fair price shop ($q_s = 0$), or it can result in underweighting of the subsidized grains ($q_s < q_s^*$). Inferior quality and long waiting time may be a reason for better off households to avoid the PDS and consume solely from the market. But if the transaction costs are low and the PDS grains are of inferior quality, better off households may still decide to purchase some quantity of the subsidized grains, however less than their entitlement.

In order to test the hypothesis regarding the primary reason for under-purchase, we study the impact of the subsidy on the consumption from the PDS.

$$\boldsymbol{d_s = q_s(p_{ratio}, \mathbb{X})},$$

where d_s can be a dummy for a PDS consumption or $d_s = q_s$, p_{ratio} is a market and fair price shop price ratio $\frac{p_m}{p_s}$ and $\mathbb{X}$ is a vector of other important variables.

If the 'demand' hypothesis holds, then q_s is a positive function of p_{ratio}. $\mathbb{X}$ comprises household characteristics (monthly per capita expenditure, hh size, social group, dwelling type and education), a share of households living below the poverty line in the FSU, and state dummies. If the household characteristics are significantly influencing d_s, when controlled for the ration card type, this supports the demand hypothesis. If the other

hypothesis is valid, so the 'supply' hypothesis, then q_s is a negative function of p_{ratio}. In practice, there are both supply and demand factors influencing the final quantity of the PDS grains purchased. Separating their impacts with empirical analysis is not possible. As a result, our analysis focuses on the net effect, stating which factors have a deciding role.

Additionally, by analyzing the impact of the household characteristics on q_s, we will better understand how well the TPDS covers the poor and the vulnerable households and whether, in the light of targeting errors, there is a negative self-selection of the richer households. Further, by including a share of households living below the poverty line in the FSU as explanatory variable, we verify the hypothesis based on the theoretical model in (Mehta & Jha, 2014) that pilferage of inferior goods is lower in poorer communities. We expect significant differences in the functioning of the PDS for wheat and for rice that is why we treat them separately, allowing for different coefficients if the model.

Understanding who has access to the PDS grains, how much is consumed by whom and why may have serious implications for the policy makers in terms of pointing at the major problematic areas and pointing at the reform direction.

4.2.2. Market consumption

If indeed PDS grains are imperfect substitutes for market grains, the effect of the subsidy on wheat and rice consumption should depend on the cross-price elasticities of their demand and the respective ration quantity, q_s^*. Figure 29 represents the demand for market grains and its rationed imperfect substitute. The blue line represents the household specific budget line depending on the relative prices. If the utility is maximized at $q_s < q_s^*$ (indifference curve U_1), so the ration constraint is not binding, then it is only the price ratio, which matters and q_m', that is the quantity from the market, is consumed. However if the utility would be maximized at $q_s > q_s^*$ (indifference curve U_2), then q_m is a function of q_s^*. As a result, the quantity bought on the market is a function of income, prices, comprising own price and prices of substitutes, PDS prices and PDS ration, a set of household characteristics and state specific factors.

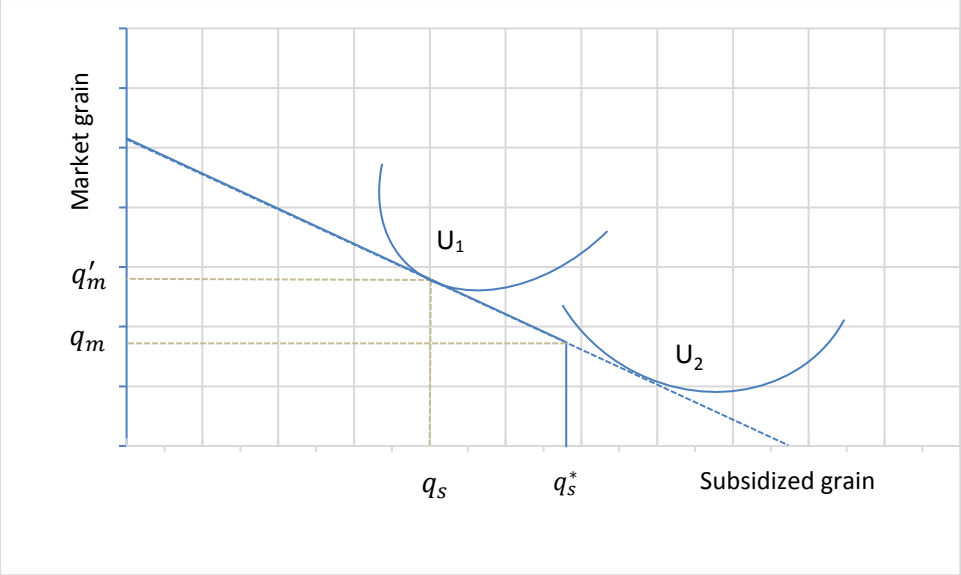

Figure 29 Demand for PDS and market grains
Source: Own design

4.3.Data

The estimation is based on the 68th round of the Indian National Sample Survey (NSS) on Household Consumer Expenditure, carried out by India's National Sample Survey Office of the Ministry of Statistics and Programme Implementation. The survey is cross-sectional and representative at the national level. It covers 101651 households in 7469 villages and 5268 urban blocks. The survey was based on a multi-stage stratified design with random household selection. Data was collected between July 2011 and June 2012 and it covers demographic data and household characteristics, as well as consumption quantity and value, total consumption expenditure, and PDS consumption, quantity and expenditure (NSSO, 2013). Basic sample characteristics are reported in table 16.

	Rural	Urban	All India
Sex of household head (male, %)	88.0	88.0	88.0
Mean age of household head	45	44	45
Education of household head			
Not literate	39.1	15.4	31.6
Literate without formal schooling	0.06	0.05	0.05
Literate with formal schooling (below primary - secondary)	51.3	49.8	50.8
Higher secondary and diploma / certificate course	5.4	13.8	8.0
Graduate	2.9	14.1	6.4
Postgraduate and above	0.8	6.5	2.6
Mean household size	4.6	4.1	4.4
Number of observations	59,693	41,967	101,660

Table 16 Sample Characteristics of NSS Data
Source: Own design

Most of the households have a male head of age 45 years on average. Over 30 per cent of households are illiterate, with much lower proportion in urban areas (15.4 per cent). The average household size is 4.4 persons, with slightly larger average households in rural areas. Our sample consists of almost 60,000 rural and 42,000 urban households.

We use India's official poverty line estimates from the Rangarajan report (Planning Commission, 2014), which are equal to Rs. 972 for rural areas and Rs. 1407 for urban areas. Mean household expenditures are well above these poverty lines (table 17), but it is estimated that almost 32 per cent of the households live below the poverty line, with proportionally more poor people living in rural areas (35 per cent). Over half of the average expenditure is spent on food and on average 18.2 kg of rice and 15.7 kg of wheat is consumed (total of market, PDS and own stock).

	Rural	Urban	All India
Mean monthly per capita expenditure (Rs.)	1414.5	2912.7	1882.7
Poverty line (Rs.)	972	1407	
Food expenditure share (%)	53.5	44.8	51.2
Below poverty line (%)	35.3	24.4	31.9
Mean market consumption of cereals per household (kg)			
Rice	19.8	14.7	18.2
Wheat	16.3	14.5	15.7

Table 17 Expenditure Characteristics
Source: Own design

	Rural	Urban	All India
Households with ration card (%)	86.0	67.3	80.1
Type of ration card (%)			
AAY	6.6	2.3	5.5
BPL	44.1	23.3	38.7
APL	49.3	74.4	55.9
Households with positive PDS consumption (%)	51.8	27.8	44.3
Mean PDS consumption per household (kg)			
Rice	7.67	3.58	6.40
Wheat	3.50	1.66	2.93

Table 18 PDS Consumption characteristics
Source: Own design

Over 80 per cent of the households is estimated to possess some sort of a ration card (table 18). The majority of them (56 per cent) have the APL card, whereas only 5.5 per cent have the AAY card, with slightly more AAY cards in rural areas. However, the number of households which actually consume any PDS wheat or rice is much lower – it is only 44 per cent on average in India, with 51.8 per cent in rural and 27.8 per cent in urban areas.

As a result, mean (over all households) PDS quantity consumed is very low – 6.4 kg of rice and 2.93 kg of wheat.

17 per cent of the below poverty line households did not have any ration card and around 45 per cent of the below poverty line households did not consume any subsidized (PDS) grains. This number is very high, however it is comparable to the leakage estimates for the survey period, which are between 42 and 47 per cent (Drèze & Khera, 2015; Gulati & Saini, 2015). Within the ration card-holders, there are 60, 44 and 23 per cent of below the poverty line households (meaning that their monthly per capita expenditure is below poverty line) in AAY, BPL and APL respectively, which indicates significant targeting errors. What is interesting, the zero consumption of the PDS grains among the APL cardholders is proportionally similar for above and below poverty line groups.

	Poor			Non-poor		
	Mean	95% confidence interval		Mean	95% confidence interval	
Food in total exp.	56.6	56.3	56.9	48.1	47.9	48.4
Staples in food	42.1	41.8	42.4	32.5	32.3	32.7
Rice market in staples	37.9	37.1	38.6	35.8	35.3	36.4
PDS rice in staples	7.3	7.0	7.6	4.0	3.8	4.1
Wheat market in staples	21.5	20.9	22.1	22.7	22.2	23.2
PDS wheat in staples	3.3	3.2	3.5	2.0	1.9	2.1
Cereal substitutes in staples	0.2	0.2	0.3	0.6	0.6	0.7
Pulses in staples	21.8	21.5	22.2	24.4	24.2	24.6
Wheat and rice products	4.2	4.0	4.3	5.9	5.8	6.1
Coarse cereals	3.8	3.5	4.1	4.5	4.3	4.8

Table 19 Weights of various food groups in expenditure (%)
Source: Own design

Poor households spend relatively more on food than non-poor households (table 19) – on average almost 57 per cent, as compared to 48 per cent. Within food expenditures, the poor spend much more on staples – 42 per cent, whereas non-poor spend only 32.5 per cent of their food expenditures on staples. What is important, even within the staple food expenditures, non-poor spend relatively more on more nutritious coarse cereals (4.5 per compared to 3.8 per cent of staple expenditures) and pulses (24.4 per cent compared to 21.8 per cent). Also the poor spend on average quite a big share of their staple food budget on the PDS grains – almost 11 per cent. The non-poor spend around 6 per cent on the PDS wheat and rice. Importantly, for both poor and non-poor, wheat and rice constitute the major source of staple food expenditure – 70 per cent for the poor and 65

per cent for the non-poor. Additionally, there are wheat and rice products (noodles, bread), which constitute 4.2 per cent of the staple food expenditures of the poor; and 5.9 per cent of the non-poor.

4.4.Results and discussion

In the first step, we generate implicit unit values of the market-consumed goods by calculating the ratio of expenditure and quantity. We use an average implicit value for the first stage unit (FSU)[40] to approximate market prices. We take FSU average prices instead of calculating them for individual households separately in order to avoid missing observations in case of non-consumption of certain goods. This method also allows us to decrease quality and measurement biases associated with unit values (Deaton, 1988). Even though, in our analysis we are considering staple foods only and their quality is usually rather uniform, there might be significant differences in varieties (especially in the case of rice) affecting the price level. This should be smoothed by taking the average in the FSU.

In order to calculate subsidized prices, we use FSU and ration card type specific prices. This allows taking into consideration eligible households (ration card-holders) with zero purchase from the PDS.

4.4.1. Consumption from the PDS

There are probably significant differences in the importance of the PDS grains for different ration card type owners due to different subsidy levels - absolute and relative to the market price paid (figures 30 and 31) but also due to different expenditure levels in these groups. Also, there are probably differences in the leakage rates between these groups, as discussed in the introduction.

[40] The first stage units (FSU) are the 2001 census villages (Panchayat wards in case of Kerala) in the rural sector and Urban Frame Survey (UFS) blocks in the urban sector. (NSSO, 2013)

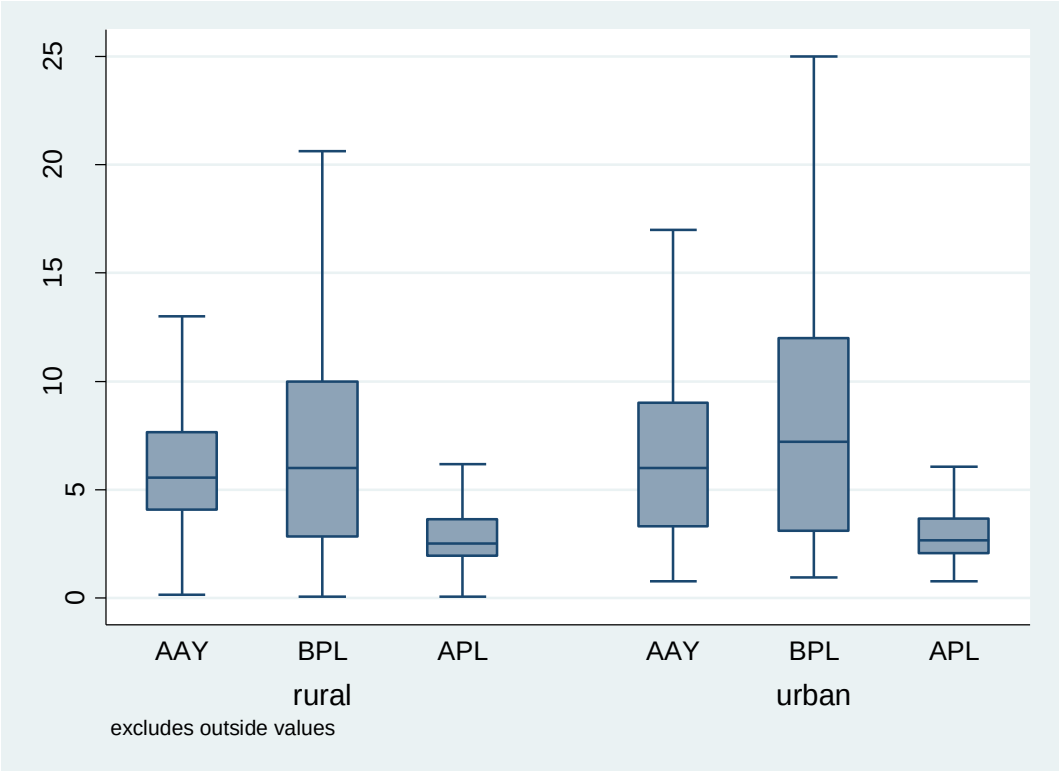

Figure 30 Price subsidy ($\frac{p_m}{p_s}$) variability by ration card type and region

Source: Own design

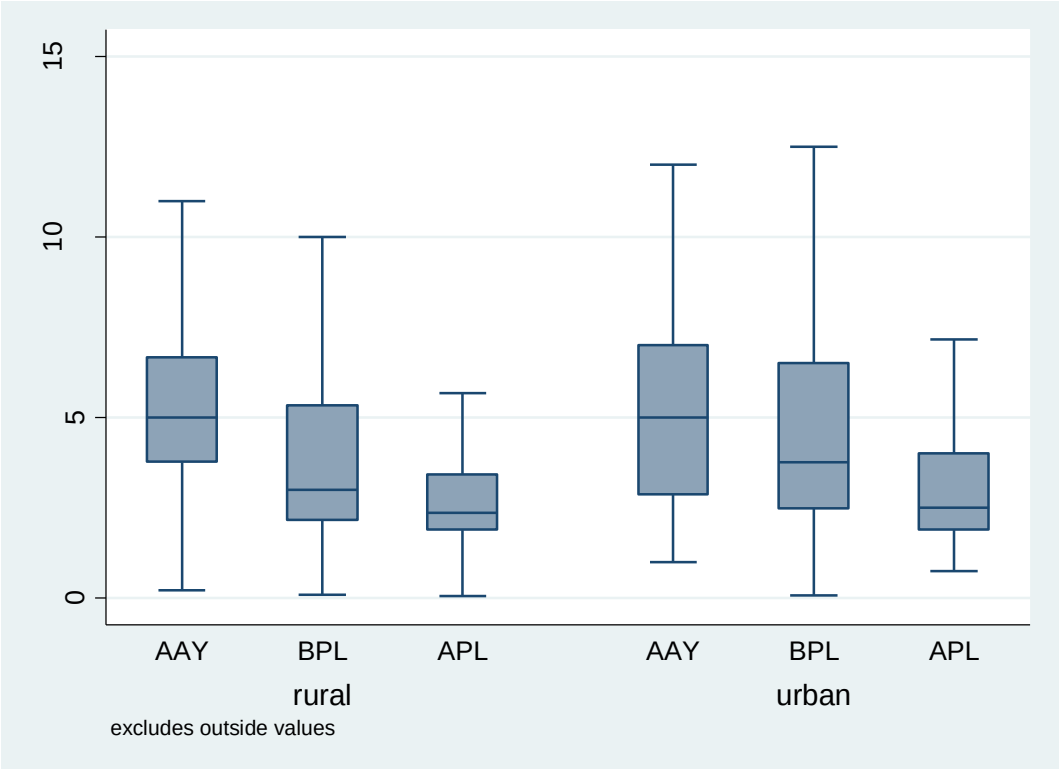

Figure 31 Price subsidy ($\frac{p_m}{p_s}$) variability by ration card type and region

Source: Own design

Table 20 summarizes consumption by different ration card types. There are clear differences between them. First, most of the AAY and BPL (around 90 per cent) actually use their cards, whereas APL cardholders predominantly do not (74 per cent). Interestingly, AAY cardholders usually consume both subsidized grains, whereas BPL cardholders often (42 per cent) consume only one commodity Also, 37 per cent of AAY rice consumers and 31 per cent of AAY wheat consumers do not buy these grains on the market, which means they consume exclusively from the fair price shops. These numbers are much lower for the APL cardholders – 3.2 and 11.3 per cent respectively. This means that the poorest rely on the PDS much more than the non-poor.

What is important, average consumption of wheat and rice by the AAY households who use their ration cards is 30.4 kg per household, which is close to the full ration (35 kg). On the other hand, BPL consumers utilize on average only 21.9 kg of wheat and rice out of the same ration quantity. Full PDS consumption, so at least 35 kg per household, is observed in 46 per cent of the AAY households and only 13.8 per cent of the BPL households. It is clear that the BPL households are much less successful than the AAY cardholders in obtaining their full ration. APL average consumption is 15.9 kg per household. However, in this group, the most striking finding is a low usage of ration cards and accordingly a high share of zero consumption from the PDS (74 per cent).

In the light of these results, we need to analyze the low take-up by the APL cardholders. The aim is to find out the reasons behind not consuming from the PDS. Is it because of self-selection, so demand driven, or maybe because of high leakage and other supply side causes. This is important because of high targeting errors, as outlined in the data section, there are 23 per cent of poor households with the APL card and many of them do not actively participate in the scheme. Next, we need to explain the low consumption of the PDS wheat and rice – why do so many households buy only a fraction of their ratio? This is especially alarming in the BPL group. Maybe this is also because of the targeting errors, as there are only 44 per cent of poor households in the BPL group, according to the data. So it might be the case that better-off households buy only a small amount of grains from the PDS.

	AAY	BPL	APL
Households' consumption from PDS (%)			
No consumption	10.5	9.6	74.0
Consumption of one crop only	25.8	41.6	13.7
Consumption of both wheat and rice	63.7	48.9	12.3
Households consuming exclusively from the PDS (%)			
Rice	37.0	16.8	3.2
Wheat	30.7	27.5	11.3
Mean PDS consumption per household (kg)			
Rice	18.0	13.8	2.8
Wheat	9.3	6.0	1.4
Mean conditional* PDS consumption per household (kg)			
Rice	21.3	16.5	14.4
Wheat	13.5	10.7	7.2
Total wheat and rice	30.4	21.9	15.9
Mean PDS - market price ratio (%)			
Rice	21.3	24.9	34.2
Wheat	24.4	37.6	37.3
Mean monthly per capita expenditure (Rs.)	1081.5	1292.2	2060.5
Below poverty line (%)	59.6	43.7	23.2

* Average over households with positive consumption from PDS

Table 20 PDS Consumption by Ration Card Type

Source: Own design

First, cardholder groups differ with respect to their financial status (table 20). BPL cardholders' expenditure is 20 per cent higher than the AAY, whereas APL cardholders spend on average 60 per cent more that the BPL group. Different take-up rates and consumption quantities may result from a lower subsidy relative to the total expenditure. This would support the hypothesis that their under-purchase is a result of a negative self-selection. Second, the PDS beneficiaries may live in income and card-type clusters. This might influence pilferage rates (Mehta & Jha, 2014). Indeed, there are 29 per cent of the FSUs without any poor households and over 45 per cent of the FSUs have less than 14 per cent poor households in them (table 21). These are probably the rich areas. On the other side there are 16 per cent of the FSUs where over 60 per cent of the households live below the poverty line, which is a very high concentration of the poor

Poor (%)	Percent	Cumulative
0.00	28.95	28.95
0.13	16.04	44.98
0.14	0.18	45.16
0.17	0.02	45.18
0.20	0.01	45.19

0.25	16.96	62.15
0.29	0.17	62.32
0.33	0.01	62.34
0.38	11.46	73.79
0.43	0.06	73.85
0.50	10.06	83.9
0.57	0.06	83.97
0.60	0	83.97
0.63	7.41	91.38
0.71	0.04	91.43
0.75	5.39	96.82
0.86	0.01	96.83
0.88	2.05	98.88
1.00	1.12	100
Total	100	

Table 21 Distribution of the FSUs by the share of poor households

Note: 0 in the column Poor means there are no poor households in a FSU, 1 means everyone in a FSU is poor. Poor measured as expenditures below the poverty line.
Source: Own design

We estimate a probit model to explain the reasons for the low take-up of the APL program. Our dependent variable, the take-up of the APL card, is equal to 1 if there is a positive rice/wheat consumption by an eligible APL cardholder and zero otherwise. As it was mentioned in the theoretical section, we expect differences in functioning of the PDS for wheat and for rice. For example wheat is reported to have higher leakage than rice (Gulati & Saini, 2015). The results are reported in table 22.

We find the price subsidy to have a mostly insignificant impact on the take-up. Only in case of rural wheat PDS take-up, there is a positive and significant impact. So there is no evidence of leakage having a deciding role on low take-up. But also, except for the rural wheat consumption, the price subsidy does not seem to positively influence the decision of purchasing the PDS grains. There might be an unobserved variable issue in rural areas, which is a transaction cost. Distance to the PDS shop in rural areas may vary substantially and be correlated with the market price. A higher distance to the PDS shop might be positively correlated with the market price – remote areas without good infrastructure and far from a market have higher market prices and higher chance of long distance to the PDS shop or worse functioning fair price shop, which means higher transaction costs, which we do not observe. As a result, we would obtain underestimated subsidy parameters for rural areas. However, the scale of the issue should be rather small. The

example from Bihar (Muralidharan et al., 2011), where at the time the survey was conducted, the TPDS was among the worst functioning in the country (Gulati & Saini, 2015), shows that the average distance to the ration shop was similar in rural and urban areas. The difference lies in longer waiting times and fewer days when a ration shop is open in rural than in urban areas. Consumer's response to waiting time is similar to response to changes in prices (Alderman, 1987). This means that transaction costs are indeed higher for the rural households than for the urban ones, but there is no evidence of correlation with the distance to the market. This might be the reason for the stronger reaction to the subsidy in case of rural households as compared to urban.

Per capita expenditure and higher secondary and above education have a significant and negative impact on the take up rates of the APL households, which might be due to self-selection - more affluent households drop out of the scheme. The expenditure impact is moderate - the probability of participating in the scheme decreases on average by 0.03-0.04 if the monthly expenditure per capita increases by Rs. 1000 at the means of all the explanatory variables. Higher secondary and above education has much stronger impact decreasing the probability of participation in the PDS by 0.149 for wheat and 0.235 for rice at the means of explanatory variables. Literacy does not affect the probability of participation in the scheme as compared to illiterate cardholders.

Household size has a positive and significant impact for both commodities, which might be that there is a higher chance that someone in the household who is available to go to the PDS shop in more populous households (for example children) or because there are higher consumption needs. This might be also an effect of per capita allocations in some states so there is more to gain from the participation in the PDS. However, the effect is rather weak – additional family member increases a probability of participation by around 0.01 at the means.

VARIABLES	(1) Rice APL	(2) Rice Marginal effects at means	(3) Wheat APL	(4) Wheat Marginal effects at means
Share of the poor in the FSU (%)	0.004***	0.001***	-0.001	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
Price ratio rural	0.001	0.001	0.017**	0.007**

	(0.008)	(0.003)	(0.008)	(0.003)
Price ratio urban	-0.007	-0.003	0.009	0.004
	(0.007)	(0.002)	(0.010)	(0.004)
Monthly per capita expenditure, MRP	-0.097***	-0.035***	-0.080***	-0.032***
	(0.018)	(0.006)	(0.017)	(0.007)
Household size	0.038***	0.013***	0.024***	0.010***
	(0.011)	(0.004)	(0.009)	(0.004)
Literate with and without formal	-0.087	-0.031	-0.027	-0.011
	(0.063)	(0.022)	(0.049)	(0.020)
Higher secondary & above	-0.662***	-0.235***	-0.374***	-0.149***
	(0.074)	(0.026)	(0.062)	(0.025)
Hired Dwelling Unit	-0.055	-0.020	-0.035	-0.014
	(0.066)	(0.024)	(0.056)	(0.022)
No Dwelling Unit	2.060***	0.309***	-2.392***	-0.512***
	(0.398)	(0.017)	(0.644)	(0.022)
Other Dwelling Unit	0.102	0.035	-0.174	-0.069
	(0.161)	(0.054)	(0.109)	(0.043)
Scheduled Castes	-0.078	-0.026	-0.112	-0.045
	(0.124)	(0.040)	(0.116)	(0.046)
Other Backward Classes	-0.226**	-0.077**	-0.035	-0.014
	(0.111)	(0.036)	(0.110)	(0.043)
Other social groups	-0.322***	-0.112***	-0.216**	-0.086**
	(0.111)	(0.037)	(0.110)	(0.043)
Urban sector	-0.058	-0.021	0.075	0.030
	(0.071)	(0.026)	(0.065)	(0.026)
Constant	1.096***		0.504***	
	(0.157)		(0.154)	
Observations	69,748	46,002	69,230	37,306
N_sub	20147		19284	

Table 22 PDS APL consumption - probit model results

*Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*
State region and lightning code dummy estimates are included but not reported
Omitted social group is scheduled tribes
Source: Own design

There are no significant differences in the PDS participation probability between households living in owned, hired and other dwelling units. However, households without any dwelling[41] significantly and strongly differ, strikingly in the opposite manner for wheat and rice. Households with no dwelling units and the APL cards are more probable to use the PDS by 0.31 in case of rice and less probable by 0.51 in case of wheat as compared to the households with own dwelling units. There is also a significantly higher probability of

[41] Households are considered to be categorized as possessing "no dwelling" when found to be living more or less regularly under bridges, in pipes, below staircases or with temporarily built flimsy improvisations etc. with a liability to be removed at any moment (NSSA classification).

the participation in the scheme for scheduled tribes and castes[42] with the APL cards as compared to other social groups with the APL cards. But this difference is larger in case of rice consumption. This might mean that the rice consuming states are better, so the rice TPDS, is better in covering the underprivileged households. This should be verified for the other card types and the quantity consumed from the PDS. In general, PDS rice take-up by the APL cardholders seems to be driven by the economic and social status, whereas wheat consumption depends more on the subsidy level.

Finally, there is a significant and positive effect of the poverty concentration in a district (FSU), measured by the share of the below poverty line households in the FSU, on the rice take-up and no effect on the wheat take-up. The marginal effect for rice is moderate – 1 per cent increase of the share of the poor in the FSU increases the probability of PDS take-up by an APL household by 0.1 per cent. As discussed above, this dependency was found by Mehta and Jha (2014); the poor communities due to higher incentives are more successful in reducing leakage from opaque subsidy programs.

We estimate a tobit model explaining the quantity consumed from the PDS; separately for wheat and rice:

$$q_s = \begin{cases} 0 & \text{if } q_s^* \leq 0 \\ q_s^* & \text{if } q_s^* > 0 \end{cases},$$

$$q_s^* = \alpha_0 + \alpha_1 p_{ratio} * CT + \alpha_2 MPCE + \alpha_3 S + \alpha_4 \mathbb{H} + \alpha_5 Poor ,$$

where q_s is an observed quantity of wheat/rice consumed from the PDS by a household, p_{ratio} is a relative subsidy level per kg (market price of wheat/rice divided their PSD price), CT is a card type (dummy for different card types), $MPCE$ is a monthly per capita expenditure, S is a state region dummy, $\mathbb{H}$ vector of household characteristics (hh size, social group, etc.), and *Poor* is a share of the poor in the FSU. We chose a tobit model instead of a linear regression as there is a significant portion of zero consumption of subsidized grains by eligible consumers, as it was shown in table 20.

[42] Scheduled castes and tribes, as listed in the Constitution of India, comprise various historically disadvantaged groups of people (Bakshi & Kashyap, 2012). Even though the Constitution guaranties affirmative action, protective arrangements and development of the scheduled casts and tribes (ibid), they are persistently characterized by lower nutrition, wealth and education as compared to the remaining Indian population (van de Poel & Speybroeck, 2009).

Estimation results are reported in table 23 for rice and in table 24 for wheat[43]. The first two columns contain results for specification with the price ratio for all card types, and the last two columns show the price ratio interacted with card type dummies.

	(1)	(2)	(3)	(4)
		Rice		Rice
VARIABLES	Rice	Marginal effects	Rice	Marginal effects
Female	-737.661***	-638.990***	-935.392***	-810.286***
	(234.173)	(202.730)	(229.586)	(198.671)
Share of the poor in the FSU (%)	33.379***	28.914***	27.284***	23.635***
	(5.176)	(4.480)	(4.948)	(4.283)
Monthly per capita expenditure, MRP ('000 Rs.)	-1,566.391***	-1,356.869***	-1,359.872***	-1,177.993***
	(184.164)	(158.548)	(163.646)	(141.015)
Household size	1,133.894***	982.223***	1,158.929***	1,003.926***
	(56.446)	(49.019)	(53.413)	(46.335)
Scheduled Castes	383.710	340.874	202.368	179.301
	(319.369)	(283.286)	(315.936)	(279.662)
Other Backward Classes	-1,246.087***	-1,089.634***	-1,151.999***	-1,007.236***
	(306.101)	(269.730)	(305.530)	(269.253)
Other social groups	-2,257.963***	-1,953.151***	-2,039.348***	-1,766.263***
	(346.230)	(301.783)	(345.314)	(301.564)
Is any member of the household a regular salary earner?	1,201.948***	1,041.174***	881.571***	763.664***
	(222.492)	(192.926)	(216.116)	(187.353)
Urban sector	-2,336.023***	-1,996.900***	-1,999.714***	-1,713.038***
	(248.867)	(209.441)	(242.497)	(204.915)
Price ratio AAY			891.121***	771.936***
			(46.883)	(40.449)
Price ratio BPL			328.921***	284.928***
			(33.804)	(29.256)
Price ratio APL			-493.403***	-427.411***
			(109.815)	(95.028)
Price ratio	286.942***	248.560***		
	(30.088)	(26.022)		
Constant	2,754.351**		4,210.401***	
	(1,252.812)		(1,203.845)	
Observations	46,411	46,411	46,411	46,411

Table 23 PDS rice consumption (grams per household per month) - estimation results and marginal effects

*Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

State region and lightning code dummy estimates are included but not reported

[43] There were no significant differences in the estimated coefficients for rural and urban sector separately, consequently, we present results of the estimation based on the full sample.

Omitted social group is scheduled tribes
Source: Own design

VARIABLES	(1) Wheat	(2) Wheat Marginal effects	(3) Wheat	(4) Wheat Marginal effects
Female	-248.380	-167.682	-323.13	-217.94
	(224.868)	(151.796)	(224.64)	(151.46)
Share of the poor in the FSU (%)	11.159**	7.533**	5.53	3.73
	(5.402)	(3.646)	(5.25)	(3.54)
Monthly per capita expenditure, MRP ('000 Rs.)	-932.455***	-629.500***	-782.98***	-528.09***
	(139.022)	(93.315)	(123.76)	(83.09)
Household size	448.608***	302.855***	470.44***	317.29***
	(50.068)	(33.902)	(48.06)	(32.50)
Scheduled Castes	-175.559	-124.877	-209.93	-147.54
	(432.917)	(308.651)	(429.83)	(302.94)
Other Backward Classes	-1,107.724***	-771.033***	-820.73**	-568.54**
	(415.748)	(294.827)	(410.26)	(288.32)
Other social groups	-2,407.146***	-1,622.697***	-2,010.55***	-1,352.38***
	(435.480)	(303.354)	(433.21)	(299.69)
Is any member of the household a regular salary earner?	881.348***	594.997***	522.32**	352.28**
	(211.057)	(142.230)	(213.15)	(143.69)
Urban sector	-1,183.693***	-788.426***	-760.80***	-508.79***
	(238.258)	(157.261)	(233.09)	(155.08)
Price ratio AAY			952.74***	642.58***
			(65.97)	(43.74)
Price ratio BPL			620.20***	418.30***
			(83.25)	(55.91)
Price ratio APL			-175.48*	-118.35*
			(93.19)	(62.80)
Price ratio	515.334***	347.902***		
	(49.437)	(33.193)		
Constant	9,411.196***		10,133.51***	
	(1,520.641)		(1,501.87)	
Observations	37,540	37,540	37,540	37,540

Table 24 PDS wheat consumption (grams per household per month) - estimation results and marginal effects

*Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*
State region and lightning code dummy estimates are included but not reported
Omitted social group is scheduled tribes
Source: Own design

Similarly to the aforementioned probit model results of the APL take-up, expenditure has a significant and negative impact on consumption of both PDS wheat and rice, and the impact is higher in case of rice. Additional thousand Rs. of expenditure decreases on

average household's consumption of rice by 1.2-1.4 kg and 0.5-0.6 kg of wheat at the means of explanatory variables. Again, this can be interpreted as evidence for negative self-selection of richer households. Also household size has a positive and significant effect on grain consumption (wheat and rice), which again can be due to per capita allocations or just more household members available to reach a fair price shop. In case of rice, the effect of a larger household by one person is up to 1 kg and in case of wheat, around 0.3 kg. All the backward classes, especially scheduled castes and tribes consume significantly more subsidized grains. Households belonging to scheduled tribes consume even 2 kg of rice or 1.6 kg of wheat from the PDS as compared to other (non-backward) social groups. Urban households on average consume less PDS grains than rural ones.

Interestingly, a regular salary earner in a household significantly increases the PDS consumption. Less than 12 per cent of rural households belong to the category of the regular salary earners. In urban areas, this is estimated to be over 45 per cent of the population. So probably the combination of the negative coefficient for the urban sector and the positive effect for the regular salary earner, similar in the amplitude, is the sign of not covering the migrant workers, which TPDS has been criticized for.

When it comes to price subsidy, it has on average a positive and significant impact on both wheat and rice consumption (see columns 1 and 2 for marginal effects). This means that the PDS under-purchase is mostly demand driven. As a result, because the PDS grain price is below the market price, we can also conclude that on average, it is treated as imperfect substitute to the market grains. Further, this finding supports the expectation and is in line with the finding in (Suryanarayana, 1995) that PDS grains are not inframarginal.

Interestingly, when the price ratio is interacted with the card type (see columns 3 and 4 for marginal effects), there is a significant difference between its impact on the consumption of the PDS grains. The price subsidy has a negative and significant impact on both wheat and rice PDS consumption of the APL cardholders and a positive and significant impact for both AAY and BPL groups. This can be linked to the already discussed differences in the leakage rates from APL and BPL quotas, and confirms the hypothesis formulated by Drèze and Khera (2015). The higher price incentive has a stronger impact on the shop owners to leak grains in case of the APL quota and a stronger impact on the

consumers to buy more in case of the BPL and the AAY cards. Further, there is a significant positive impact of the share of the poor in the FSU (similarly to the probit model for the APL take-up results). This is true for both rice and wheat (except for the specification 3, table 24). Which is again along with the hypothesis formulated by Mehta and Jha (2014) that the poor communities due to higher incentives are more successful in reducing leakage from opaque subsidy programs.

Another interesting result is that a female household head dummy has a negative and significant effect on rice PDS consumption and a negative but insignificant impact on wheat PDS consumption quantity. When interacted with the ration card type (table 25), the negative effect of the female household head is significant only for the APL cardholders, also to a lesser extend for the wheat PDS consumption. APL households with a female head consume on average 1.6 kg of PDS rice and 0.46 kg of PDS wheat less than their male led counterparts. This is an alarming result, as the women led household are usually socially more vulnerable and food insecure (ADB & FAO, 2013). Women led households are often households without a man, led by divorced or widowed women. These households are extremely marginalized (Masoodi, 2015). This malfunction of the PDS has not been mentioned in the literature so far and should be further analyzed. Higher under-purchase is probably related to the marginalization of female led households. This is why a 'head of the household' definition adopted in the National Food Security Act, which is the eldest woman, who is not less than eighteen years of age, is a very important legal provision.

	(1)	(2)	(3)	(4)
		Rice		Wheat
VARIABLES	Rice	Marginal effects	Wheat	Marginal effects
Female AAY	-792.23	-686.32	-1,075.95	-725.73
	(823.06)	(713.00)	(778.36)	(524.94)
Female BPL	-231.69	-200.72	118.67	80.04
	(312.64)	(270.80)	(304.01)	(205.07)
Female APL	-1,836.04***	-1,590.59***	-679.37*	-458.24*
	(381.44)	(330.56)	(358.74)	(241.96)
Observations	46,411	46,411	37,540	37,540

Table 25 PDS rice consumption (grams per household per month) and a household head – some estimation results and marginal effects

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Exogenous variable set the same as in regressions in table 8 and 9

Source: Own design

4.4.2. Market wheat and rice consumption

Unfortunately, we do not have the exact information on the ration quantity – as it was discussed above, despite the official uniform 35 kg per household, some states provide less grains for the BPL, and even more often for the APL cardholders. Only actual consumption of the market grains can be observed. We can control for ration card type, however it is highly correlated with the subsidized price level. As a result, we estimate two alternative specifications – with PDS prices and with ration card types as explanatory variables.

We estimate a tobit model for market consumption of wheat and rice[44]:

$$q_m = \begin{cases} 0 & \text{if } q_m^* \leq 0 \\ q_m^* & \text{if } q_m^* > 0 \end{cases},$$

and $q_m^* = \alpha_0 + \alpha \ln P + \beta_1 \ln m + \beta_2 \ln^2 m + \gamma \mathbb{X}$,

where q_m is the observed per capita market consumption of wheat or rice, $\ln P$ is a vector of logarithms of prices of staple foods, including either PDS prices or a ration card type, *m* is monthly per capita expenditure (MPCE) and $\mathbb{X}$ is a vector of household characteristics and state dummies. Results are presented in table 26.

From the formula above, we can calculate price and expenditure elasticities of the latent variable q_m^*. Expenditure elasticity of the good *m* consumption:

$$\eta_m = \frac{\partial q_m}{\partial m}\frac{m}{q_m} = \frac{\beta_1 + 2\beta_2 \ln m}{q_m}$$

Price elasticity of the good *m* consumption with respect to the price of good *n*:

$$\epsilon_{mn} = \frac{\partial q_m}{\partial p_n}\frac{p_n}{q_m} = \frac{\alpha_n}{q_m},$$

where α_n is an element of a vector α, corresponding to price coefficient of the good *n*. Respective price and income elasticities for wheat and rice at the mean expenditure and consumption levels are presented in table 27.

[44] There were no significant differences in the estimated coefficients based on rural and urban sample. Consequently, we provide the results from the estimation on the full sample.

For both wheat and rice, own prices have negative and significant coefficient estimates[45], which is according to the theory. Rice consumption has a positive response to upward wheat price changes, however, in case of wheat the coefficients are not significant. Logarithms of income have positive and significant coefficients. This is again, according to the expectations based on the Engel's law – consumption increases with income at a diminishing rate. Further, their squared values have negative and significant coefficients.

VARIABLES	(1) Rice	(2) Rice	(3) Wheat	(4) Wheat
ln price other cereals	804.02**	921.35***	574.72	491.44
	(348.74)	(326.68)	(437.39)	(397.25)
ln price rice	-8,158.47***	-8,912.01***	1,437.58	2,361.56**
	(672.84)	(643.09)	(997.33)	(919.57)
ln price wheat	4,591.35***	5,716.84***	-9,684.74***	-10,712.73***
	(893.14)	(886.13)	(935.96)	(879.87)
ln price cereal substitutes	-961.40***	-1,178.93***	-302.58	-577.09
	(313.82)	(314.69)	(453.77)	(502.66)
ln price pulses	-2,159.85***	-2,309.89***	1,499.31	1,162.87
	(696.13)	(684.37)	(1,214.52)	(1,162.31)
ln price PDS rice	-1,632.14***		1,351.21***	
	(265.20)		(331.60)	
ln price PDS wheat	2,208.38***		2,778.69***	
	(257.79)		(359.05)	
ln MPCE	3,927.38***	2,409.50***	8,354.47***	7,145.97***
	(408.54)	(399.25)	(495.85)	(462.51)
ln square MPCE	-722.58***	-390.55**	-1,988.14***	-1,747.01***
	(169.93)	(162.02)	(214.45)	(201.73)
Household size	3,496.15***	3,375.59***	4,787.09***	4,872.28***
	(81.55)	(78.83)	(124.77)	(118.08)
literate with and without formal schooling	-222.52	-384.28	141.54	-406.06
	(309.03)	(290.93)	(355.91)	(338.63)
Higher secondary & above	-472.61	-949.75***	-493.99	-1,609.36***
	(352.28)	(338.59)	(422.37)	(402.45)
AAY card		-7,041.42***		-8,844.99***
		(816.32)		(845.12)
BPL card		-5,405.57***		-5,218.16***
		(364.75)		(410.17)
APL card		-1,481.48***		1,257.23***
		(272.10)		(317.77)
Urban sector	-767.57***	-1,084.43***	-1,964.74***	-2,253.60***
	(282.98)	(278.67)	(374.18)	(364.53)
Constant	31,435.60***	36,780.56***	-10,760.25**	3,551.46
	(4,093.02)	(4,124.23)	(5,478.14)	(5,570.01)
Observations	39,761	43,936	31,618	35,583

[45] These are not elasticities as the explanatory variable is expressed in levels, not logarithms.

Table 26 Market rice and wheat consumption (grams per capita per month) – tobit model results

Note: State and dwelling unit code dummy estimates were included but not reported
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Exogenous variable set the same as in regressions in table 8 and 9
Source: Own design

	PDS price elasticity	Own price elasticity	Income elasticity
Rice	-0.08	-0.42	0.17
Wheat	0.13	-0.44	0.31

Table 27 Market consumptionprice and income elasticities – calculated from the tobit model results

Note: Elasticities were calculated at means of expenditure and consumption quantities
Source: Own design

PDS price of rice has a significant and negative effect and PDS wheat price has a positive and significant effect on market rice consumption (column 1, table 26). For market wheat consumption, both PDS wheat and rice prices have a significant and positive impact (column 3, table 26). So higher subsidy (coming from a lower PDS price) for rice actually increases market rice consumption and decreases market wheat consumption. Lower PDS price for wheat decreases consumption of both market wheat and rice. In terms of price elasticities this means that a lower PDS rice price by one per cent increases market rice consumption by moderate 0.08 per cent, whereas one per cent decrease in wheat PDS price decreases market wheat consumption by 0.13 per cent (table 27). Interestingly, in case of rice, the rural AAY cardholders consume the least grains from the market and the consumption increases with the card type, especially between the BPL and the APL cards. No card means the highest market rice consumption, controlling for all the other factors. However, in case of wheat, APL cardholders consume slightly more than no card households. What is important, the highest coefficients are between around 7,000 and 8,900, which means that the AAY households consume on average 8.9 kg of wheat or 7 kg rice less than no card households. In case of wheat, the average PDS consumption by the AAY cardholders is 9.3 kg, so it seems that the PDS slightly increases the total wheat consumption. In case of rice, the average PDS consumption by the AAY households is 18 kg, so total rice consumption is significantly higher. This result is similar to the conclusions from the specification with the PDS prices – there is a significant and strong crowding in effect of rice and a small effect of wheat consumption by the PDS. We can conclude, that

PDS wheat and rice are substitutes (though not perfect substitutes) for market rice and wheat.

4.5.Summary and conclusions

Understanding the consumption patterns of the PDS grains, so who and how much consumes and why, contributes to solving a puzzle of low take up and consumption from the PDS in India. It has important implications for policy measures taken to improve its functioning. Further, impact of the subsidy on market grain consumption has several implications – both for covered households, through impacting their diets, and households not covered by the PDS, through impacting total demand and market prices.

What we see in the data, is that the vast majority of the poorest of the poor, at least those with an AYY card, consumes subsidized grains and on average, they buy almost the full ration. However, AAY constitute only 5.5 per cent of all card owners in the country and there are many poor who do not buy any PDS grains. Rural coverage with the PDS is quite high – there were almost 52 per cent of households consuming some amount of the subsidized grains, on average a little above 11 kg per household. Under-purchase among the BPL and APL cardholders is much higher than in the case of the AAY group. Additionally, the APL group is characterized by the very low take-up – only 26 per cent bought any amount of the PDS grains. With our detailed analysis on the all India level we contribute to improved understanding of the strengths and weaknesses of the TPDS.

There is no evidence of leakage having a deciding role on the low take-up observed in the APL group, but also, except for rural wheat consumption, the price subsidy does not seem to positively influence the take-up rate of the PSD grains. Rice PDS seems to be better in covering underprivileged, backward classes and families without a dwelling unit than the wheat distribution. Higher income and education levels can be associated with lower probability of APL take-up, which is probably due to the negative selection of the more affluent households. A similar effect of income was found on the quantity of PDS grains consumed in all ration card groups. Our results further suggest that the migrant workers and female led households are not well covered by the TPDS- despite having a card, they under-purchase from the PDS. To our knowledge, this is the first empirical analysis of the various targeting errors on all India level.

There is a significant difference in impact of the price subsidy on the PDS consumption between the card types. The price subsidy has a negative and significant impact on both wheat and rice PDS consumption of the APL cardholders and a positive and significant for both AAY and BPL groups. This can be linked to the difference in the leakage rates from APL and BPL quotas. The higher price incentive has a stronger impact on the shop owners to leak grains in case of the APL quota and a stronger impact on the consumers to buy more in case of the BPL and AAY cards. This conclusion is supported by the discussed above lack of impact of the subsidy on the take-up rates among the APL households, which are mostly driven by wealth and social status. This means that those APL cardholders who turn to the PDS scheme are income driven and would consume more subsidized grains than they do if not for the leakage and diversion. With our result, we empirically confirm the hypothesis made by Drèze and Khera (2015). This phenomenon can be a consequence of the misinformation about the ration among the APL cardholders – despite the centrally guaranteed 35 kg per household, many states provide less to this group. There are also sporadically some additional allocations for the APL quota, which are not realized by the cardholders. As a result, it is easier for the PDS shopkeepers to divert grains from the APL quota compared to the other groups. Further, PDS recipients in poor areas consume slightly more PDS grains which might be attributed to better monitoring of the Fair Price Shops by these communities and consequently lower leakage. This result supports a theoretical model and empirical results in Mehta and Jha (2014).

There is a significant and strong crowding in effect of total rice consumption by the PDS rice. In case of wheat, it is significant but much weaker. We conclude, that PDS wheat and rice are substitutes (though not perfect substitutes) for market rice and wheat and PDS consumption is not inframarginal. This result contributes to the growing evidence that the PDS crowds in consumption of wheat and rice and we also conclude that in the light of the targeting errors, higher total demand for wheat and rice might have negative consequences for the poor and underprivileged excluded from the system.

To sum up, there are several issues which should be addressed if the food distribution in kind is continued. More diversified rations, including for example pulses, eggs and vegetables, could be highly beneficial for the improved nutrition of the poor. But also, some problems, like corruption and targeting errors can prevail even under the cash based

system, so certain institutional improvements must be done irrespective of the system. In addition to that, the benefit of the negative self-selection of the rich would disappear under the cash transfers, which makes precise targeting one of the crucial elements of the transition to cash transfers. Another one, due to a large variation in prices, is linking the transfer amount to the local market prices as well as local price changes. However, the benefits of the cash based system can be large, both fiscal and on the ground of food security and nutrition. The growing evidence shows that child nutrition and household's food security status can be improved by cash transfers. All this shows that there is high potential and urgent need to seriously discuss and consider cash transfers for the Indian system.

Among the limitations of our method are lack of information about the institutional differences and limited information on the household characteristics and its district (like number of children, distance to the PDS shop and functioning of the PDS shop, distance to the market), which might have a significant influence on the household's decision making process and the outcomes of these decisions. Another caveat is that our analysis is done jointly on the all India level, even though the local (regional or state) differences in cultures and production systems might be an important factor influencing the response to the policies we analyze. However, the aim of this study is to analyze the consequences of the central policy measures on the country as a whole, as opposed to exploring the regional differences in responses to various policies. Nonetheless, further research should be focused on confirming our results on the state scale and testing whether the omitted control variables significantly affect the conclusions.

5. Conclusions

The main findings of this study and its limitations are discussed in detail in the preceding chapters. This last chapter provides a brief summary of the key findings from the analytical chapters and draws corresponding policy conclusions. The chapter finishes by proposing directions for further research.

5.1. Summary of the findings

Since the time of independence, India has gone through a tremendous transformation in terms of its food grain sector - from a food scarce country to a major rice exporter; from provision of a marginal support to the urban poor to the right to food act, among others. A history of dreadful famines and the adopted socialist approach resulted in a highly regulated food economy with a large procurement, stocks and distribution of wheat and rice. In the last years, food subsidy has grown to almost one per cent of the GDP. Yet still, the country is plagued with malnutrition and hunger, and the food system is criticized for inefficiencies and corruption. Further, even larger system with a broader coverage is currently being implemented under the National Food Security Act (NFSA). This poses several questions that ask, for example, what can be done to improve the system and whether its financing is feasible in the medium or long term. It is also necessary to explore the alternatives and analyze their consequences.

This dissertation studies various aspects of the food grain sector and food grain policies in India in order to provide a comprehensive analysis of the policies, their interactions and the outcomes. The study provides many new findings.

Chapter 1 reviews a brief history of the food grain sector in India and brings the political economy perspective. It explains the reasons behind the current system and its roots. The food grain policy of a current shape was initialized after the great Bengal Famine of 1943, when more than two million people died of starvation due to a drastic fall in production and a malfunctioning grain market with restrictions on grain movements. This meant a shift away from reliance on the private sector to the one establishing complete government monopoly in the procurement, storage and distribution of food grains. These

intensified government interventions in the food sector initiated the Green Revolution in India in the 1960s. This marked the beginning of self-sufficiency in wheat and rice and high public stock levels.

Next, the current system itself together with the ongoing reform – the National Food Security Act (NFSA), is outlined. A general problem statement in the form of a critique of the current policy measures and the recent developments in the food grain sector is brought about. Currently, Indian government unboundedly procures wheat and rice from the farmers with the guaranteed Minimum Support Price (MSP). The procured grain is stored as the buffer stocks, distributed to the poor at the heavily subsidized Central Issue Price (CIP) through the Targeted Public Distribution System (TPDS) and Other Welfare Schemes (OWS)[46], and released to the market through the Open Market Sales Scheme (OMSS) or exported. Most of the operations are conducted by the parastatal agency, the Food Corporation of India (FCI). There are also trade regulations and private stock limitations used on an *ad hoc* basis to increase domestic availability, isolate domestic prices from international prices or boost public procurement. NFSA was passed in September 2013 and it, among others, provides a legal right to highly subsidized food-grains for eligible households. The Act aims to provide food security to 67 per cent of the country's population by distributing a fixed quantity of highly subsidized grain every month. High fiscal costs, leakages, targeting errors, illegal diversion of food grains, and significant wastage due to poor storage and transport facilities are listed among the direct and indirect costs of the system. The absence of clear rules to release surplus stocks resulted in mounting stocks and high food inflation. The current system is further criticized for skewing production and consumption towards wheat and rice away from more nutritious coarse cereals, pulses or oil plants. Trade policies are criticized for fueling international price volatility and net-taxing Indian farmers by understating domestic prices. As a result, there is a lot of pressure both domestically and internationally to reform the system.

Chapter 2 attempts to unravel the major linkages between policies and markets for wheat and rice. It describes and analyses different fragments of the system on a macro level,

[46] Jointly TPDS and OWS are referred to as Public Distribution System (PDS).

using time series analysis of all India aggregate outcomes. The policies in focus are procurement, storage and distribution (with market sales and exports) policies and the major variables of interest are stock levels, market prices and fiscal costs. We find strong and particularly growing in the recent years, impacts of the policy measures on market outcomes. Strikingly, this strong influence is found in all the analyzed elements of the food system. In some cases, markets are so distorted that their fundamentals hardly respond to prices. For example, rice aggregate demand is mostly driven by the PDS distribution. In general, rice market appears to be more regulated than the wheat market. Consequently, starting from 2006-07, there has been a clear upward trend in inflation adjusted fiscal costs associated with procurement, storage and distribution of wheat and rice. Not only have total fiscal costs increased, fiscal costs per unit released through the PDS have also increased.

Chapter 3 builds on the results from Chapter 2 in order to simulate within a two commodity dynamic partial equilibrium model with stochastic shocks on current and possible future reform outcomes. It is found that the NFSA puts a high pressure on fiscal costs and public stocks in the medium term. This can be slightly mitigated with well-designed policy measures. However, there is always a tradeoff between the fiscal costs, grain availability, price levels and stability. For example, relying on imports with the low MSPs results in a high stock-out risk and the lowest fiscal costs, but with high domestic price levels and volatility and high international prices. A policy strategy to manipulate procurement prices in order to maintain public stocks close to the norms leads to a slightly higher fiscal costs with lower and more stable prices and ample stocks. However, on the contrary to a cash-based solution, the differences in outcomes within the NFSA scenarios are not large. A cash-based regime can bring considerable savings and curb fiscal costs, particularly if targeted to the poor, and would leave ample total stocks due to higher private stocks. However, this scenario shows the highest market price levels and variability, which can have negative effects on some producers and consumers as well as on political stability.

The last analytical chapter, Chapter 5, explores TPDS coverage and consumption of wheat and rice – both from the PDS and the market using household level data from the 68th round of the National Sample Survey. The vast majority of the poorest of the poor, at least

those with the AYY (the Poorest of the Poor) card, seem to be well covered by the PDS. In general, by comparison to the wheat distribution, rice PDS appears to be better in terms of covering the traditionally underprivileged classes and those families without dwelling units. We also find evidence for a negative selection of the more affluent households both for a take-up in the Above Poverty Line (APL) scheme and the quantity consumed from the PDS in all groups. This phenomenon results in cost savings, which would be lost under a cash-transfer scheme. Migrant workers and female led households, however, are not well covered by the TPDS, which is an alarming result given that these are vulnerable social groups.

Further, we find evidence that there are different leakage rates from the Above Poverty Line (APL) and the Below Poverty Line (BPL) quotas. The higher price provides a stronger incentive for shop owners to leak grains in case of the APL quota and a stronger incentive on the consumers to buy more in case of the BPL and AAY cards. Another finding is that leakage from the PDS is lesser in poor communities, which is probably due to better monitoring of the system by the beneficiaries. PDS wheat and rice are also found to be imperfect substitutes of the market grains and as a result, the PDS consumption is not inframarginal. There is a strong crowding-in effect of rice consumption by the PDS rice. These findings have important implications for total demand for wheat and rice and hence market prices. In the light of the targeting errors, higher total demand for wheat and rice might have negative consequences for the poor, the underprivileged and the excluded from the system.

5.2.Policy implications

There is a growing consensus, among both proponents and opponents of the PDS, that deep reforms of the system are necessary. For example Jean Drèze and Amartya Sen (2013; 2011) advocate for a better functioning PDS with a universal distribution and against introduction of cash transfers in India. Their argument is that cash transfers need to be supported by well-functioning public services whose provision in India is too weak. Insufficient bank infrastructure is another obstacle to replacing Fair Price Shops with bank branches (Drèze, 2015). To avoid targeting errors and make use of negative self-selection of the rich households, they propose a universal in-kind food distribution. On the other

side of the debate, we find proponents of the cash system. Given the high costs generated by the PDS and the potential benefits of improving the food security and nutrition by less leakage and a change in consumer behavior, these proponents, both in academia and among policy-makers (Basu, 2010; S. Jha & Ramaswami, 2010) argue for switching to cash transfers. For example, a pre-pilot study in Bihar conducted by J-Pal South Asia (Muralidharan et al., 2011) gives an image of a potentially high benefits from the implementation of the cash based system. First, open market shops are much more available, especially in terms of the 'effective access', which is for example opening hours or waiting time. Second, there were fewer complaints about cheating, like underweighting, in open market shops as compared to the PDS shops. Also open market prices were found to be rather stable throughout a year and most importantly, the discussion group revealed a strong interest in receiving cash transfers. However, on average, the cash transfer had to be higher than the equivalent of the subsidy received through Fair Price Shops.

The results from this dissertation might be highly useful in realization of both scenarios, by flagging malfunctions and inefficiencies of the system, quantifying reform consequences and providing inputs for further research. In fact, there are infinitely many scenario realizations with various combinations of in-kind and cash provisions. Clearly, one of the major issues that needs to be solved, regardless of the choice between the two policy instruments, is corruption. Although a discussion on good governance is beyond the scope of this dissertation, we find it necessary to emphasize the importance of the scale of corruption on realization of the outcomes of all the policy measures and success of the reforms. In general, stronger public institutions combined with decentralized and participatory approaches could be more effective at delivering the antipoverty programs and have various benefits, including fiscal sustainability and a long-term growth (von Braun, Gulati, & Fan, 2005).

The modeling exercise showed that there are various aspects which should be taken into consideration when deciding on the particular policy measures. For instance, even under the implementation of the NFSA, there are several strategies of managing the system which can result in different bundles of outcomes regarding price levels and stability, fiscal costs, or grain availability. The degree of reliance on the private sector is also an important

factor to consider. Delegating, for example part of the stockholding[47] or distribution to private agents could curb costs. Further, some degree of reliance on the world market – so allowing or not and to which extent, for supplementing domestic supplies with imports in times of low availability, is the next important issue to be considered. It has several implications for both fiscal costs, as well as domestic and international prices. Choices will depend on the risk attitude, government budget and trust in private sector. Better support for producers of other than wheat and rice crops in order to alleviate rural poverty and diversify production can be further considered. Beside the MSP measures, it is important to investigate - market instruments, like subsidized credit and insurance. Even larger changes can be brought about by moving to cash-based instruments (*e.g.* cash-transfers, deficiency payments). For example, fiscal costs can be reduced significantly but under higher price volatility. Food prices, however, are a very sensitive political issue in India so the decision should consider possible political outcomes.

On the distribution side, policies should consider inclusion of diversified food products in the PDS so as to improve nutrition outcomes. Targeting errors need to be addressed for example through scaling up well targeted programs, like Mid-Day Meal Scheme or enabling more flexible use of ration shops in order to include the migrant workers. Further digitalization of the PDS might positively contribute to leakage eradications. In case cash system is introduced, the major challenge is linking it to the very heterogeneous prices and price changes. Innovative banking techniques – like mobile banking should be considered in order to enable access for the remote areas without bank outlets. Inclusion errors should be addressed as in the case of cash that negative self-selection of the more affluent households will probably disappear. A very important faze of implementation of the cash system is a transition time. With a big share of fragile population in the country, even short term failure to deliver support might result in irreversible negative consequences (Kalkuhl et al., 2013).

[47] Public private partnership for stockholding has been already initiated; however, the scale of it is rather marginal.

5.3. Implications for further research

The partial equilibrium model framework in this dissertation neglects regional differences and state-specific environments, as well as heterogeneity of the agents. Further research should be carried out on the state level data and different income groups. There are several research questions which could be answered with this extended framework. For instance, how would the poor benefit (*e.g.* in terms of total wheat and rice consumption) from the cash transfers as compared to the non-poor? Several questions regarding the implementation of the deficiency payments also remain open. For example, should it be offered to every farmer or should it be targeted to the poor? What would it mean for the total production level? How would it practically be implemented?

Our analysis merely focuses on the domestic market and hence further research should be done to analyze impacts of supply and demand shocks in the world markets. It would also be particularly interesting to analyze outcomes under different trade regimes.

Household level analysis, controlling for local and household level characteristics, should be conducted, and further studies worth conducting could include the impacts of the PDS on nutrition defined through micro- and macro-nutrients. Further, the above mentioned market based solutions like subsidized credit and insurance should be investigated. For example, would the access to financial services (which comes with cash-transfers) have much stronger co-benefits on the poor than the actual cash-transfer?

Another interesting group of questions is regarding the reasons for the distinct differences in the functioning of the wheat vs. rice systems, which were found in this dissertation. Why does rice PDS seem to be functioning much better in terms of providing support to the underprivileged and having lesser leakage? Is it due to better institutions in the rice consuming states? What is the actual contribution to this phenomenon of the universal or semi-universal distribution in some states (most prominently Tamil Nadu)?

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Appendix 1 – Price series construction

In order to transform the wholesale price index component into a price time series, we need a conversion factor. The monthly price is calculated by assigning a weight to the price in a state by the most recent share of that state in total production and then calculating the weighted average price for all of India. This is done for four consecutive years. Then, the monthly conversion factor is calculated as the ratio of the monthly price and the WPI component. The average over four years is taken to use it as the final conversion factor. The stronger seasonality of production-weighted prices goes into the conversion factor. The fluctuations of the conversion factor are the rationale why we cannot use just one month to scale the WPI.

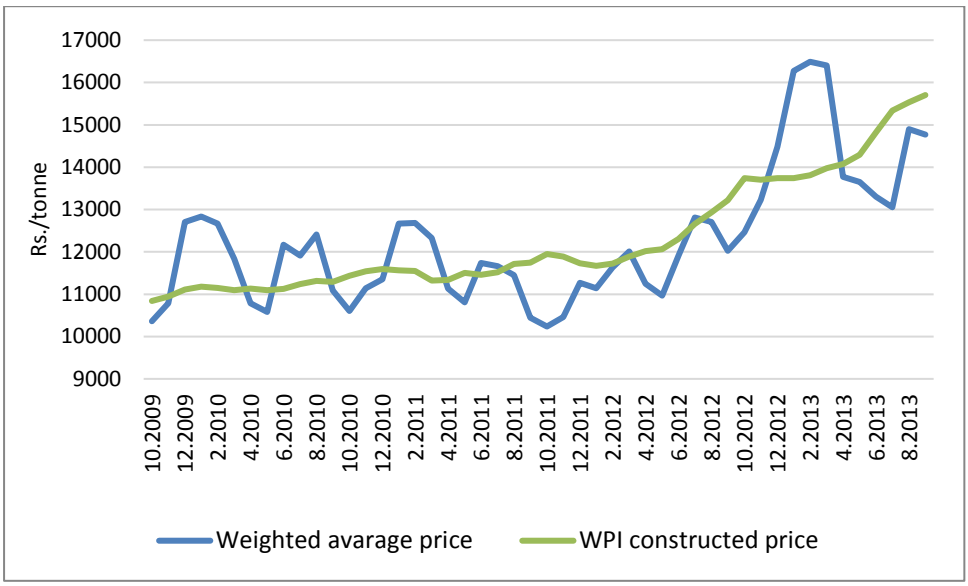

Figure 32 Paddy WPI and major producing states production weighted price average
Source: Own calculation based on http://www.dacnet.nic.in/

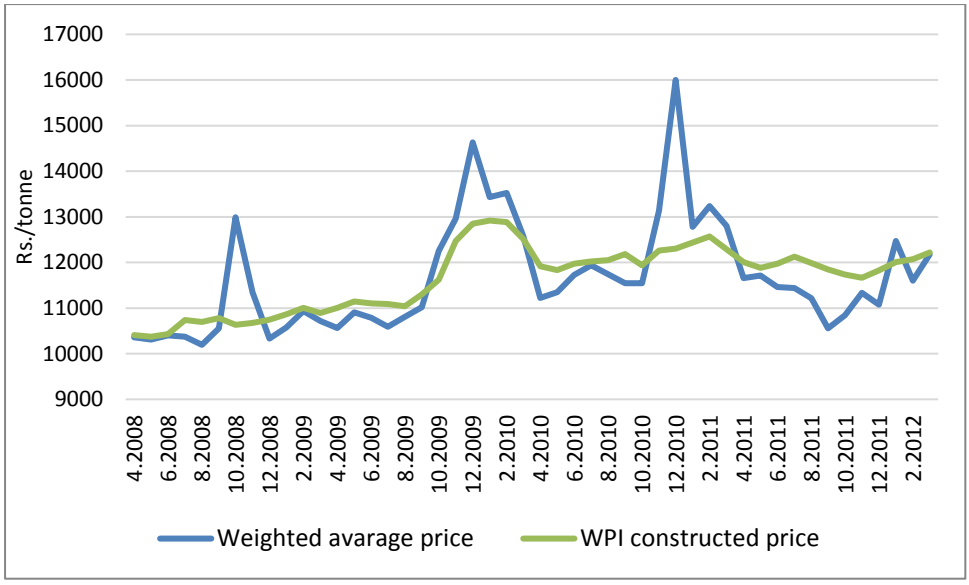

Figure 33 Wheat WPI and major producing states production weighted price average

Source: Own calculation based on http://www.dacnet.nic.in/

Appendix 2 – Regional heterogeneity of prices

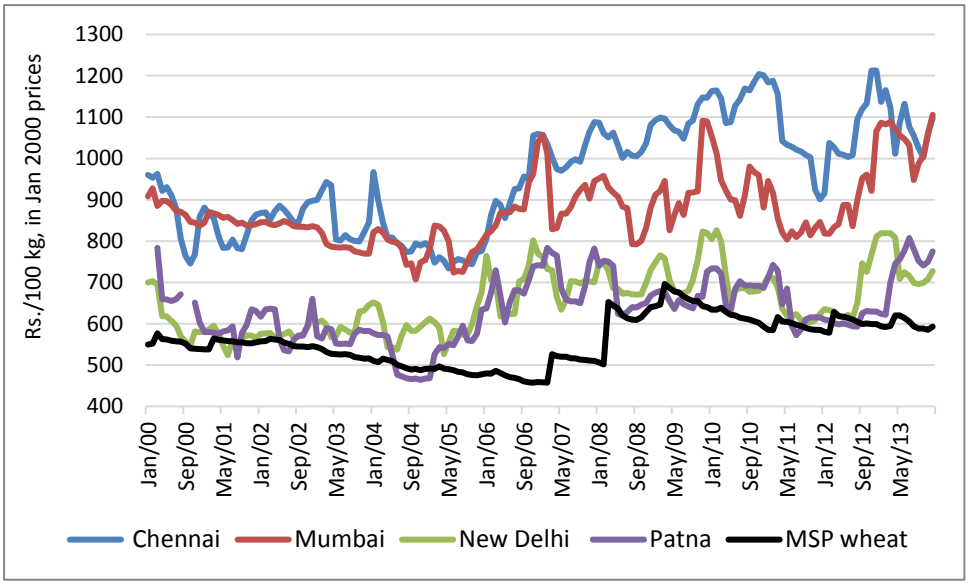

Figure 34 Wheat wholesale prices in selected markets

Source: Own design based on the GIEWS, FAO data

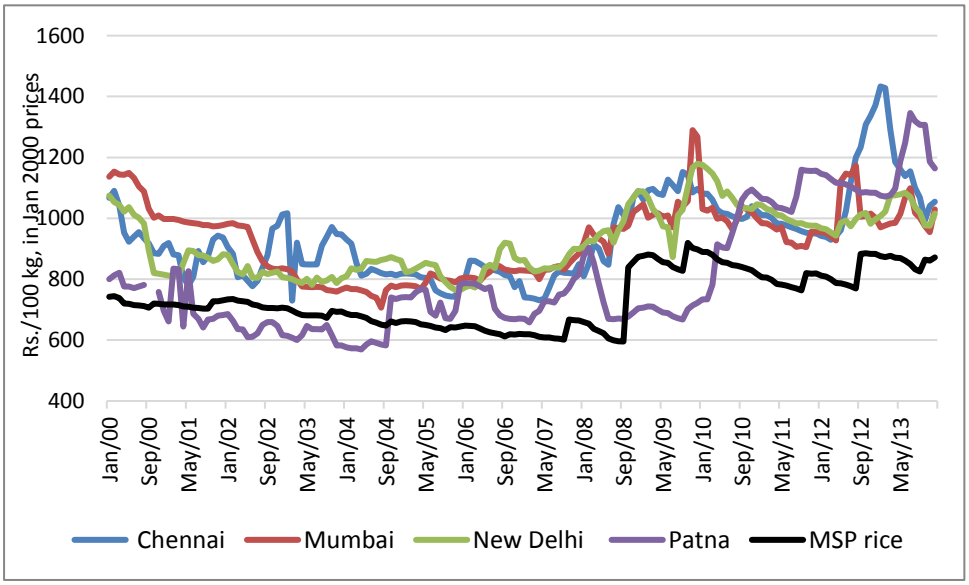

Figure 35 Rice wholesale prices in selected markets

Source: Own design based on the GIEWS, FAO data

Appendix 3 – Data sources

Variable	Source
Production	USDA
Consumption	USDA
Marketed surplus	Ministry of Agriculture, Government of India
Procurement	Food Corporation of India (FCI)
TPDS, OWS off-takes	FCI
MSP	FCI
WPI	Ministry of Statistics and Programme Implementation, Government of India
Stocks	FCI
Rainfall	India Meteorological Department, Government of India
Personal disposable income	Reserve Bank of India
Food subsidy	Ministry of Finance, Government of India

Table 28 Data sources
Source: Own design

Appendix 4 – Demand estimation – IV first stage results

VARIABLES	(1) Log market wheat price (harvest)	(2) Log market wheat price (harvest)	(3) Log market wheat price (harvest)
Lag log market wheat price (annual)	0.261**	0.310***	0.310***
	(0.0974)	(0.0975)	(0.0975)
Log PDS per capita off takes	-0.0884***	-0.112***	-0.112***
	(0.0286)	(0.0260)	(0.0260)
Lag log income	-0.0969*		
	(0.0538)		
Log time trend	0.0835**	0.0267	0.0267
	(0.0335)	(0.0166)	(0.0166)
Log MSP wheat	0.283***	0.174*	0.174*
	(0.0961)	(0.0927)	(0.0927)
Lag rain	-4.88e-05	-7.61e-05	-7.61e-05
	(9.14e-05)	(9.55e-05)	(9.55e-05)
Int price#export ban	-0.00208	-0.00157	-0.00157
	(0.00565)	(0.00582)	(0.00582)
Constant	1.209**	1.070**	1.070**
	(0.431)	(0.429)	(0.429)
Observations	28	30	28
R-squared	0.630	0.603	0.603

Table 29 Wheat IV estimation – first stage results

Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with robust standard error estimation. Robust standard errors in parentheses.

VARIABLES	(1) Log market rice price (harvest)	(2) Log market rice price (harvest)	(3) Log market rice price (harvest)
Log market rice price (annual)	0.491**	0.560***	0.655***
	(0.176)	(0.181)	(0.182)
Lag log income	-0.318***		-0.145**
	(0.0947)		(0.0542)
Log PDS per capita off takes	0.00667	-0.127***	-0.0234
	(0.0601)	(0.0323)	(0.0560)
Log time trend	0.114**	-0.0249	
	(0.0458)	(0.0169)	
Log MSP rice	0.672***	0.341***	0.549***
	(0.120)	(0.0996)	(0.107)

Int price#export ban	0.00624	0.00749	0.0112**
	(0.00617)	(0.00628)	(0.00540)
Rain	2.84e-05	6.86e-05	7.71e-05
	(6.55e-05)	(8.17e-05)	(6.89e-05)
Constant	0.617	-0.162	-0.0799
	(0.558)	(0.528)	(0.508)
Observations	29	30	29
R-squared	0.801	0.717	0.758

Table 30 Rice IV estimation – first stage results

Note. *,**,*** indicates significance levels at 10, 5 and 1%, respectively with robust standard error estimation. Robust standard errors in parentheses.

Appendix 5 – Model fit graphs

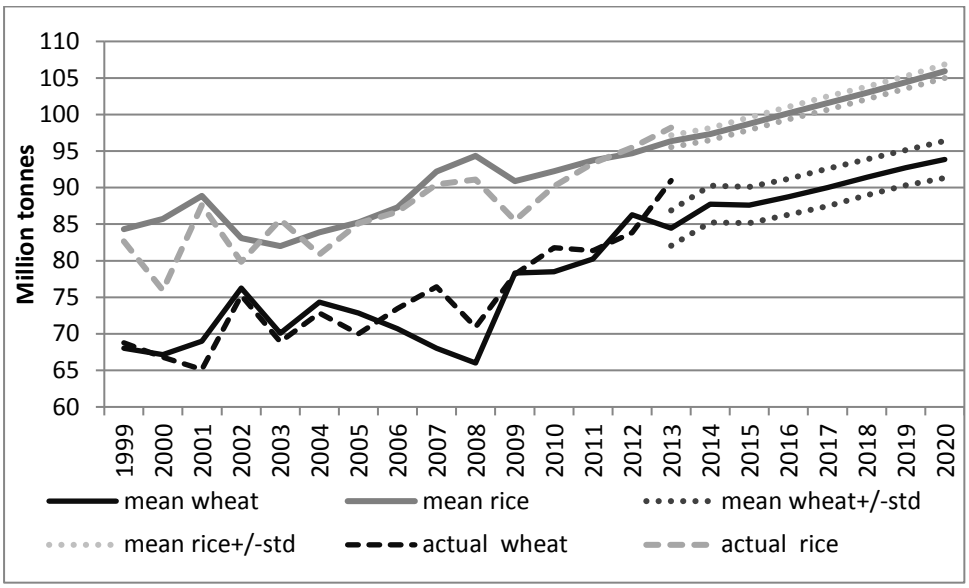

Figure 36 Ex-post and baseline scenario total consumption simulation
Source: Own design

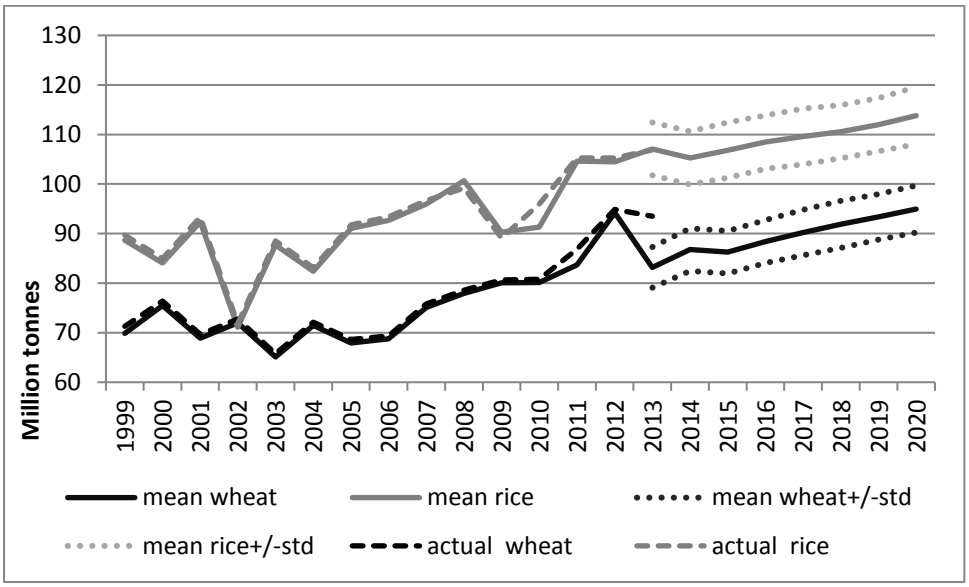

Figure 37 Ex-post and baseline scenario production simulation
Source: Own design

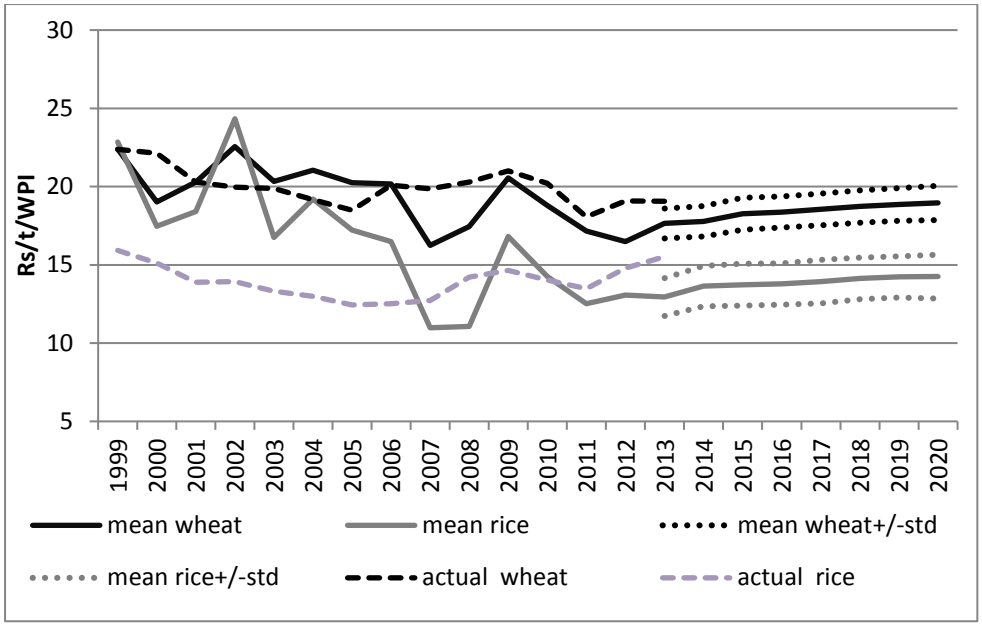

Figure 38 Ex-post and baseline scenario price simulation

Note: Rice price in this graph is for paddy. In the study we use 0.66 as a conversion factor from paddy to rice.

Source: Own design

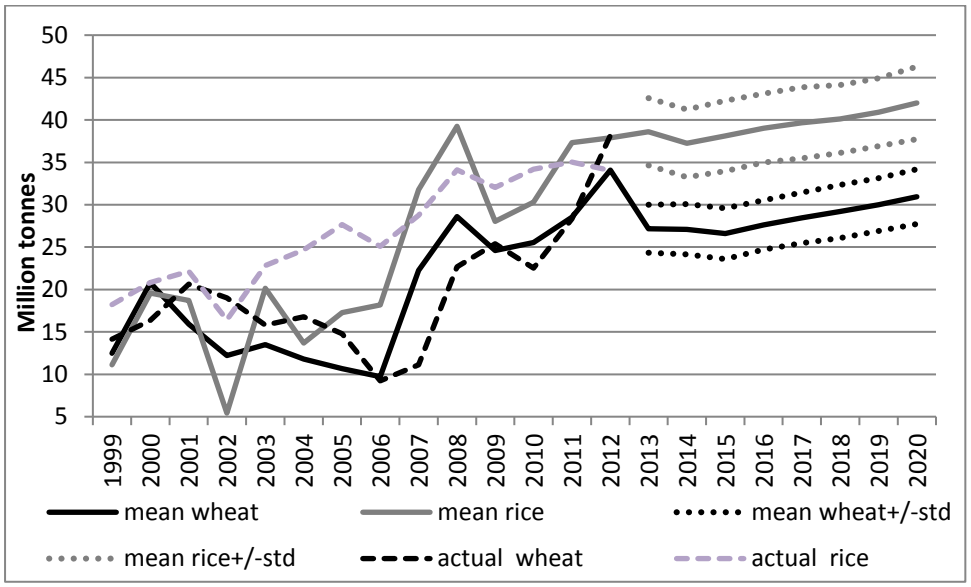

Figure 39 Ex-post and baseline scenario procurement simulation

Source: Own design

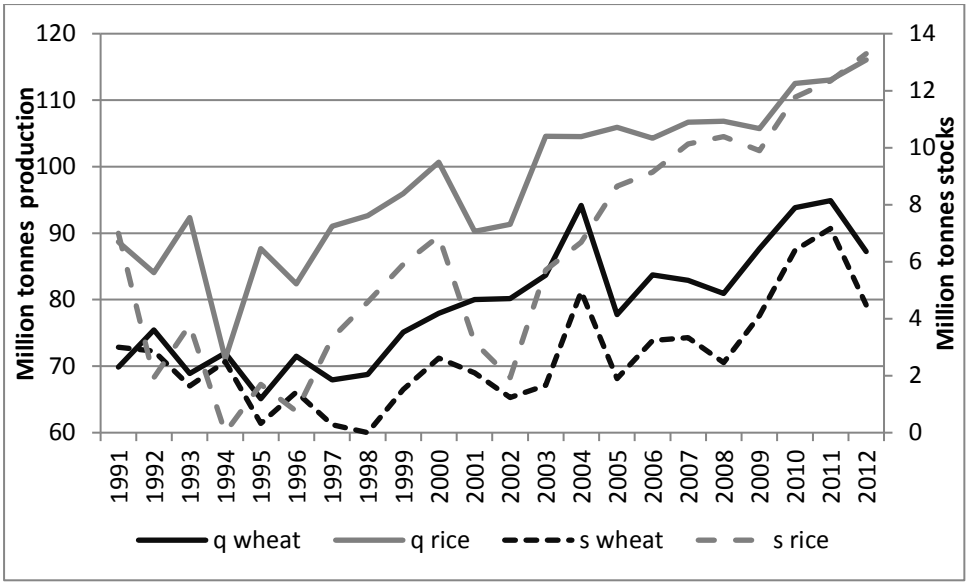

Figure 40 One realization of private stocks (s) and production (q) in cash scenario
Source: Own design