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To Reform and to Procure: An Analysis of the Role of the State and the Market in Indian Agriculture

Kartik Misra
Sewanee University of the South

Deepankar Basu
University of Massachusetts - Amherst

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Kartik Misra

Sewanee: The University of the South

and

Deepankar Basu

University of Massachusetts Amherst

Abstract

Since the early 2000s, many Indian states started reforming their agricultural marketing policies and allowed private traders to buy directly from farmers outside the state-regulated market system. The experience of these states during the period 2000 - 2012 can shed light on the impact of market-oriented reforms and the role of public procurement. Using individual-level National Sample Survey Data on agricultural wages and a new dataset on state-level average real farm income per cultivator for 18 major Indian states between 1987 – 2012, this paper shows, using both a difference-in-difference and a triple difference framework, that marketing reforms alone did not contribute to higher farm incomes and agricultural wages. However, when these reforms were coupled with public procurement at the minimum support price, farm incomes and agricultural wages significantly improved. The effects of public procurement were driven primarily by rice procurement. Our results suggest that market-reforms and public procurement at minimum support prices were complements which together contributed to raising rural incomes in states like Haryana, Madhya Pradesh, and Andhra Pradesh.

Keywords: farm incomes, agricultural wages, market-oriented reforms, public procurement, India

JEL Codes: O13; Q13; Q18

1. Introduction

In 2021, India's farmers protested against three new farm laws which aimed to reform the agricultural marketing system by reducing the role of licensed middlemen and public procurement at minimum support prices. The peaceful year long struggle by farmers outside the national capital forced the BJP government in New Delhi to repeal the proposed reforms which were legislated in September 2020. While the farmer movement succeeded in reinstating status quo ante, the question of whether reforms would have benefitted a wider range of farmers remains somewhat unanswered.

Since early 2000s, several Indian states started liberalizing their agricultural marketing systems *(mandis)* and allowed for greater direct purchases by private traders and large corporations. The experience of these states during the period 2000 - 2012 can shed light on the impact of market-oriented reforms and the role of public procurement. By comparing changes between reform states and non-reform states, this paper shows that market-oriented reforms alone have not had any causal impact on farm incomes and agricultural wages. However, when these reforms are coupled with public procurement at a minimum support price, farm incomes and agricultural wages significantly improved. The experience of states between 2000 – 2012 demonstrates that agricultural reforms and public procurements are *complements* which together contributed to raising rural incomes in states like Haryana, Madhya Pradesh, and Andhra Pradesh.

As the farmer movement dominated the academic and public discourse, the role of the state in restricting market competition or providing a safety-net to attenuate rural distress was fiercely debated. On the one hand, proponents of reforms argued that the traditional agricultural marketing system restricted the ability of the private sector to buy directly from farmers. These policies hindered competition and kept agricultural incomes depressed by limiting the buyers available to farmers. Further, policies like the minimum support price (MSP) were regressive as they primarily benefitted rich farmers in a few northern states of Punjab and Haryana while subsistence farmers were excluded from this income safety-net. Therefore, opening up agricultural markets to greater competition would raise crop prices and address the allocational inefficiencies in the system, argued supporters of reforms.

On the other hand, farmer organizations believed that reforms would dismantle the regulated market sites known as *mandis* that had been established under the Agricultural Produce Markets Commission of 1930. They argued that contrary to popular belief, the existing system incentivized greater competition and price discovery. Under the old (and now reinstated) system, the *arhatiyas* or the broker would

mediate sales between farmers and buyers. The buyers could be the government, private traders, exporter, or domestic processors. Since the *arhatiya's* brokerage was a fixed percentage of total revenue, it would be in their interest to ensure that farmers would get the highest possible price.[1] As the MSP is fixed by the federal government and cannot be negotiated, the *arhatiyas* maximized their returns by ensuring that the maximum possible quantity of grain was sold to the government. In addition, these commission agents also provide timely cash payments to farmers and help them with intertemporal loans. Farmer organizations believed that the reforms would actually stifle competition by forcing farmers to individually negotiate with large corporate buyers.

Further, the reforms would also render the promise of the minimum support price by the government redundant as opening up direct sales between farmers and private traders would be accompanied by a reduction in the actual procurement by the state. This would increase farmers' reliance on the buyers who can depress prices by exploiting the monopsonies in agricultural commodity markets.

Following the farmer's protests last year, the political and academic discourse around farm laws has focused primarily on issues of procurement, MSP, and the ability of private traders and large corporations to buy crops directly from farmers. However, reforming the agricultural sector consists of a broad range of policy recommendations including contract farming, rationalization of farm taxes and subsidies, direct sale to private sector firms outside the mandis, excluding fruits and vegetables from the purview of the mandis and allowing e-trading of agricultural goods (Chand & Singh, 2016). Most of these reforms were outlined in the model APMC Act of 2003. Since agriculture is a state subject, the implementation of this Act was left to the Indian states which selectively enacted provisions of this Act in the subsequent decade.[2] The Model APMC Act of 2003 provided a broad framework for states to adopt far reaching reforms aimed at increasing market access. The rationale behind these policy suggestions was that an increase in the number of *potential* buyers would generate greater competition and raise prices for the farmers (Ghosh, 2013). Further, this would also reduce the reliance of farmers on the MSP and allow them to diversify away from food crops like wheat and rice.

While farmers have objected to several provisions of these reforms, their primary opposition has been towards two proposed changes. First, farmers have opposed the deregulation of the mandis and the

[1] The commission rates vary significantly across states. For instance, *arhatiyas* in Punjab and Haryana charge around 2.5 percent commission but those in Andhra Pradesh charge around 1 percent (Chaba and Damodaran, 2020).

[2] The next section provides an overview of the progress in reforms across the states. For a full history of APMC Reforms see (Purohit et al., 2017; Chand, 2016).

delicensing of commission agents *(arhatiyas)* in the regulated markets. Second, farmers have demanded a retention of the MSP and guarantees of procurement by the state. These provisions of the earlier farm laws were dismantled by the new farm laws legislated in September 2020. While the government assured farmers that the *de jure* provisions of the three new farm laws would not impact government procurement and MSP, farmers argued that the laws would *de facto* eliminate the MSP by reducing government procurement.

Several commentators have argued for decades that sectors of the Indian economy like the manufacturing sector, which were not sufficiently liberalized, have performed worse than the services sector, which were deregulated in the 1990s. In the context of agriculture, the existing regulatory framework of controlling prices led to created food shortages and distorted incentives (Mehta, 2013). Chand and Singh (2016) argue that lack of reforms in the agricultural sector contributed to low and cyclical growth rates and greater concentration of poverty in this sector in comparison with the reformed non-agricultural sector.

However, the arguments supporting the liberalization of agricultural markets has failed to account for certain structural features of Indian agriculture. For instance, market prices are highly correlated with actual procurement of food grains by FCI. In places where the government actually buys wheat and rice from the farmers, it creates a price floor for private buyers. This increases competition and farm incomes, rather than decreasing it. Second, agricultural prices vary significantly between farmers. Most small and marginal farms in India lack access to storage facilities and are forced to sell their produce at low prices (farm gate prices) after harvest, when supply is at its peak. Finally, stagnant agricultural productivity, low levels of public capital formation and credit constraints adversely impact incomes of over 55 million small and marginal farmers in India (Gulati and Bathla, 2001; Krishnamurthy, 2012; Chatterjee, 2017; Chatterjee *et al.*, 2020; Gulati, Kapur and Bouton, 2020).

In addition to these well documented imperfections in agricultural market, the debate on the role of marketing reforms has paradoxically, overlooked the experience of states that already adopted a market-friendly marketing system between 2004 and 2012. For example, the state of Madhya Pradesh, has been a frontrunner in enacting agricultural reforms allowing large private corporations like ITC to buy directly from farmers by circumventing the *mandi* system completely. Madhya Pradesh has also witnessed some of the highest growth rates in agricultural productivity between 2005 - 2012 (Gulati, Rajkhowa and Sharma, 2017). However, this state has also witnessed many farmer agitations and protests during the same period. Further, both central and state governments have provided farmers with monetary

incentives to raise production and have consistently increased public procurement to address farmers' discontent and agrarian distress in the state. Therefore, in Madhya Pradesh, reforms and public procurement seems to have been used as complementary tools.

Like Madhya Pradesh, several states selectively adopted the recommendations of the Model APMC Act during 20004 – 2012 and in the process, developed various models of agricultural marketing. For instance, Bihar completely abolished the AMPC *mandi* system and farmers relied (almost) exclusively on private markets to sell their crops. Similarly, in states like Maharashtra, Gujarat and Karnataka, the primacy of APMC mandis as the primary site of exchange between farmers and traders was significantly reduced. Other states like Assam and Rajasthan developed hybrid marketing system where unregulated market systems were created outside the APMC mandis. Finally, other states like West Bengal, Punjab and Uttar Pradesh did not change their agricultural marketing system and continued to rely on the APMC *mandis* for the sale of agricultural commodities.

As states were changing their agricultural marketing laws to allow for greater participation by private corporations, the role of public procurement at the minimum support price (MSP) also evolved. Some states like Punjab, Tamil Nadu and Uttar Pradesh relied almost exclusively on price support provided to farmers by food grain procurement and eschewed reforms, while others like Andhra Pradesh, Haryana and Madhya Pradesh augmented market reforms with a robust public procurement of wheat and rice.

One of the main reasons for the absence of evidence driven discourse in the debate around the performance of states that enacted various market-friendly reforms was the absence of consistent time series data on state-level farm incomes. Chand, Saxena and Rana (2015) suggest that by subtracting the total wage bill in agriculture from the net value added, we can construct estimates of farm income per cultivator. Basu and Misra (2022) use this formulation to construct the first state-level estimates of farm incomes from 1987-88 to 2011-12. This time series data shows that states like Maharashtra, Gujarat and Assam that enacted market-oriented reforms did not necessarily raise their farm incomes significantly in the period between 2000 - 2012.

The wide variation in state-level agricultural policies and regulatory frameworks between 1987 - 2012 provide us with a quasi-experimental setting to test whether agricultural reforms actually contributed to higher farm incomes? To answer this question, this paper uses the data on state-level real farm income from Basu and Misra (2022) to estimate the causal impact of market-oriented reforms on average farm incomes per cultivator in a difference-in-differences framework. Since an analysis of state-level farm

incomes reduces the sample size of our analysis, we complement this with an analysis of farm incomes at the individual level constructed using the Employment and Unemployment Rounds of the National Sample Survey data between 2000 – 2012.

To ascertain whether a state adopted market reforms we conducted archival research of the academic literature, government reports and newspaper articles. Since a causal interpretation of the impact of reforms on wages relies on the randomness of reform allocation across states, we control for state-level macro and agricultural factors and check for pre-existing trends. There are three main findings of our paper.

First, our difference-in-differences estimation shows that states that adopted market-friendly reforms between 2000 and 2012 did not increase their farm incomes or agricultural wages relative to states that did not change their agricultural marketing system. Thus, by itself, market-oriented reforms did not have any positive impact on agricultural incomes or wages.

Second, by exploiting the regional and temporal variation in marketing reforms and public procurement of food grains in a triple difference framework, and after controlling for state level factors, state, and time fixed effects and for place-specific linear time trends, we find that farm incomes and agricultural wages are higher in states where market reforms and robust public procurement systems coexisted. The guarantee of procurement at minimum support prices may create a price floor for farmers and help them negotiate higher prices in negotiations with private traders and corporations. States that benefitted from public procurement *and* adopted market-oriented reforms witnessed a differential farm income increase of around 0.39 (natural) log points. This translates to an annual increase of around 2891 INR per annum between 2000 - 2012. Similarly, daily agricultural incomes in these states witnessed a differential increase of around 0.53 (natural) log points from a baseline mean of around 42 INR (in real terms) in 1999 - 2000. This translated into an annual increase of around 22 INR (in real terms) per day during the period 2000 - 2012.

Finally, by decomposing the impact of public procurement between wheat and rice, we find that higher agricultural wages were correlated with rice procurement and not wheat procurement. This disparity between rice and wheat prices is also highlighted in the existing empirical literature. For instance, Chatterji and Kapur (2016) also find that market prices for wheat are lower in districts with procurement.

There are three main contributions of this paper. First, we contribute to the debate on the role of reforms in raising farm incomes by analyzing the experience of Indian states that adopted market-oriented reforms

between 2000 and 2012. We show that market-oriented reforms by themselves are not sufficient to raise farm incomes. Second, this paper provides the first empirical evidence on the impact of both market-oriented reforms and public procurement on farm incomes to show that states that adopted a diversified market structure coupled with a robust system of procurement did significantly better in raising farm incomes. This paper argues that the experience of Indian states between 2000 – 2012 suggests that public procurement *complements* market-oriented reforms. This is contrary to the existing discourse that views public procurement and market-oriented reforms as competing policy alternatives for raising farm incomes.

Finally, the results in this paper contribute to the political economy of agrarian change by discussing how farmer incomes may be sensitive to policy choices and availability of institutional support to farmers. Further, changes in factor price and collective bargaining may significantly impact farm incomes and agricultural wages in the countryside.

The rest of this paper is organized as follows. Section 2 presents a brief overview of the agricultural sector and the role of marketing farm laws in India. Section 3 discusses the data and empirical strategies used in the paper and Section 4 presents an analysis of the main results of the paper. Section 5 disaggregates the impact of procurement between wheat and rice and section 6 concludes the paper an agenda for future research and some policy recommendations.

2. Context

The process of structural transformation which reduced agricultural labor force and its contribution to India's GDP started in the 1970s (Michler, 2020). The subsequent changes in the rural economy have been both, confounding for policymakers and distressing for millions of workers in the agrarian economy. Given the variation in regional agricultural experience across states and regions and the limitations of data, an analysis of the salient features of India's structural transformation is difficult. However, to better understand the crisis in Indian agriculture, we summarize some expected and some unexpected features of the agrarian economy.

2.1 Overview of India's Agricultural Sector

Agricultural production in India started rising since the Green Revolution of 1960s. Factors significant advances in production technology, intensity of input use and price guarantees by the government contributed to higher production and productivity gains in agriculture. However, major gains in productivity and public subsidies were confined to cereals like wheat and rice.

Agricultural production in India peaked in the 1980s and started declining subsequently. The growth rate in agriculture started declining from around 4 percent per year in the 1990s to around 2 percent per year in 2000s (Mathur, Das and Sircar, 2003). Both food and non-food crops witnessed a decline, but food grains productions recovered briefly around mid-1990s but declined again in the 2000s. This decline in national-level agricultural growth masks the wide variation in agricultural growth at the state-level. For instance, during the 1993 – 2003 decade, states like West Bengal, Bihar (with Jharkhand) Andhra Pradesh and Kerala witnessed rapid agricultural growth. However, states like Odisha, Gujarat and Maharashtra witnessed negative growth rates (Mathur, Das and Sircar, 2003).

The stagnation in agricultural growth has paradoxically, coincided with rapid extension of irrigation and access to fertilizers which significantly improved the productivity of land in comparison to improvements in productivity per worker (Michler, 2020). Further, the economic reforms of 1990s were expected to improve the terms of trade in favor of agriculture and provide an impetus for agricultural growth. However, agricultural growth and crop diversification after economic reforms of 1990s stagnated (Bhalla and Singh, 2010). Since India's agricultural sector is labor abundant, technological innovation has focused on the relatively scarce resource, namely land. (Ruttan and Hayami, 1990). As improvements in land productivity were driven by increased intensity of input use. Correspondingly, the decline in the last three decades was caused primarily by diminishing returns to input use (Mukherjee and Kuroda, 2003; Nin Pratt, yu and Fan, 2008; Michler, 2020; Wong *et al.*, 2020).

As agricultural productivity and growth started stagnating, the share of farm incomes in total household incomes started declining as rural households diversified their income sources by greater participation in nonfarm activities offered by rural industry which concentrated in low wage regions (Foster and Rosenzweig, 2004; Foster *et al.*, 2016). During the same period, rates of crop diversification within agriculture did not change significantly even when crop prices and productivity rates differed significantly between food and nonfood crops (Rahman, 2009; Basu and Misra, 2022). This income diversification at the extensive margin and the relative absence of crop diversification at the intensive margin suggests that rural distress was a pan agriculture phenomenon and not conditional on crop choice, market demand or public procurement.[3] Therefore, the acute distress in the farming sector may have significantly contributed to declining agricultural labor in India.

[3] For instance, if over production led to a decline in cereal prices inadequate public procurement reduced the demand for cereals, farmers may have shifted to other crops to augment their incomes and reduce their reliance on

Basu and Misra (2022) document the trends in farm incomes across Indian states during 1987 – 2012. During 2004 – 2012, farm incomes grew rapidly providing some relief to farmers but growth rates in income have plummeted since 2012 (Chand, Saxena and Rana, 2015). Further, increased trade and production in agricultural commodities led to a steady decline in the growth rate of agricultural prices during the period 1900 – 2004 (Mathur, Das and Sircar, 2003). This stagnation in agricultural prices was coupled with raising agricultural wages on account of public employment guarantee since 2005 (Azam, 2012; Zimmermann, 2012; Berg *et al.*, 2018; Misra, 2019). Correspondingly, farm incomes may have been squeezed between rising labor costs and stagnant agricultural prices.

As the impetus provided by the Green Revolution technologies and large public infrastructure projects of the 1960s and 1970s started weakening, the importance of government expenditure in rural capital formation and input subsidies increased. However, since the 1980, capital formation in agriculture is financed primarily by private capital (Rao and Gulati, 1994; Gulati and Bathla, 2001). According to the 2017-18 Economic Survey of India, the share of the public sector in the gross capital formation in agriculture since 2011-12 was less than 3 percent of the Gross Value Added (GVA) in agriculture while the corresponding figure for private capital formation was around 15 percent. Complementing the decline in public capital investment in agriculture, input subsidies for fertilizers, electricity and irrigation also declined since 2000-01 which further attenuated the crisis in the agrarian sector (Mathur, Das and Sircar, 2003).

Therefore, the stagnation of agricultural incomes, diminishing input elasticity of production and a reduction in public investment in agriculture constitute the *push* factors which may have contributed to large scale labor movement away from agriculture. Unsurprisingly, according to the World Bank Data, the proportion of labor force engaged in agriculture has fallen from around 70 percent in 1980s to around 44 percent in 2015. Historical experience of structural transformation may suggest that this exodus of workers from agriculture would reduce the population pressure on agriculture and raise real incomes of farmers who continue to stay behind (Ray, 1990). However, given the rates of population growth, the absolute number of people dependent on agriculture continues to rise (Michler, 2020). Moreover, the rate of labor movement out of agriculture has not kept pace with the decline in agriculture's share in the GDP. For instance, between 1980 and 2015, the share of agriculture in India's GDP fell at a rate of 1.65 percent per annum while employment in agriculture fell by only 1.04 percent (Briones and Felipe, 2013).

cereal production. However, trends in agricultural income show that rural distress was not conditional on crop choice.

The evidence suggests that not only is agriculture the largest employer, its role as the employer of last resorts has also not changed. Unsurprisingly, average landholding size has decreased and effective landless has increased since the 1970s (Basole and Basu, 2011).

Since early 2000s, focus of agricultural policies shifted towards increasing market competition for agricultural commodities by allowing private corporations to buy directly from farmers and the use of e-platforms to link markets across states. The Model APMC Act of 2003 provided states with a framework to undertake market-integration and reform the marketing of agricultural commodities by reducing the primacy of government regulated markets (*mandis)* and facilitating direct trade between farmers and large private corporations. While the Model AMPC Act argued for the deregulation of agricultural markets, the actual implementation of these policy recommendations was left to the states. Correspondingly, there has been a significant variation in the policy choices and agricultural performance between states since early 2000s. The next section discusses the variation in the experience of different states in adopting these marketing reforms.

2.2 Marketing Reforms

Given the regulatory framework governing the sale and marketing of agricultural commodities, the role of the government in determining agricultural prices and market access for farmers has received considerable scrutiny in the past few years. It is argued that under the highly restrictive provisions of the Agricultural Produce and Markets Commission (APMC) Act of 1930s and the Essential Commodities Act of 1955, the ability of private players to transport, purchase, store and export food grains is stymied (Chatterjee & Kapur, 2016; Purohit et al., 2017). While these regulations were intended to ensure that farmers could be paid a high price, by restricting market access and competition, the mandi system ended up (unintentionally) reducing mutually beneficial open market transactions which kept farm incomes depressed in many states.

However, recent empirical research using secondary data and ethnographic studies on state and national level data on prices, procurement and market access has revealed the monopsonistic and spatially segregated nature of agricultural markets where the MSP and actual procurement by licensed buyers in the mandis, not only provide an income safety net for farmers but also serves as a price floor necessary for farmers to negotiate a higher price from private players outside the mandis (Chatterjee et al., 2020; Chatterjee & Krishnamurthy, 2021).

Moreover, the absence of storage facilities and non-negligible transportation costs, reduces the ability of producers, who are predominantly marginal or small farmers to negotiate with private traders. The commission agents or *arthiyas* address this institutional failure by aligning the interests of the agents with those of the farmer. Since the *arthiyas* earn a percentage of the total revenue earned by farmers, they ensure that farmers get a high price. Therefore, the mandi system is uniquely suited to ensure collective bargaining by farmers.

Whether the APMC system worked to benefit farmers or enriched the *arthiyas* may vary between states and crops. To better understand the role of APMC framework and the impact of agricultural reforms, we now discuss variations in marketing laws across the states.

Even before the new federal farm laws of 2020, Madhya Pradesh started reforming its agricultural sector by diluting the role of mandis as the predominant sites of wholesale trade and allowing large agribusinesses, supermarkets, and other private players to buy directly from farmers outside the APMC framework (Krishnamurthy, 2012, 2021). In the next few years many other states adopted the recommendations of the Model AMPC Act by either completely abolishing their *mandi* system like Bihar or following a hybrid system of complementing the *mandis* with increased market access for private corporations to buy directly from farmers like Rajasthan and Andhra Pradesh. Figure 1 shows states that adopted marketing reforms by year. States like Uttar Pradesh, West Bengal and Punjab did not adopt the marketing-reforms recommended by the Model APMC Act.

Interestingly, the pre-existing growth rates did not influence states to select marketing reforms. For instance, states that did not enact reforms included West Bengal and Punjab which witnessed rapid agricultural growth during 1993 – 2003. Similarly, states like Bihar, Karnataka and Andhra Pradesh which enacted reforms also witnessed high rates of agricultural growth in the decade preceding the model APMC Act. Conversely, both reform (treatment) and non-reform (control) groups comprised of states with low rates of agricultural growth. Treatment states like Gujarat and Madhya Pradesh had negative growth rates while control states like Kerala witnessed lowest agricultural growth rate of -18.6 percent. However, average farm incomes in control states were higher than those in treatment states as shown in Figure 2. In the next section, we will discuss trends in farm incomes and agricultural wages between states that adopted market reforms and those that did not.[4]

[4] Section 3.1.b provides details of state-level marketing reforms.

2.3 Impact of Reforms on Real Farm Incomes

Figure 2 presents the trends in the natural log of average farm income per cultivator for states that adopted market-oriented reforms and those between 2004 – 2012 (treatment states) and those that did not (control states). Farm incomes for all states have risen during the period 1987 – 2012 and show some evidence of convergence between states. States that did not enact market-oriented reforms started with higher real farm incomes in 1987-88 and which continued for over two decades till 2012. While treatment states witnessed an increase in farm incomes, this was less than that witnessed by control states which suggests that market-oriented reforms may not have contributed to a rise in farm incomes in treatment states. However, since control states started with higher real farm incomes, it can be argued that states with low levels of pre-reform farm incomes enacted chose to enact reforms. Therefore, comparing control and treatment states may not allow us to causally estimate the impact of reforms.

Figure 3 shows the trends in the natural log of daily agricultural wages during the period 1987 – 2012 for control and treatment states. Agricultural wages follow similar trends between control and treatment districts during the entire period. As can be seen from figure 2, daily agricultural wages (in real terms) for all states are rising during the period 1987 – 2009 and is declining between 2010 – 2012. Based on our discussion in Section 2.1 we can see that trends in agricultural wages are correlated with agricultural productivity and output. For instance, agricultural growth rates stagnated in the 1990s, the growth of agricultural wages also slowed between 1994 – 2000. Further, following the National Rural Employment Guarantee Act (NREGA) of 2005, agricultural wages started rising rapidly. Finally, as the budgetary allocation to NREGA started declining since 2010, agricultural wages started declining.

2.4 Food Procurement by FCI

Figure 4 shows trends in the procurement of wheat and rice by the Food Corporation of India between 2000 – 2012. We can see from the figure that the proportion of food grains procured from control states has remained constant throughout the period while procurement from Madhya Pradesh that undertook marketing reforms in 2004 increased rapidly. States like Himachal Pradesh and Andhra Pradesh which adopted reforms in 2005 continued to benefit from high procurement rates throughout the period. The trends in procurement proportions suggest that increased market access provided by the reforms did not *crowd-out* the supply of food grains to the FCI as states either increased or maintained relatively stable procurement proportions. If increased market access provided farmers with better prices, farmers would have reduced their dependence on public procurement. However, the trends show that procurement not

only provides income support to farmers but also creates a price floor for price negotiation by the farmers.[5]

3. Data and Empirical Strategies

This section will first present the data and discuss the empirical strategies used in this paper.

3.1 Data and Variable Construction

This section describes the construction of two outcome variables namely, state-level annual farm income measures and daily agricultural wages. Next, we discuss the archival research of state-level farm laws which helped us determining the state's reform status. Finally, we describe the procurement data from the Food Corporation of India. Table 2 presents the summary statistics for variables used in this paper and Appendix A discusses their construction in greater detail.

a. Farm Incomes

There are three main sources of farm income data in the empirical literature. First, sample surveys like the Rural Economic and Demographic Survey (REDS) collect information on various labor and non-labor inputs used in cultivation. This dataset also collects information on the value of total output produced by the farmer. Farm incomes can be calculated as a difference between the input costs and the sale price of the output (Deininger *et al.*, 2017). The REDS data collects information from around 17 major states, with the latest round of data corresponding to the agricultural season 2005-2006. Therefore, this data cannot be used to construct measures of farm incomes after 2006. Further, since the access to markets enjoyed by farmers may vary by location and farm size, the prices obtained by farmers may vary. This may create difficulties in aggregating sample survey data on agricultural incomes to construct estimates of state-level farm incomes. Finally, while the REDS dataset collects information about marketed inputs like hired labor, fertilizer, seeds, and the cost of rented machinery, it does not include the cost of unpaid family labor which may lead to overestimation of agricultural incomes.

Second, the Commission for Agricultural Costs and Prices (CACP) of the Ministry of Agriculture present details of input costs since the 1970s (Raghavan, 2008). These costs can be subtracted from the value of agricultural output to create estimates of farm income. Under the Comprehensive Scheme for Studying

[5] States that contributed to food procurement by the FCI remained relatively constant throughout the period 1999 – 2012. All rice procurement was done from Andhra Pradesh, Haryana, Odisha, Madhya Pradesh (and Chhattisgarh), Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. Similarly, 90 percent of wheat procurement was done from Bihar (and Jharkhand), Gujarat, Haryana, Madhya Pradesh (and Chhattisgarh), Punjab, Tamil Nadu, and Uttar Pradesh.

the Cost of Cultivation of Principal Crops in India, the Directorate of Economics and Statistics collects data on the input cost of factors like labor and machinery. Additionally, this data also includes the *imputed labor cost* to account for household labor. However, there are two main limitations of this data. First, the CACP only estimates the cost of cultivation for the major crops for which the government announces the minimum support prices. This excludes over half the total crops cultivated by farmers in India. Second, there is considerable variation in the wholesale price index between districts with APMC mandis and those without mandis (Chatterjee and Kapur, 2016). Therefore, constructing estimates of the sale price of agricultural output may not be straightforward even for crops for which CACP data exists.

Finally, the third measure of farm income is constructed by subtracting the total wage bill from the total value added in agriculture in a state (Chand, Saxena and Rana, 2015). Data on agricultural value added is published by the Reserve Bank of India[6] and data on the total wage bill in agriculture is constructed using various rounds the Employment and Unemployment Surveys of the National Sample Survey Organization data.[7] The estimates of farm income are then divided by the number of cultivators to construct estimates of average farm income per cultivator in each state. This measure is finally deflated using the Consumer Price Index for Rural Laborers published by the Labor Bureau of India. There are many advantages of using this measure of farm income. First, this estimate does not rely on assumptions of uniform market access to farmers across states. Existing studies have shown that farm incomes and access to markets is conditional on farm size, distance from the market, government procurement and crop choice (Sarap, 1990; Takeshima *et al.*, 2012; Deininger *et al.*, 2017; Chatterjee *et al.*, 2020). Second, this measure allows us to construct estimates of average real farm incomes in a state for all farmers (including those growing crops for which CACP data does not exist) for the period 1987-88 to 2011-12. However, our measure of real farm incomes does not include the imputed costs of family labor and the rental cost of cultivating own land, taxes, and subsidies. Therefore, our estimates may be considered as upper bounds of farm incomes across states in India.

b. Agricultural Wages

While estimates of annual farm incomes constructed by subtracting the agricultural wage bill from total value added provides us with state-level farm incomes, this measure does not account for district-level

[6] Table 6, Components of Net State Domestic Product at Factor Cost by Industry of Origin, *Handbook of Statistics on Indian Economy*. See https://www.rbi.org.in/scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy

[7] Appendix A provides the details of variable construction.

variation between agricultural prices and incomes. Further, this measure significantly reduces our sample size, which, in turn, reduces the precision of our estimates. To address these concerns, we complement our analysis of state-level average, annual real farm incomes with an analysis of daily real wages for agricultural workers using unit-level data from various rounds of the nationally representative Employment and Unemployment Surveys of the National Sample Survey (NSS) Organization. The unit-level data used in the analysis corresponds to the 43rd round (1987-88), the 50th round (1992-93), the 55th (1999-00), the 61st round (2004-05), the 64th round (2007-08), the 66th round (2009-10) and the 68th round (2011-12) of the national sample survey.

One advantage of using individual level data is that we are able to control for unobservable factors at the district level (using dummy variables for districts). However, since state and district boundaries have changed significantly between 1987 and 2012, we could not match all of the current districts across all NSS rounds. For our empirical analysis, therefore, we restricted our sample to 150 districts across 14 major states which could be unambiguously identified across all rounds between 1999 -2000 and 2011 -2012. Since agricultural wages differ by seasons, we create a measure for daily wages and constructed a measure for daily real agricultural wages by deflating the nominal wages by the Consumer Price Index for Rural Laborers published by the Labor Bureau of India

c. Reform Variable

Several states have been reforming their agricultural policies since the early 2000s. Madhya Pradesh spearheaded the reforms by adopting alternative marketing channels for cash crops like soy (Goyal, 2020) and food crops like wheat (Krishnamurthy, 2021). Large firms like ITC to procure directly from farmers outside the mandis (Krishnamurthy, 2021). The scale and scope of these reforms accelerated after the Model APMC Act was passed in 2003. To take another example, in 2006, Bihar completely abolished the APMC mandi system (Kishore et al., 2021). Similarly, Gujarat also implemented all reforms and reduced actual procurement in 2006.

Other states like Andhra Pradesh, Assam, Karnataka, Maharashtra, Rajasthan, and Haryana partially implemented the reforms. These states allowed mandis to operate but also allowed farmers to sell in open markets, including trading in various e-markets across the country (Aggarwal et al., 2017; Ramesh Chand & Singh, 2016; Ghosh, 2013). At the other end of the spectrum were states like Punjab, Tamil Nadu, Tripura, Kerala, and West Bengal, where none of the marketing reforms proposed by the APMC Act of

2003 were adopted. Uttar Pradesh initially adopted the reforms in 2004 but following widespread opposition from farmer organizations, the state government withdrew the reforms (Ghosh, 2013).

The existing literature tracks reform progress along several parameters including contract farming, decentralizing sales by setting up of private mandis, single license for state-wide traders, rationalizing of taxes on agricultural commodities, extension of e-trading facilities and joining the e-NAM initiative by linking mandis to the national electronic trading portal (Purohit et al., 2017). Chand and Singh (2016) rank Maharashtra, Gujarat and Rajasthan as the top states implementing market friendly reforms while Jammu Kashmir, Tamil Nadu and Uttarakhand are among the worst performing states on their reform index.

Most states have made some efforts to expand e-trading and use of technology enabled price dissemination services in the last decade. The major difference between state-level policy framework exists in the role of APMC mandis as the primary site of transactions between licensed buyers and farmers. Further, the primary opposition of farmers to the September 2020 Farm Law Amendments also revolved around the role of APMC mandis, licensed agents *(arhatiyas)* and the MSP. Correspondingly, this paper focuses on state-level reforms that diversified markets for farmers and reduced the ability (dependence) of farmers to sell in APMC mandis. We construct a binary reform variable that takes the value 1 if farmers could sell to private players (either exclusively or along with APMC mandis) and 0 otherwise.

To construct this reform variable, we conducted archival research of state-level policies by analyzing various annual reports of the Ministry of Agriculture and Framer's Welfare, academic research, and newspaper articles. There were two main objectives of this research. First, we wanted to ascertain whether farmers sold primarily in the APMC mandis or whether they were free to sell directly in the open market. Second, we wanted to know if the state government had reformed the previous APMC Act, and if it did, to ascertain the year in which this change took effect? The process of classifying states into reform (treatment) and non-reform (control) states is described below.

The reform status for some states was easy to infer. For instance, Bihar completely abolished the APMC system in 2006 (Kishore et al., 2021) and states like Maharashtra and Gujarat have introduced many significant policy changes to reduce the primacy of mandis and deregulate the entry of private corporations. Correspondingly, these states have high scores on all published reform indices. There is general consensus in the literature that these states are top reformers in the country. On the other hand, states like Tamil Nadu, Kerala and Jammu and Kashmir have not adopted the Model APMC reforms.

Similarly, states like Punjab and West Bengal have not altered their mandi system. Correspondingly, these states have been classified as states in the control group.

For other states like Uttar Pradesh, Assam, and Tripura, assigning the reform classification was not straightforward. We relied extensively on academic research, published reports, newspaper articles and ethnographic research to determine whether farmers in these states had access to mandis or not (R Chand, 2020; Ramesh Chand & Singh, 2016; Ghosh, 2013; Purohit et al., 2017). For states like Odisha, Karnataka and Madhya Pradesh which developed a hybrid marketing system, we defined the reform variable based on academic studies and reports. For instance, Chatterji et al. (2020) document the pluralistic market system in Odisha which includes multiple licensing authorities, private markets, and Regulated Market Committees (RMCs). Correspondingly, mandis are not the only sites for exchange. Based on this evidence, we classified Odisha as a reform state. Similarly, the significant progress made by Karnataka in expanding market access for private corporations and linking their markets to e-NAM initiatives are well documented in the literature (Aggarwal et al., 2017). Madhya Pradesh's economic reforms, infrastructure development and robust public procurement system are identified as major drivers of its rapid agricultural growth between 2005 – 2015 (Gulati et al., 2017). Similarly, Haryana also implemented several market-oriented reforms since 2006 but continued a robust system of government procurement of both wheat and rice. Since farmers in both these states could sell in the open market and in APMC mandis we classify these as reform states in this paper.

Finally, for states that were classified as reformed, assigning the date of reform implementation was another challenge. The Annual Reports published by the Ministry of Agriculture and Farmer's Welfare since 2016 provide details of reform status for most states. However, these Reports do not provide information on the timing of these reforms. In order to assign the reform year, we relied on extant literature and newspaper reports. For instance, Madhya Pradesh had allowed private corporations to buy directly from farmers since 2000 (Goyal, 2020). However, it was only by 2004 that warehouses facilitating direct sales to private buyers were established in the state. Correspondingly, we assign 2004 as the date of marketing reforms for Madhya Pradesh. Similarly, Ghosh (2013) documents a history of APMC reforms for several states which helps us assign treatment dates for Andhra Pradesh, Assam, and Himachal Pradesh.

Table 1 presents the reform status for each of the 18 states analyzed in this paper. This table also lists the major source of archival information on the reform status and timing. Our reform variable can be

compared to the composite reform index constructed by Chand and Singh (2016) and Purohit et al.(2017). While these papers present an index of reform focusing on various parameters, we restrict our analysis to the reforms pertaining to market access and the functioning of AMPCs in states. Our reform variable is comparable to Chand and Singh (2016) for all states except Assam, and Odisha.

The major difference relates to the actual procurement and functioning of the mandis. For instance, Assam and Odisha score only 37 and 28 on a 100-point reform scale constructed by Chand and Singh (2016). However, our research suggests that farmers in these states do not predominantly rely on APMC mandis to sell their crops and that private markets have been operational in these states for over a decade. While these states have reformed their agricultural marketing system, they have not made significant progress in expanding their e-trading infrastructure and have not joined the e-NAM initiative. This may account for their low scores on the Chand-Singh composite reform index (Ramesh Chand & Singh, 2016). Since these states allow for direct sale by farmers, we are classifying them as reform (treatment) states for this analysis.

d. Procurement

The role of market-oriented reforms in raising farm incomes has received a lot attention in the past year. However, the issue of allocative inefficiencies and market distortions created by the procurement of food grains by the Food Corporation of India has dominated the discourse on India's agricultural crisis since the economic reforms of 1990. Market-oriented reforms, public procurement of food grains and the MSP are intimately related to each other. Hence, we would like to bring in the dimension of procurement and MSP into our analysis of the impact of market-oriented reforms on farm incomes. What complicates the picture of procurement is its significant diversity across crops and regions of India. While the government announces the MSP for several food and non-food crops including jowar, bajra, tur, groundnut, barley, sugarcane, and cotton, the FCI primarily buys wheat and rice from the APMC mandis. Since 1999-2000, Punjab, Haryana and Uttar Pradesh have dominated the procurement of wheat and rice by the FCI. The procurement of wheat is primarily concentrated in Punjab, Andhra Pradesh, Haryana, and West Bengal. Table 3 presents an overview of the trends in procurement of wheat and rice by the FCI as a proportion of total production in a state using the data on procurement released by the FCI and the data on total production given by the Directorate of Economics and Statistics.

3.2 Empirical Strategy

The main goal of this paper is to estimate the causal impact of marketing reforms on farm incomes and agricultural wages. In this section, we discuss our empirical strategies and discuss possible threats to identification of causal effects.

a. Difference-in-Differences

Since there is significant regional and temporal variation in the adoption of market friendly reforms by states, we adopt a difference-in-differences estimation method to estimate the causal impact of these reforms on average, state-level, real farm incomes. Our regression specification takes the following form.

$$y_{st} = \beta_1 Reform_s \times Post_t + \beta_2 X_{st} + \beta_3 H_{st} + \tau_t + \varphi_s + \varepsilon_{st} \qquad (1)$$

where s and t are indexes for states and periods, y_{st} is the natural log of annual real farm income per cultivator, $Reform_s$ is a dummy variable equal to 1 if the state enacted marketing reforms and 0 otherwise, $Post_t$ is a dummy variable equal to 1 if the observation is after the year of reform for a given state, X_{st} corresponds to state-level macro controls like the log of state GPD, population and tax revenue, H_{st} includes state-level agricultural controls like the number of agricultural workers, productivity of wheat and rice and the proportion of wheat and rice procured by the FCI; $\tau_t \; and \; \varphi_s$ are period and state fixed effects respectively. Standard errors ε_{st} are adjusted for correlations at the state level.[8]

The main coefficient of interest is β_1 which measures the change in real wages in reform states after they adopted market friendly reforms relative to the corresponding change in real farm incomes in states that did not adopt these reforms. We face three challenges in estimating a causal effect. First, the sample size of our analysis using state-level annual farm-incomes is small, which can impact the precision of our estimates. Second, the difference-in-differences estimation relies on the random allocation of treatment across the population (Heckman et al. 1997). Our difference-in-differences estimate of the causal effect of market-oriented reforms would be biased if farm incomes in reform states are trending differentially from those in non-reform states or if market-oriented reforms were correlated with excluded control variables. Finally, since the adoption of market-oriented reforms by a state is ascertained by archival research, the impact of reforms may be conditional on the inclusion (or exclusion) of certain states as

[8] In our empirical analysis, $s = 1,2, \dots, 18$, is the index for the 18 states in our sample, and $t = 1,2, \dots, 7$, is the index for the following 7 time periods for which the we have data from the national sample survey: 1987-88, 1993-94, 1999-00, 2004-05, 2007-08, 2009-10 and 2011-12. The complete list of control variables appears in the footnote to Table 2.

reform states. Section 3 discusses how our reform status differs from that of Chand and Singh (2016) for Assam and Odisha. We discuss each of these concerns in detail below.

First, since real value added in agriculture is only available at the state level, we cannot construct farm incomes at a more disaggregated level. However, we address this concern by complementing our analysis of state-level farm incomes with an analysis of agricultural wages. Data on the daily agricultural real wages can be constructed at the individual level from different rounds of the nationally representative sample survey (as we have explained in section 3.1). An additional advantage of using individual-level data from the national sample surveys is that we are able to control for unobservable confounders at the district level. We do so by estimating our model on a pooled cross-section data set by restricting observations to 150 districts that we could consistently identify across the national sample survey rounds from 1987-88 to 2011-12.

Our individual-level difference-in-differences model is the following:

$$y_{idt} = = \beta_1 Reform_d \times Post_t + \beta_2 X_{dt} + \beta_3 H_{idt} + \tau_t + \varphi_d + \delta_d \times t + \varepsilon_{idt} \quad (2)$$

where *i*, *d* and *t* are indexes for individuals, districts and time periods, y_{idt} is the natural log of real daily agricultural wage, $Reform_d$ is a dummy equal to 1 if the district is part of a state that enacted marketing reforms and 0 otherwise, $Post_t$ is a dummy equal to 1 if the observation is after the year of reform for a given state, X_{dt} corresponds to district-level controls like the agricultural controls like the number of cultivators and agricultural productivity. H_{idt} includes individual-level controls like the age, gender, religion, and caste of the induvial; $\tau_t \; and \; \varphi_d$ are year-quarter and district fixed effects respectively. Since we cannot control for all district level factors, we also include district-level linear time trend $\delta_d \times t$. Standard errors ε_{idt} are adjusted for correlations at the district level. The main coefficient of interest is β_1 which measures the change in daily real wages in reform states after they adopted market friendly reforms relative to the evolution of daily real wages in states that did not adopt these reforms.[9]

Second, most states adopted market-oriented reforms after the Model APMC Act of 2003 which provided states with a blueprint for reforms. However, whether a state adopted the recommendations of the Model APMC Act could be correlated with factors like incomes, population, agricultural productivity, and public procurement. We address this concern partly by controlling for observable differences between

[9] The sample for estimating this model has individual-level observations from 150 districts in 14 major states for the years 1999-00, 2004-05, 2007-08, 2009-10 and 2011-12.

reform and non-reform states. Table 2 shows the summary statistics for these controls. We see that these macro and agricultural variables are not statistically different between treatment and control states. However, unobservable factors may impact farm incomes, causing treatment and control states to have divergent trends in farm incomes before they adopted market-oriented reforms. Hence, we test if treatment and control states followed different trends in real farm incomes following Muralidharan and Prakash (2017)

$$y_{st} = \beta_1 Reform_s \times Trend + \beta_2 X_{st} + \tau_t + \varphi_s + \varepsilon_{st} \qquad (3)$$

where *s* and *t* are indexes for states and time periods, y_{st} denotes either the natural log average real farm income or the natural log of daily real wage in state s in period *t*, $Trend_t$ is a continuous indicator for year (1 for 1987-88 and 3 for 1999-00). To test the parallel trends assumption, we estimate model (3) for all pre-market reform years (1987-88, 1993-94 and 1999-00). The estimate of β_1 in model (3) can be seen in Table 4. The coefficient is statistically insignificant. This is evidence in favor of the parallel trends assumption, the key identifying assumption for the validity of the DD research design.

Finally, to account for differences in the reform status of Assam and Odisha, we also estimate the difference-in-differences specification of equation (1) and equation (2) using the composite reform index of Chand and Singh (2016) – because their treatment of Assam and Odisha are different from what we identify through our archival research. In this specification, if a state scores more than 50 on a 100-point reform index constructed by Chand and Singh (2016), we consider it a reform/treatment state (reform dummy equal to 1) and control state otherwise. We find that the results of the difference-in-differences specification are qualitatively similar even when we use the Chand and Singh reform classification. This may suggest that our results are not sensitive to the identification of Assam and Odisha as reform (or non-reform) states.

b. Triple Difference

Next, we test how market-oriented reforms interact with public procurement by the FCI to impact farm incomes using a triple difference framework given below.

$$\begin{aligned} y_{st} = {} & \beta_1 Reform_s \times Procurement_{st} \times Post_t + \beta_2 Reform_s \times Post_t \\ & + \beta_3 Procurement_{st} \times Post_t + \beta_4 Reform_s \times Procurement_{st} \\ & + \beta_5 Procurement_{st} + \beta_6 X_{st} + \beta_7 H_{st} + \tau_t + \varphi_s + \delta_s \times t + \varepsilon_{st} \end{aligned} \qquad (4)$$

where *s* and *t* are indexes for states and time periods, y_{st} is the natural log of annual real farm income per cultivator, $Reform_s$ is a dummy equal to 1 if the state enacted marketing reforms and 0 otherwise. $Post_t$ is a dummy equal to 1 if the observation is after the year of reform for a given state; $Procurement_{st}$ is a dummy equal to 1 if the FCI procured grains form the state and 0 otherwise; X_{st} corresponds to state level controls discussed in Table 2; $\tau_t \; and \; \varphi_s$ are period and state fixed effects respectively. Additionally, we also include state-specific linear time trends ($\delta_s \times t$) to control for potentially heterogenous pre-program trends. Standard errors ε_{st} are clustered at the state level to take account of possible correlation of unobserved factors over time for each state.

The coefficient of interest, β_1, measures the differential change in real farm income per cultivator in reform states from which the FCI procured wheat or rice after market-oriented reforms were adopted in these states. Similar to the differences-in-difference specification, the validity of the triple difference estimator depends on the exogeneity of the procurement variable. We address this concern in three ways. First, Figure 3 shows trends in procurement across treatment and control states during the period between 1999-00 and 2011-12. As can be seen from the figure, trends in procurement for all states except Madhya Pradesh United (which adopted reforms in 2004) remains consistent throughout the period. While MP United witnessed a rapid rise in the quantum of procurement, Table 3 shows that procurement as a proportion of total output in the state remained relatively stable throughout the period. Next, we include state-specific linear time trends to control for differential trends in procurement between treatment and control states.

Second, we complement our analysis of state-level average, real, annual farm incomes with individual level daily real agricultural wages using the individual-level NSS data from a pooled cross-section data set for 14 major states and 5 time periods (1999-00, 2004-05, 2007-08, 2009-10 and 2011-12). We restrict the sample to observations for 150 districts that we can consistently identify for all these time period. More specifically, we estimate the following triple difference specification.

$$\begin{aligned} y_{idst} = \; & \beta_1 \, Reform_s \times Procurement_{st} \; \times Post_t + \beta_2 Reform_s \times Post_t \\ & + \; \beta_3 \, Procurement_{st} \; \times Post_t \; + \; \beta_4 \, Reform_s \times Procurement_{st} \\ & + \; \beta_5 Procurement_{st} \; + \; \beta_6 \, X_{dt} + \; \beta_7 H_{idst} + \; \tau_t + \; \varphi_d + \; \delta_d \times t + \; \varepsilon_{st} \end{aligned} \qquad (5)$$

where *i*, *d, s* and *t* are indexes for individuals, districts, states and time periods, y_{idst} is the natural log of real daily agricultural wage, $Reform_s$ is a dummy equal to 1 if the state enacted marketing reforms and 0 otherwise, $Post_t$ is a dummy equal to 1 if the observation is after the year of reform for a given state,

X_{dt} corresponds to district level agricultural controls like the number of cultivators and agricultural productivity, H_{idt} includes individual level controls like the age, gender, religion, and caste of the induvial, $\tau_t \; and \; \varphi_d$ are year-quarter and district fixed effects respectively. Since we cannot control for all district level factors, we also include district-level linear time trend $\delta_d \times t$. Standard errors ε_{idt} are adjusted for correlations at the district level.

Third, we test for pre-program trends for the triple difference specification by estimating the following specification:

$$\begin{aligned} y_{idst} = \; & \beta_1 \, Reform_s \times Procurement_{st} \; \times Trend_t + \beta_2 Reform_s \times Trend_t \\ & + \; \beta_3 \, Procurement_{st} \; \times Trend_t + \; \beta_4 \, Reform_s \times Procurement_{st} \\ & + \; \beta_5 Procurement_{st} \; + \; \beta_6 \, X_{dt} + \; \beta_7 H_{idst} + \; \tau_t + \; \varphi_d + \; \delta_d \times t + \; \varepsilon_{idst} \end{aligned} \qquad (6)$$

where $Trend_t$ is a continuous indicator for year-quarter, and all other variables are the same as those described in equation (5) above. In table 5 we show the results for the parallel trends regressions of equations for the difference-in-differences (DD) and triple difference (DDD) estimation of the parallel trends regression using unit-level data for the pre-reform period. In both cases, the coefficient β_1 is statistically insignificant. Therefore, the parallel trends assumption is satisfied as we cannot reject the null hypothesis.

Additionally, the appendix shows that our results are robust to several alternative specifications. For instance, to account for a small number of clusters in our state-level regressions we bootstrap standard errors using the method proposed in Cameron, Gelbach, and Miller (2008). We conduct placebo treatment and demonstrate that our estimates are robust to the exclusion of different years and states from the sample.

4. Results

4.1 Impact of Reforms on Farm Incomes and Agricultural Wages

Table 6 presents the results of the difference-in-differences model represented by equation (1). Each column shows the results of a different specification. Column (1) presents the naïve model without any controls. Column (2) includes macro controls and column (3) presents the complete model with macro and agricultural controls and state and year fixed effects. As can be seen from Table 6, market-oriented reforms did not contribute to higher incomes in states that adopted these reforms. The results do not

change even when we use the Chand and Singh (2016) classification of states based on a composite reform index. In both cases, the log of real farm incomes increased by 0.02 log points. However, this result is not statistically significant.

Since this paper presents the first estimates of changes in real farm incomes between states that enacted market-oriented reforms and those that did not, we cannot compare our results directly with existing studies. However, we compare our results with papers that study the impact of market reforms on similar agricultural variables. For instance, using a composite index of agricultural reforms, Purohit et al. (2017) show that reforms promoted agricultural growth and technology adoption. Similarly, Chand et al. (2015) find that between the period 2004 – 2012, farm incomes grew at around 5.4 percent but this change was caused by rising agricultural prices and a decline in the number of agricultural workers and cultivators. These findings suggest that while agricultural reforms may have contributed to rising output of agricultural commodities, farm incomes depended critically on the ability of farmers to negotiate with private buyers for high prices. In the next section, we discuss how procurement by FCI might have impacted the bargaining power of farmers and allowed them to capture beneficial impact of reforms when public procurement generated a price floor.

Next, we analyze if agricultural reforms had an impact on daily real agricultural wages. The results are shown in Table 7.[10] Similar to the results for annual real farm-incomes, we find that agricultural reforms did not have any impact on daily real agricultural wages. In column (3) of Table 7, we present our complete specification including controls and district-level linear time trend. The coefficient is not statistically significant.

4.2 Impact of Marketing Reforms and Public Procurement on Farm Incomes and Agricultural Wages

Tables 8 presents the results of the triple difference specifications of equations (4), which constitute the main results of this paper. Each column presents a different specification. Column (4) presents the results for the complete specification presented in equation (4). This table shows that in states that adopted market-oriented reforms *and* where FCI procured wheat or rice, the log of real farm incomes increased by around 0.39 log points even after we control for macro and agricultural controls, state and time fixed effects and state-specific linear time trends. This corresponds to an increase of around 1,575 INR per annum between 2005 – 2012 from a baseline mean of 28,282 INR in 2005.

[10] The sample for estimating this model has individual-level observations from 150 districts in 14 major states for the years 1999-00, 2004-05, 2007-08, 2009-10 and 2011-12.

This suggests that real farm incomes benefitted from increased market access provided by reforms, but that these gains were conditional on food grain procurement by the government. These results indicate that agricultural commodity markets are highly monopsonistic. Private buyers of crops can depress prices unless farmers can fall back on robust public procurement, which creates a price floor for agricultural prices. These findings are consistent with existing research which studies price variations across agricultural markets in India (Chatterjee and Kapur, 2016; Chatterjee *et al.*, 2020).

Similar to the triple difference specification for farm incomes, Table 9 shows the results for the triple difference specification of equation (5).[11] Our preferred specification including all controls, year quarter fixed effects and district level fixed effects and district specific time trends is shown in column (3). We find that real agricultural wages rose by 0.53 percentage points in states that adopted market reforms *and* benefitted from FCI procurement of wheat and rice. This translates into an increase of around 22 INR per day during the period 2000 – 2012.

Existing studies suggest that composite market-oriented reforms may benefit agricultural growth and production (Purohit et al., 2017). However, these impacts are driven by reductions in transaction costs and greater technology adoption. The literature suggests that variations in farm prices have been a critical determinant of agricultural growth (Mathur et al., 2003). Further, persistent variation in prices between *mandis* within a state suggests that public procurement at MSP may be an important determinant of farm incomes received by cultivators (Chatterjee & Kapur, 2016). Our triple difference results provide empirical estimation in support of this hypothesis.

4.3 Decomposition of Triple Difference Results

The results in table 9 suggest that marketing reforms coupled with FCI procurement has a statistically significant impact on agricultural wages. Does this result vary across major crops like rice and wheat? To answer this question, we decompose the results by wheat and rice procurement at the state level. To be more specific, we re-estimate equation (5) for rice and wheat separately. We find that our triple difference results are primarily driven by the procurement of rice. Column (3) of Table 10 presents our preferred specification for the triple difference for rice procurement (reform x post x rice procurement). We find that the triple difference coefficient is 0.67 log points which is significant at the 1 percent level. This

[11] The sample for estimating this model has individual-level observations from 150 districts in 14 major states for the years 1999-00, 2004-05, 2007-08, 2009-10 and 2011-12.

implies that states that enacted market reforms and benefitted from the procurement of rice witnessed a significant increase in real agricultural wages.

By contrast, the triple difference coefficient for wheat is -0.22 which is statistically insignificant. This suggests that the impact of public procurement is concentrated in states from which the FCI procured rice and the impact of wheat procurement on real agricultural wages is muted. The difference in the impact of rice and wheat procurement is perplexing and is an issue that needs to be further investigated. Someresults found in the extant literature provide some clues that reiterate this puzzle. For instance, Chatterjee and Kapur (2016) find that market prices for wheat are *lower* in districts with procurement, compared to those without procurement. If public procurement of wheat generates a price floor for the farmers, then it is not clear why market prices should be lower in the presence of procurement.

Our results in Table 9 and 10 are robust to alternate specifications. For instance, in the appendix we show that if we re-estimate equation (5) for states that only procured rice or states that only procured wheat, the disparity in the effect of rice and wheat procurement still exists. Future research may shed greater light on the causes of differences in the procurement of wheat and rice. While careful empirical analysis of the difference between rice and wheat procurement may be needed to explain this result, we suggest posisble factors that may explain this divergence between rice and wheat procurement. Rice procurement shares (procurement as a share of production) across states have remained constant throughout the time period 2000 – 2012. This consistency in procurement may have provided farmers with a credible price floor to negotiate higher wages from private traders. By contrast, the proportions of wheat procured by states varies during the time period under study. This may have created uncertainty over the volume of wheat procurement from states like Uttar Pradesh, Bihar, and Rajasthan. This uncertainly might have diluted the effect of public procurement in these states.

5. Conclusion

The three farm laws of September 2020 reignited the debate about the role of APMCs in improving the livelihoods of cultivators and farm workers. Most studies have focused on how market competition and the entry of large corporations may impact the prices received by farmers (Jodhka, 2021; Krishnamurthy, 2021) and how competition between buyers and greater flexibility in selling outside the *mandis* may benefit the farmer (Chatterjee & Kapur, 2016; Gulati et al., 2020). This paper contributes to this literature by presenting a causal analysis of the impact of market-oriented reforms on farm incomes and agricultural

wages. We find that market-reforms, by themselves, did *not* have any impact on agricultural incomes and wages during 2000 – 2012.

However, in states where these reforms were coupled with robust public procurement by the Food Corporation of India, farm incomes and agricultural wages were significantly higher. This suggests that market-oriented reforms and public procurement by the state may actually be complements which can help reduce imperfections in agricultural markets by providing farmers with a credible price floor to negotiate higher wages from private traders. Finally, by decomposing the composite effect of procurement and reforms to the procurement of rice and wheat, we identify a puzzle: the positive effects of procurement are visible only in rice procurement; the interaction of reforms and public procurement does not generate any positive impact for wheat. More research is needed to address this puzzle.

Our analysis shows that agricultural prices and rural incomes depend on several institutional factors like commission agents *(arhatiyas)* who may help address institutional failures, access to markets and ability of farmers to collectively bargain for better prices with private traders and large corporations. The evidence suggests that instead of conceptualizing the role of markets and states as substitutes, addressing rural distress may require strengthening both the role of the state and market access for farmers. While market reforms may be necessary to foster greater competition and price discovery, they are not sufficient. The role of the state in providing farmers with a price floor by procuring food grains is critical in increasing the bargaining power of farmers and ensuring that market reforms become successful in raising farm incomes. Finally, in addition to the direct intervention by the state in correcting monopsonistic tendencies in agricultural markets, the government can also strengthen farmers' bargaining position indirectly by increasing public investment in agriculture. More specifically, investment in storage facilities, improving market linkages and increasing the number of mandis may be beneficial in ensuring that market reforms are successful.

References

Azam, M. (2012) 'The Impact of Indian Job Guarantee Scheme on Labor Market Outcomes: Evidence from a Natural Experiment', *IZA Discussion Paper*, (6548). doi: 10.2139/ssrn.1941959.

Basole, A. and Basu, D. (2011) 'Relations of Production and Modes of Surplus Extraction in India: Part I – Agriculture', *Economic & Political Weekly*, 46(14), pp. 41–58. Available at: http://epw.in/epw/uploads/articles/15906.pdf.

Basu, D., Barenberg, A. J. and Soylu, C. (2017). 'The Effect of Public Health Expenditure on Infant Mortality: Evidence from a Panel of Indian States, 1983-84 to 2011-12,' *Journal of Development Studies*, 53(10), pp. 1765-1784.

Basu, D. and Misra, K. (2022) 'An Empirical Investigation of Real Farm Incomes Across Indian States Between 1987-88 and 2011-12', *University of Massachusetts Amherst*. Available at: https://scholarworks.umass.edu/econ_workingpaper/320/.

Berg, E. *et al.* (2018) 'Can public works increase equilibrium wages? Evidence from India's National Rural Employment Guarantee', *World Development*. Elsevier Ltd, 103, pp. 239–254. doi: 10.1016/j.worlddev.2017.10.027.

Bhalla, G. S. and Singh, G. (2010) 'Economic Liberalisation and Indian Agriculture ':, *Economic and Political Weekly*, 44(52), pp. 34–44.

Briones, R. and Felipe, J. (2013) 'Agriculture and Structural Transformation in Developing Asia: Review and Outlook'.

Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2008). Bootstrap-based improvements for inference with clustered errors. *The Review of Economics and Statistics*, *90*(3), 414-427.

Chaba and Damodaran (2021) ' Explained: Who are arhtiyas, also part of the farmers' protest? What is their role?, Indian Express. https://indianexpress.com/article/explained/the-arhtiya-business-7098629/

Chand, R., Saxena, R. and Rana, S. (2015) 'Estimates and analysis of farm income in India, 1983-84 to 2011-12', *Economic and Political Weekly*.

Chatterjee, S. *et al.* (2020) 'A Study of the Agricultural Markets of Bihar , Odisha and Punjab - Final Report', *Center for the Advanced Study of India, University of Pennsylvania: Philadelphia.*

Chatterjee, S. and Kapur, D. (2016) 'Understanding Price Variation in Agricultural Commodities in India: MSP, Government Procurement, and Agriculture Markets India Policy Forum', *India Policy Forum*.

Chatterjee, T. (2017) 'Spatial Convergence and Growth in Indian Agriculture: 1967–2010', *Journal of Quantitative Economics*. Springer India, 15(1), pp. 121–149. doi: 10.1007/s40953-016-0046-3.

Deininger, K. *et al.* (2017) 'Does Land Fragmentation Increase the Cost of Cultivation ? Evidence from India Does Land Fragmentation Increase the Cost of Cultivation ? Evidence from India', *The Journal of*

Development Studies. Routledge, 53(1), pp. 82–98. doi: 10.1080/00220388.2016.1166210.

Foster, A. D. *et al.* (2016) 'Agricultural Productivity Growth , Rural Economic Diversity , and Economic Reforms', 52(3), pp. 509–542.

Foster, A. D. and Rosenzweig, M. R. (2004) 'Agricultural productivity growth, rural economic diversity, and economic reforms: India, 1970-2000', *Economic Development and Cultural Change*, 52(3), pp. 509–542. doi: 10.1086/420968.

Gulati, A. and Bathla, S. (2001) 'Capital Formation in Indian Agriculture: Re-Visiting the Debate', *Economic and Political Weekly*, 36(20), pp. 1697–1708.

Gulati, A., Kapur, D. and Bouton, M. M. (2020) 'Reforming Indian agriculture', *Economic and Political Weekly*, 55(11), pp. 35–42.

Gulati, A., Rajkhowa, P. and Sharma, P. (2017) 'Making Rapid Strides- Agriculture in Madhya Pradesh: Sources , Drivers , and Policy Lessons', *Working Paper 339, Indian Council for Research on International Economic Relations*, (April).

Krishnamurthy, M. (2012) 'States of wheat: The changing dynamics of public procurement in Madhya Pradesh', *Economic and Political Weekly*, 47(52), pp. 72–83.

Krishnamurthy, M. (2021) 'Agricultural market law, regulation and resistance: a reflection on India's new "farm laws" and farmers' protests', *Journal of Peasant Studies*, 48(7), pp. 1409–1418.

Mathur, A. S., Das, S. and Sircar, S. (2003) 'Status of Agriculture in India - Trends and Prospects', *Economic and Political Weekly*, 41(2000), pp. 5327–5336. Available at: www.epw.in.

Michler, J. D. (2020) 'Agriculture in the process of development: A micro-perspective', *World Development*. Elsevier Ltd, 129, p. 104888. doi: 10.1016/j.worlddev.2020.104888.

Misra, K. (2019) 'Does historical land inequality attenuate the positive impact of India's employment guarantee program?', *World Development*. Elsevier Ltd, 124, p. 104662. doi: 10.1016/j.worlddev.2019.104662.

Mukherjee, A. N. and Kuroda, Y. (2003) 'Productivity growth in Indian agriculture: Is there evidence of convergence across states?', *Agricultural Economics*, 29(1), pp. 43–53. doi: 10.1016/S0169-5150(03)00038-0.

Nin Pratt, A., yu, B. and Fan, S. (2008) 'The total factor productivity in China and India: New measures and approaches', *China Agricultural Economic Review*, 1(1), pp. 9–22. doi: 10.1108/17561370910915339.

Raghavan, A. M. (2008) 'Changing Pattern of Input Use and Cost of Cultivation Changing Pattern of Input Use', 43(26), pp. 123–129.

Rahman, S. (2009) 'Whether crop diversification is a desired strategy for agricultural growth in Bangladesh?', *Food Policy*. Elsevier Ltd, 34(4), pp. 340–349. doi: 10.1016/j.foodpol.2009.02.004.

Rao, C. H. H. and Gulati, A. (1994) 'Indian Agriculture: Emerging Perspectives and Policy Issues', *Economic and Political Weekly*, 29(53), pp. A158–A169. Available at: http://www.jstor.org/stable/4402192.

Sarap, K. (1990) 'Factors Affecting Small Farmers ' Access to Institutional Credit in Rural Orissa , India', *Development and Change*, 21.

Takeshima, H. *et al.* (2012) 'Minor millets in Tamil Nadu , India : local market participation , on-farm diversity and farmer welfare', pp. 603–632. doi: 10.1017/S1355770X12000368.

Wong, H. L. *et al.* (2020) 'Effects of input vouchers and rainfall insurance on agricultural production and household welfare: Experimental evidence from northern Ethiopia', *World Development*. Elsevier Ltd, 135, p. 105074. doi: 10.1016/j.worlddev.2020.105074.

Zimmermann, L. (2012) 'Labor Market Impacts of a Large-Scale Public Works Program: Evidence from the Indian Employment Guarantee Scheme', *IZA Discussion Papers, Forschungsinstitut zur Zukunft der Arbeit (IZA)*, (6858). Available at: ftp://ftp.iza.org/RePEc/Discussionpaper/dp6858.pdf%5Cnhttp://www.econstor.eu/handle/10419/67214.

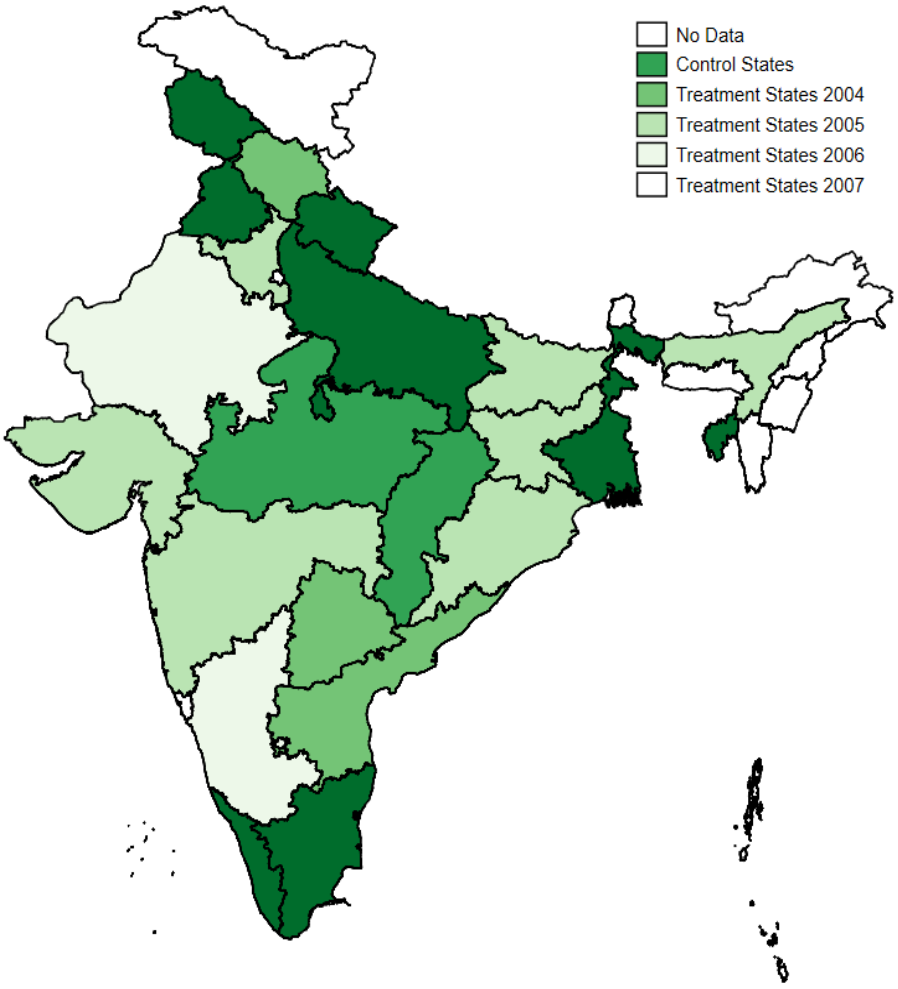

Figure 1: Reform Status by State

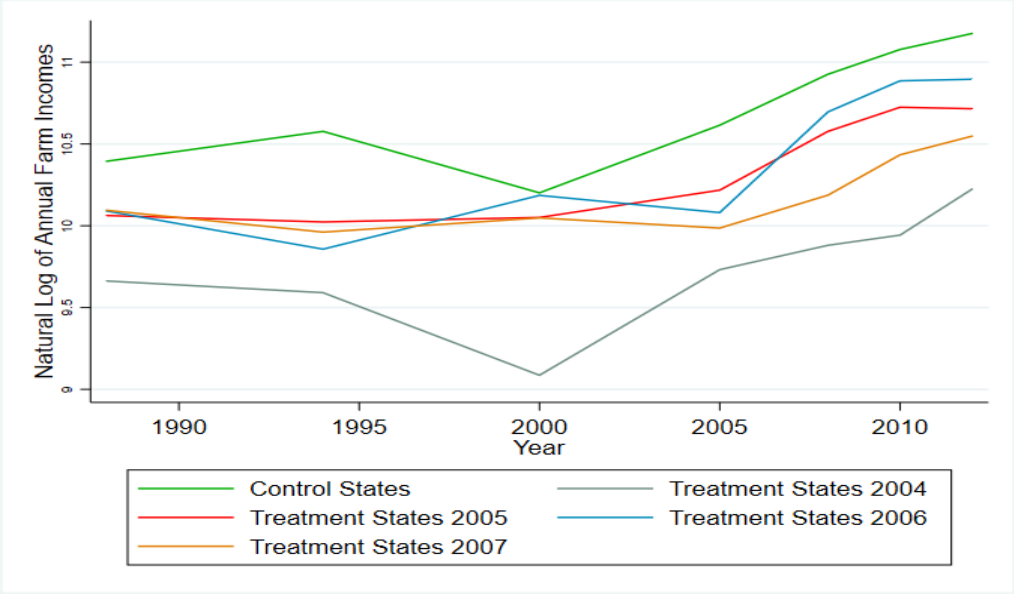

Figure 2: Real Farm Incomes by Reform Status

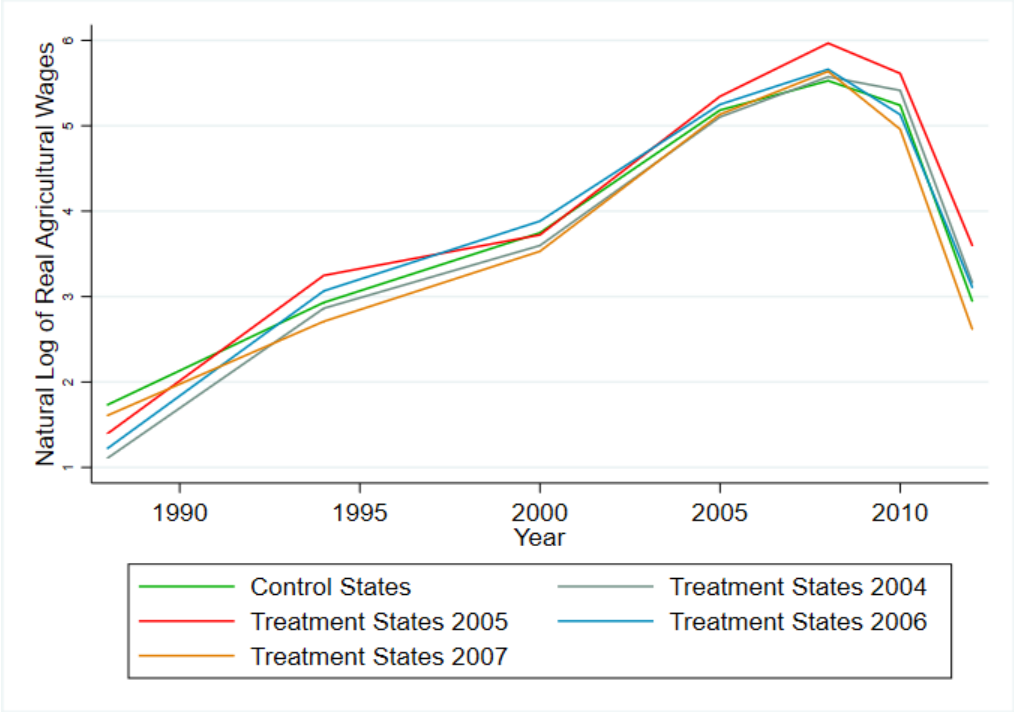

Figure 3: Real Agricultural Wages by Reform Status

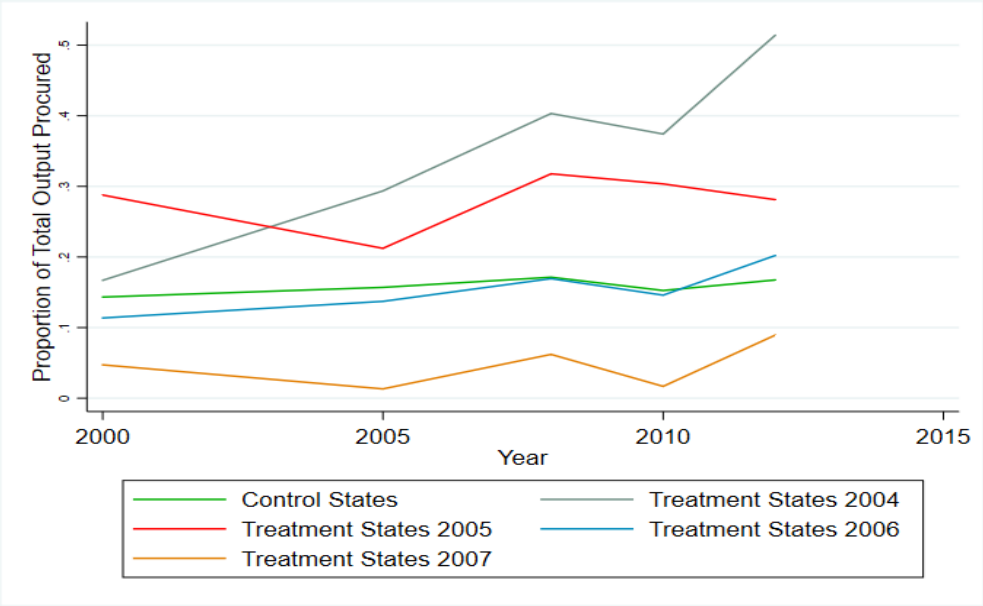

Figure 4: FCI procurement by Reform Status

Table 1: Marketing Reforms Across States				
Group	**State**	**Marketing Reform**	**Date of Reform**	**Primary Source**
Control States	Jammu & Kashmir	0		Chand (2020), Indian Express
	Kerala	0		Chand (2020), Indian Express
	Punjab	0		Chatterji et al.(2020)
	Tamil Nadu	0		Purohit at al.(2017)
	Tripura	0		Chand and Singh (2016)
	Uttar Pradesh United	0		Ghosh (2013)
	West Bengal	0		Ghosh (2013)
Treatment in 2004	Madhya Pradesh United	1	2004	Krishnamurthi (2012) Goyal (2020)
Treatment in 2005	Andhra Pradesh	1	2005	Ghosh (2013)
	Himachal Pradesh	1	2005	Ghosh (2013)
Treatment in 2006	Assam	1	2006	Ghosh(2013) and Purohit et al.(2017)
	Bihar United	1	2006	Kishore et al.(2021)
	Gujarat	1	2006	Ministry of Agriculture and Framer's Welfare. *Annual Reports*
	Haryana	1	2006	Ministry of Agriculture and Framer's Welfare. *Annual Reports*
	Maharashtra	1	2006	Ghosh (2013)
	Odisha	1	2006	Chatterji et al.(2020)
Treatment in 2007	Karnataka	1	2007	Agarwal et al.(2016)
	Rajasthan	1	2007	Ministry of Agriculture and Framer's Welfare. *Annual Reports*
Note: Compiled by the authors				

Table 2: Summary Statistics

Variable	Non-Reform States	Reform-States	p-value	Source
Ln Real Average Annual Income	10.76	10.25	0.09	Calculated by Authors
Ln (Daily Agricultural Wage)	6.67398	6.6302	0.807313	NSS
Rice Produced *(in 000 tonnes)*	6392.65	4420.17	0.45	DES, GOI
Wheat Produced *(in 000 tonnes)*	6493.80	3355.07	0.49	DES, GOI
Log of State Value added in Agriculture	10.10	10.38	0.63	Reserve Bank of India
Population *(in million)*	60.07	60.21	0.96	Census of India
Agricultural Workers (in million)	3.29	4.95	0.35	NSS
Rice Procured (in 000 tonnes)	1936.69	1354.22	0.67	Food Corporation of India
Wheat Procured (in 000 tonnes)	1774.91	894.78	0.59	Food Corporation of India
Rice Productivity	2.84	2.01	0.03	DES, GOI
Wheat Productivity	2.71	1.93	0.34	DES, GOI
Own Tax Revenue per capita	2655.51	2815.21	0.86	Basu, Barenberg and Soylu (2017)
Age	35.03	34.96	0.97	NSS
Household Size	4.764	5.17	0.28	NSS
Hindu	0.605	0.74	0.03	NSS
Muslim	0.17	0.06	0.01	NSS
Scheduled Caste	0.19	0.16	0.52	NSS
Scheduled Tribe	0.03	0.093	0.04	NSS
Other Backward Castes	0.57	0.57	0.99	NSS
Number of States	7	11		
Districts	92	58		
Observations	226,062	150,844		

Note: This table presents summary statistics for the variables used in this paper. Columns (1) and (2) present the mean values of variables for states that did not enact market-oriented reforms and those who enacted reforms respectively. Column (3) presents the p-values of the student's t-test of equality of means in columns (1) and (2) and column (4) provides the data source used for each variable. Annual Farm incomes per cultivators and daily agricultural wage is deflated by the Consumer Price Index for rural labor to calculate real annual farm incomes in 2004-05 prices. DES refers to the Directorate of Economics and Statistics of the Government of India and NSS refers to the Employment and Unemployment Rounds of the National Sample Survey data.

Table 3: Procurement of Wheat and Rice by the FCI as a Proportion of Total Production in a State															
Reform Status	**1999-2000**			**2004-2005**			**2007-2008**			**2009-2010**			**2011-2012**		
	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total
Control	0.16	0.11	0.14	0.20	0.13	0.16	0.24	0.15	0.17	0.19	0.12	0.15	0.17	0.19	0.17
Treatment 2004	0.31	0.07	0.17	0.49	0.08	0.29	0.49	0.33	0.40	0.48	0.28	0.37	0.52	0.51	0.51
Treatment 2005	0.29	0.00	0.29	0.21	0.00	0.21	0.32	0.00	0.32	0.30	0.00	0.30	0.28	0.00	0.28
treatment 2006	0.12	0.08	0.11	0.15	0.09	0.14	0.14	0.12	0.17	0.14	0.09	0.15	0.17	0.16	0.20
Treatment 2007	0.00	0.05	0.05	0.00	0.01	0.01	0.00	0.06	0.06	0.00	0.02	0.02	0.00	0.09	0.09
Note: This table presents trends in FCI procurement of cereals (rice and wheat) as a proportion of total production of these crops for states that implemented market-oriented reforms and those that did not adopt these reforms. Data on procurement is taken from the Food Corporation of India web portal and data on total agricultural production comes from the Directorate of Economics and Statistics, Government of India.															

Table 4: Parallel Trends: Real Average Annual (Ln) Farm Incomes

	(1)
Treat x Post	0.175
	(0.129)
Observations	46
R-squared	0.834
State FE	YES
Year FE	YES
Controls	YES

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

Table 5: Testing the Parallel Trends: Daily Real (Ln) Agricultural Wages

	(1)	(2)
	DD	DDD
Reform x Year x Procurement		-0.774
		(0.803)
Procurement x Reform		2.761
		(1.825)
Reform x Year	-0.0524	0.616
	(0.114)	(0.690)
Procurement x Year		0.128
		(0.429)
Procurement	0.295	-0.592
	(0.184)	(1.186)
Reform	-0.661***	-3.416**
	(0.239)	(1.654)
Observations	65,696	65,696
R-squared	0.753	0.753
District FE	YES	YES
Year-Quarter FE	YES	YES
District Specific Linear Time Trend	YES	YES

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

Table 6: Impact of Marketing Reforms on Annual (ln) Real Farm Incomes

	(1)	(2)	(3)
	DD Marketing Reform	DD Marketing Reform	DD Marketing Reform
Reform x Post	0.0264	0.0214	0.0241
	(0.118)	(0.0962)	(0.120)
Observations	119	119	89
R-squared	0.887	0.908	0.939
State FE	YES	YES	YES
Year FE	YES	YES	YES
Macro Controls	NO	YES	YES
Agriculture Controls	NO	NO	YES
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Table 7: Impact of Marketing Reforms on Daily (ln) Real Agricultural wages

	(1)	(2)	(3)
	DD	DD	DD
Reform x Post	0.0311	-0.0352	-0.000595
	(0.0546)	(0.0570)	(0.0672)
Observations	30,315	30,315	30,315
R-squared	0.805	0.821	0.829
District FE	YES	YES	YES
Year Quarter FE	YES	YES	YES
Controls	NO	YES	YES
District Specific Linear Time Trend	NO	YES	YES
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Table 8: Impact of Reforms and Public Procurement on Annual Real (ln) Farm Incomes

	(1)	(2)	(3)	(4)
Reform x Post x Procurement	0.522**	0.413**	0.472**	0.394**
	(0.181)	(0.161)	(0.194)	(0.169)
Reform x Post	-0.0939	-0.0813	-0.186	0.0187
	(0.168)	(0.133)	(0.154)	(0.198)
Post x Procurement	-0.227***	-0.148*	-0.156*	-0.211**
	(0.0606)	(0.0746)	(0.0845)	(0.0775)
Reform x Procurement	-0.0145	0.0265	-0.0555	-0.193
	(0.198)	(0.187)	(0.180)	(0.139)
Observations	89	89	89	89
R-squared	0.932	0.941	0.946	0.983
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Macro Controls	NO	YES	YES	YES
Agriculture Controls	NO	NO	YES	YES
State Specific Linear Time Trend	NO	NO	NO	YES
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table 9: Impact of Reforms and Public Procurement on Daily Real (ln) Agricultural Wages

	(1) DDD	(2) DDD	(3) DDD
Reform x Post x Procurement	0.301**	0.402**	0.528**
	(0.125)	(0.157)	(0.223)
Reform x Post	0.140*	-0.106	-0.264**
	(0.0809)	(0.0949)	(0.108)
Post x Procurement	-0.520***	-0.281*	-0.201
	(0.129)	(0.152)	(0.188)
Reform x Procurement	0.180***	-0.0405	-0.145
	(0.0595)	(0.0948)	(0.0925)
Observations	30,315	30,315	30,315
R-squared	0.806	0.821	0.829
State FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES
Controls	NO	YES	YES
District Specific Linear Time Trend	NO	NO	YES
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Table 10: Impact of Reforms and Public Procurement of Rice on Daily Real (ln) Agricultural Wages

	(1) DDD	(2) DDD	(3) DDD
Reform x Post x Procurement	0.793***	0.638***	0.667***
	(0.150)	(0.160)	(0.221)
Reform x Post	-0.0156	-0.0952	-0.0942
	(0.0688)	(0.0628)	(0.0797)
Post x Procurement	-0.660***	-0.625***	-0.584***
	(0.171)	(0.180)	(0.216)
Reform x Procurement	-0.272***	-0.452***	-0.314***
	(0.0933)	(0.0833)	(0.0800)
Observations	30,315	30,315	30,315
R-squared	0.807	0.823	0.829
District FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES
Controls	NO	YES	YES
District Specific Linear Time Trend	NO	NO	YES
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Table 11: Impact of Reforms and Public Procurement of Wheat on Daily Real (ln) Agricultural Wages

	(1) DDD	(2) DDD	(3) DDD
Reform x Post x Procurement	-0.460**	0.138	-0.216
	(0.186)	(0.268)	(0.351)
Reform x Post	0.0664	-0.0953	-0.115
	(0.0556)	(0.0587)	(0.0776)
Post x Procurement	0.167	-0.297	0.0312
	(0.140)	(0.227)	(0.225)
Reform x Procurement	0.482***	0.394***	0.363**
	(0.0955)	(0.0942)	(0.139)
Observations	30,315	30,315	30,315
R-squared	0.808	0.823	0.830
District FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES
Controls	NO	YES	YES
District Specific Linear Time Trend	NO	NO	YES

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

Appendix A: Robustness Checks

I. Difference-in-difference by year

This section presents several alternative specifications to test the validity of our results. First, we show the difference-in-differences coefficient for each year-quarter between 2000 - 2012. We interact the dummy for market reforms with year-quarter dummies to estimate impact of market reforms on real agricultural wages. The results for the complete specification of equation (2) are presented in Figure A1.

We can see from Figure A1 that the difference-in-difference coefficient for agricultural wages after market-oriented reforms was initially negative and statistically significant at the 95 percent confidence interval. As the interval from the reforms increases, the coefficient becomes insignificant. Further, Figure A1 also shows that in the pre-reform period, the difference-in-differences coefficient is not significantly different from zero which confirms the parallel trend assumption necessary for the difference-in-differences estimation.

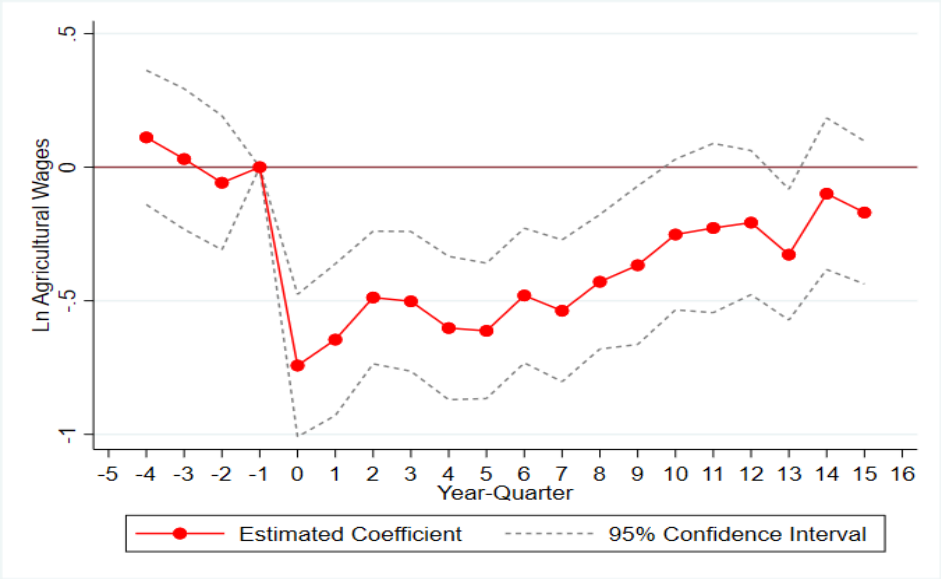

Figure A1: Difference-in-differences by year

II. Difference-in-differences with Chand Reforms

As discussed in Section 3.1.c, our reform variable constructed by the authors by reviewing state-level farm laws. Our classification of reform status is comparable to existing research including Purohit et al., (2016)

and Chand and Singh (2016) for all states except Assam and Odisha. We test the impact of market-oriented reforms on farm incomes and agricultural wages using the reform index constructed by Chand and Singh (2016). To test whether our results are driven by the inclusion of Assam and Odisha, we assign a treatment dummy to states that scored above 50 on the composite index are Chand and Singh and zero otherwise and re-estimate equations (1) and (2). The results are shown in Table A1. In column (1) we show the results of equation (2) and column (2) shows the results of the difference-in-differences specification using the reform index of Chand and Singh (2016). Similar to the results of the difference-in-differences of Tables 4 and 6, we find that marketing reforms have no impact on real farm incomes.

Table A1: DD with Chand and Singh (2016) data

	Parallel Trends	(Ln) Real Farm Incomes
		DD
	(1)	(2)
Chand Reform x Trend	-0.0746	
	(0.665)	
Chand Reform x Post		0.0277
		(0.148)
Observations	47	89
R-squared	0.921	0.939
District FE	YES	YES
Year Quarter FE	YES	YES
Controls	YES	YES
State Specific Linear Time Trend	YES	YES

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

Table A2 below shows the results for the difference-in-differences specifications for real agricultural wages. Similar to the main results in Table 5 and 7, we find that market reforms did not have any significant impact on agricultural wages.

Table A2: Ln Agricultural Wages with Chand and Singh (2016) data

	Parallel Trends	(Ln) Real Farm Incomes
		DD
	(1)	(2)
Chand Reform x Trend	0.121	
	(0.266)	
Chand Reform x Post		0.0434
		(0.0952)
Observations	17,406	17,406
R-squared	0.719	0.719
District FE	YES	YES
Year Quarter FE	YES	YES
Controls	YES	YES
District Specific Linear Time Trend	YES	YES
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

III. Placebo Treatment

Next, we test the validity of our difference-in-differences estimates by designing placebo treatment using the pre-reform period (1994 – 2000). Using data from 2000 as the post period, we re-estimate the difference-in-differences equations (1) and (2). The results for real farm incomes are presented in Table A3 and those for real agricultural wages are presented in Table A4. In both cases, we include all controls, two-way fixed effects, and region-specific linear time trends. We find that in both cases, there is no impact of the reforms on real farm incomes.

Table A3: Placebo Treatment Real Farm Incomes

	(1)	(2)
	Market Reforms	Chand and Singh (2016) Reform Index
Reform x Post	0.0602	-0.816
	(0.29)	(0.86)
Observations	35	35
R-squared	0.92	0.981
State FE	YES	YES
Year FE	YES	YES
Controls	YES	YES
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

A4: Placebo Treatment Real Agricultural Wages

	(1)	(2)
VARIABLES	Market Reforms	Chand and Singh (2016) Reform Index
Reform x Post	0.0417	0.0695
	(0.102)	(0.103)
Reform x Post		
Observations	29,982	29,982
R-squared	0.094	0.095
District FE	YES	YES
Year-Quarter FE	YES	YES
Individual Controls	YES	YES
District Specific Linear Time Trend	YES	YES
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

IV. Addressing small number of clusters

One of the major concerns with our estimate is the low number of clusters. Cameron, Gelbach, and Miller (2008) show how studies with a small number of clusters tends to underestimate standard errors which leads to over-rejection of the null. Since we have only 18 states, the number of clusters in our sample is small and this may bias our estimates. To address this concern, we correct our difference-in-differences and triple difference estimates by bootstrapping our standard errors according to the procedure described in Cameron, Gelbach, and Miller (2008). Table A5 shows the bootstrapped standard errors for our main estimates for our state-level regressions for real farm incomes. We find that our results remain significant.

V. Dropping states that enacted reforms in a given year

Since we study real farm incomes and agricultural wages over the period 2000 – 2012, we test whether our triple difference estimates of Tables 8 and 9 are driven by the inclusion of some specific states. To test whether our results are robust to the exclusion of states that enacted reforms in a given year, we re-estimate the triple difference specification of equations (4) and (5) by excluding states that enacted reforms in a given year.

The results for real farm incomes are shown in Table A5 and for real agricultural wages are shown in Table A6. In both cases we find that our results are not driven by the inclusion of states that enacted reforms in a given year.

VI. Dropping states from the sample

Next, we test whether our triple difference estimates of Tables 8 and 9 are driven by the inclusion of some specific states. To test whether our results are robust to the exclusion of states, we re-estimate the triple difference specification of equations (4) and (5) by excluding one state at a time.

The results for real farm incomes are shown in Table A7 and for real agricultural wages are shown in Table A8. In both cases we find that our results are not driven by the inclusion of states that enacted reforms in a given year.

VII. Decomposition Analysis – keeping states that only procured wheat and only procured rice

Finally, we test the robustness of the decomposition of our triple difference results presented in Tables 10 and 11 by excluding states that witnessed both wheat and rice procurement. The results are shown in

Table A9. We find that our results are not driven by the inclusion of states like Uttar Pradesh, Punjab, and Haryana which benefit from both wheat and rice procurement.

A5: Bootstrapped Standard Errors

	(1) Market Reforms	(2) DDD
Reform x Post x Procurement		0 .274** (0.129)
Reform x Post	0.097 (0.0971)	-0.1416 (0.096)
Observations	29,982	89
R-squared	0.094	0.946
State FE	YES	YES
Year FE	YES	YES
Controls	YES	YES
Bootstrapped Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Table A6: Robustness Check: Triple Difference Estimation Real Farm Incomes

	Dropping states that adopted reforms in			
	2004 (1)	2005 (2)	2006 (3)	2007 (4)
Reform x Post x Procurement	0.432** (0.203)	0.496* (0.249)	0.836*** (0.180)	0.504** (0.185)
Observations	84	79	59	79
R-squared	0.943	0.948	0.960	0.955
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table A7: Robustness Check: Triple Difference Estimation Real Agricultural Wages

	Dropping states that adopted reforms in			
	2004	2005	2006	2007
	(1)	(2)	(3)	(4)
Reform x Post x Procurement	-0.341	0.947***	-1.074	0.190
	(0.289)	(0.268)	(1.589)	(0.225)
Observations	28,098	27,276	19,460	29,193
R-squared	0.824	0.833	0.822	0.830
District FE	YES	YES	YES	YES
Year-Quarter FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
District Specific Linear Time Trend	YES	YES	YES	YEs

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

Table A8: Robustness Check Triple Difference Estimation Real Farm Incomes

	Dropping the Following states																	
	Andhra Pradesh	Assam	Bihar United	Gujarat	Haryana	Himachal Pradesh	Jammu & Kashmir	Karnataka	Kerala	Madhya Pradesh United	Maharashtra	Odisha	Punjab	Rajasthan	Tamil Nadu	Tripura	Uttar Pradesh United	West Bengal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Reform x Post x Procurement	0.480**	0.463*	0.509**	0.522***	0.485**	0.485*	0.327*	0.401**	0.431*	0.432**	0.583***	0.419*	0.463**	0.577***	0.334*	0.462**	0.461**	0.487**
	(0.182)	(0.219)	(0.204)	(0.173)	(0.197)	(0.265)	(0.164)	(0.187)	(0.226)	(0.203)	(0.185)	(0.232)	(0.204)	(0.186)	(0.190)	(0.201)	(0.186)	(0.196)
Observations	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	85	84	84
R-squared	0.947	0.946	0.945	0.956	0.945	0.947	0.954	0.951	0.946	0.943	0.952	0.945	0.938	0.950	0.952	0.944	0.947	0.945
State FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Macro Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Agriculture Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A9: Robustness Check Triple Difference Estimation Real Agricultural Wages

Dropping the Following states	Andhra Pradesh	Bihar United	Gujarat	Haryana	Himachal Pradesh	Jammu & Kashmir	Madhya Pradesh United	Odisha	Punjab	Rajasthan	Tamil Nadu	Tripura	Uttar Pradesh United	West Bengal
DDD	0.526**	0.851***	0.740***	0.534**	0.471**	0.115	-0.00198	0.779**	0.802***	0.484**	-0.00682	0.798***	0.581***	0.345*
	(0.204)	(0.193)	(0.201)	(0.207)	(0.207)	(0.196)	(0.193)	(0.304)	(0.236)	(0.206)	(0.192)	(0.197)	(0.209)	(0.198)
Observations	27,636	25,798	29,945	30,017	29,955	30,115	28,098	24,645	29,448	29,193	26,031	30,009	29,109	24,096
R-squared	0.820	0.813	0.817	0.819	0.817	0.818	0.813	0.816	0.820	0.819	0.839	0.818	0.812	0.793
District FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year-Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
District Specific Linear Time Trend	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A10: Keeping States that had only Rice and Wheat Procurement

VARIABLES	(1) DDD Rice	(2) DDD Wheat
Reform x Post x Procurement	1.553***	-0.194
	(0.588)	(0.130)
Observations	30,315	30,315
R-squared	0.824	0.829
Distrcit FE	YES	YES
Year-Quarter FE	YES	YES
Controls	YES	YES
District Specific Linear Time Trend	YES	YES

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

Appendix 2: Variable Construction

Value Added

We construct a consistent time series of state-level value added in agriculture at current prices in two steps.

First, we extract data on value added in agriculture from Table 6, Components of Net State Domestic Product at Factor Cost by Industry of Origin (at current prices) from the 2004-05 Handbook of Statistics on Indian Economy (available on the website of the Reserve Bank of India).[12] This table gives two value added series, an old series with base year 1980-81 and a new series with base year 1993-94. The unit of measurement is rupees crore. We take the 1980-81 base year series data for the years 1980-81 to 1993-94; we take the 1993-94 base year series data for years 1993-94 to 2004-05. For each year we compute the growth factor of value added in agriculture as the ratio of value added in a year and value added in the previous year. Thus, we get an annual growth factor series (for value added in agriculture) that runs from 1980-81 to 2004-05.

Second, we extract data on value added in agriculture from Table 6, Components of Net State Domestic Product at Factor Cost by Industry of Origin (at current prices), from the 2012-13 Handbook of Statistics on Indian Economy (available on the website of the Reserve Bank of India). This table gives value added series with base year 2004-05 in rupees billion. Data are provided for the years from 2004-05 to 2012-13 for most states; for some states, data is available till 2011-12. For these latter states, we take the figure for 2012-13 from Table 6 in the 2013-14 Handbook of Statistics on Indian Economy. The unit of measurement of this data is rupees billion. So, we multiply it by 100 to express it in crores of rupees.

Our value-added series for agriculture uses the figures with base 2004-05 for the years 2004-05 to 2012-13, and then we project the series backward from 2003-04 to 1980-81 using the growth factor series that we calculated in the first step. This gives us a consistent state-level value-added series for agriculture at current prices at an annual frequency running from 1980-81 to 2012-13.

Total Wage Bill

We construct a state-level series for the total wage bill in agriculture using unit level data from the Employment and Unemployment Survey (EUS) conducted the NSSO for the 43rd round (1987-88), the 50th round (1992-93), the 55th (1999-00), the 61st round (2004-05), the 64th round (2007-08), the 66th round (2009-10) and the 68th round (2011-12). The total wage bill in a state is defined, for any EUS year, as the sum of total wages earned by agricultural laborers in a year.[13] Data on average daily wage rate for

[12] The reader should note that we focus on agriculture and not the agriculture and allied activities sector. The latter includes three sub-sectors: agriculture, forestry & logging, and fishing. Thus, we do not add the value added coming from forestry, and logging & fishing.

[13] Using the weekly employment status of workers reported in the EUS Rounds of the NSS, we calculated the weekly agricultural wage bill by multiplying the average weekly wage for agricultural workers with the total number of agricultural workers. This weekly wage bill is then multiplied by 52 (number of weeks in a year) to calculate the total wage bill in a year.

agricultural workers, average number of days worked per week by agricultural workers and total number of agricultural workers is extracted from the EUS.[14]

Real Farm Income per Cultivator

We compute the state-level farm income as the difference between value added in agriculture and the total wage bill. To convert nominal farm income into real, or inflation-adjusted, farm income, we divide the nominal magnitude by the state-level consumer price index for rural labourers (CPIRL, published by the Labour Bureau of India). We divide this by the total number of cultivators to get real farm income per cultivator, where data on the total number of cultivators is extracted from the EUS.[15]

[14] In the EUS unit level data, a person is identified as an agricultural worker if she worked as a regular or casual employee in agriculture. For instance, in the 68th round of EUS, her "status" code was 31, or 51, and her "industry" code was 01.

[15] In the EUS unit level data, a person is identified as a cultivator if she worked in a household enterprise (self-employed) in agriculture. For instance, in the 68th round of EUS, her "status" code was 11, 12 or 21, and her "industry" code was 01.