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Global Food Price Surge, In-Kind Transfers, and Household Welfare Evidence from India

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Abstract

This paper studies the impact of high global food prices on household welfare in India. I use the 2007-08 surge in global food prices and household share of area under rice and wheat at the baseline to show that food cultivating households gain from high prices. These welfare gains mainly accrue to net food producers. I observe that net food producer households were able to maintain their per capita spending and consumption of rice and wheat by decreasing consumption of market purchased rice and wheat and increasing consumption of government- subsidized rice and wheat. Net consumer households, on the other hand, experienced a decline in the total per capita consumption of rice and wheat even though they substituted their market purchases with homegrown produce and subsidized grains. The role of in-kind food transfers in insulating households from high prices was evident for both net producers and consumers. Finally, high prices induced working-age adult males in net food-producing households to increase work days and hours worked per day on their own farm and reallocated labor from market wage work to labor on their own farm.

Keywords: Global food prices, net producers, in-kind transfers, welfare, India

JEL Code: O12, I38, Q18

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Global Food Price Surge, In-Kind Transfers, and Household Welfare

Evidence from India

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Abstract

This paper studies the impact of high global food prices on household welfare in India. I use the 2007-08 surge in global food prices and household share of area under rice and wheat at the baseline to show that food cultivating households gain from high prices. These welfare gains mainly accrue to net food producers. I observe that net food producer households were able to maintain their per capita spending and consumption of rice and wheat by decreasing consumption of market purchased rice and wheat and increasing consumption of government-subsidized rice and wheat. Net consumer households, on the other hand, experienced a decline in the total per capita consumption of rice and wheat even though they substituted their market purchases with homegrown produce and subsidized grains. The role of in-kind food transfers in insulating households from high prices was evident for both net producers and consumers. Finally, high prices induced working-age adult males in net food-producing households to increase work days and hours worked per day on their own farm and reallocated labor from market wage work to labor on their own farm.

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1. Introduction

There is much debate on the impacts of high food prices on household welfare in developing countries (Swinnen, 2010). Since food is a necessity, the welfare effects of high prices would be experienced universally. The major cause of concern is that as exposure to high food prices is proportional to its budget share in household expenditure, the worst affected population groups would be ones placed at the bottom of the income distribution (Easterly and Fischer, 2001). Therefore, rising food prices have become a matter of serious concern for developing countries, which are home to a majority of the world's poor (World Bank, 2008; IMF, 2008; Wodon et al., 2008).

In this paper, I study the impact of high global food prices, primarily rice and wheat, on the welfare of Indian households.[1] Much of the literature studying the welfare impacts of the 2007-08 surge in global food prices has concluded that high food prices are bad for the poor (Headey and Fan, 2008; Ivanic and Martin, 2008; De Hoyos and Medvedev, 2011; Wodon and Zaman, 2010; Ivanic and Martin, 2014). In general, an increase in food prices will affect the welfare of both consumers and producers, but in different directions (Budd, 1993; Swinnen, 2010). The consumers may lose as higher food prices will make food less affordable and reduce the real value of income. Producers may gain as higher food prices will increase the returns from food cultivation. Since farm households in developing countries also produce food, the total effect will depend upon the household's net consumer or producer status (Deaton, 1989). In addition, higher food prices may also lead to higher wages and a greater derived demand for labor, inputs, and other commodities locally (Ravallion, 1990; Gulati and Narayanan, 2003; Aksoy and Hoekman, 2010; Jacoby, 2016; Headey, 2018; Van Campenhout et al., 2018). Therefore, the net welfare effects of high food prices are ambiguous and open to rigorous empirical explorations.

[1] By food, I specifically refer to rice and wheat. I will use “rice and wheat” and “food” interchangeably in the paper.

Governments in developing countries often intervene heavily in the food sector and generally provide safety nets to ensure the food and nutrition security of the most vulnerable populations. Safety nets in the form of food vouchers, in-kind food transfers or employment schemes directly influence the relationship between food prices and household welfare (Aksoy and Hoekman, 2010; Gadenne et al., 2021). While concerns about high food prices are legitimate, one often ignored aspect is the mediating role of safety net programs operational in the country. The ways in which, for example, in-kind food transfers interact with the welfare effects of high food prices are not obvious and are a function of a variety of factors including how well these policies are targeted to the poor and the vulnerable. In this paper, I also study the role of one such safety net operational in the country, the availability of highly subsidized food via the Public Distribution System (PDS) of India. Since the PDS provides highly subsidized rice and wheat to the poor, the welfare impacts of high prices on Indian households are not entirely obvious. Moreover, the PDS itself can turn out to be a coping strategy for households. This is something I explore in this paper.

This paper uses the Indian Human Development Survey (IHDS) data for empirical analysis. The IHDS offers nationally represented household-level panel data covering more than 30,000 households tracked over two survey rounds conducted in 2004-05 and 2011-12. It provides data on various household characteristics including income and consumption patterns and individual-level data on workdays, hours, and participation in different work activities. There are multiple advantages of using the IHDS data. First, the timing of the IHDS surveys is appropriate to study the 2007-08 surge in global price of rice and wheat which are a staple of Indian households. Second, the IHDS is the only large-scale household-level panel data for India and allows me to use a household fixed effects strategy that rules out the influence of all time-invariant variables. Third, the baseline IHDS survey has information on cropping patterns and crop production enabling me to identify food cultivating and net food producer and consumer households. Fourth, IHDS has rich information on different government policies, like in-kind food subsidies and large-scale workfare programs. Finally, it also enables me to study shifts in food consumption behavior and indirect effects in the form of higher agricultural expenditures, wages, and farm and nonfarm labor usage of net food producing and consuming households.

The primary measure of welfare considered in this paper is the monthly per capita value of household consumption which I refer to as the household consumption expenditure. I also use headcount poverty, share of non-food in total consumption, and household categories based on income quantiles as other measures of welfare.[2] I find that high global food prices led to an increase in household consumption expenditure and the share of non-food component for food cultivating households. There is also evidence that high food prices led to a decline in headcount poverty among food-growing households. These welfare gains mainly accrued to net food producers. I observe that net producer households were able to resist a rise in their per capita spending and consumption of rice and wheat by decreasing consumption of market purchased rice and wheat and increasing consumption of government-subsidized PDS rice and wheat. Net consumer households, on the other hand, experienced a decline in the total per capita consumption of rice and wheat even though they substituted their market purchases with homegrown produce. Although I observe a decline in rice and wheat consumption for net consumer households, I find that they increased consumption of coarse cereals and were able to maintain their total calorie intakes. These coping strategies were enough to ensure stable food expenditures for the households. Finally, I find that high food prices induced working-age adult males in net food-producing households to reallocate labor from market wage work to labor on their own farm.

[2] Value of household consumptuion and the shares of food and non-food components have commonly been used as measures of household welfare (see Deaton, 1997).

This paper contributes to the literature studying the welfare impacts of high food prices. Early studies used simulations based on Deaton's (1989) net benefit approach to analyze the welfare consequences of the 2007-08 surge in food prices (Ivanic and Martin, 2008; De Hoyos and Medvedev, 2011; Ivanic et al., 2012). I follow the basic insights from Deaton (1989) but use a reduced form approach to directly estimate the welfare impacts. The reduced form household fixed effects regressions allow for uncovering a more nuanced consumption and labor reallocation response than what has been captured in previous studies. In particular, I capture the insurance role of in-kind food transfers which invariably influences the net welfare gains and losses.

This paper also relates to reduced form studies on the impacts of commodity price shocks on household welfare. There is evidence that cycles in prices of cash crops like cocoa and coffee have a strong passthrough to consumption, nutrition, and child health and schooling of grower households (Kruger, 2007; Miller and Urdinola, 2010; Cogneau and Jedwab, 2012; Bladimir, 2020; Kebede, 2021). Moreover, commodity price shocks have also been linked to social unrest and civil conflicts (Kamola, 2007; Brückner and Ciccone, 2010; Dube and Vargas, 2013; Bellemare, 2015). A few studies have also looked at the impact of food prices on household welfare (Edmonds and Pavnik, 2005; Tandon, 2015; Bellemare et al., 2018; Yamauchi and Larson, 2019). In comparison to cash crops and other non-food commodity prices, the channels through which food prices interact with household welfare are much more complex. In particular, a rise in the price of cash crops may not lead to a decline in the real value of consumption for grower households. However, I find that the labor reallocation effects of high food prices are consistent with what Kebede (2021) reports in the case of coffee prices for Ethiopia.

Finally, this paper also indirectly connects with the literature debating the welfare impacts of in-kind food transfers. The insurance role of in-kind food transfers has been written about in the policy community (Kotwal, Murugkar, and Ramaswami, 2011; Dreze, 2011) and has recently been theoretically and empirically demonstrated in Gadenne (2020) and Gadenne et al. (2021). Consistent with Gadenne et al. (2021), I also find evidence that in-kind food subsidies provided by the Public Distribution System of India insulated households from loss in per capita food consumption due to high food prices.

The rest of the paper is organized as follows. The next section documents the related literature. Section 3 explains the main data sources and presents the global and local trends in food prices. Section 4 lays out the empirical strategy. Section 5 presents the estimates and their heterogeneity based on the net producer or net consumer status of the households. Section 6 presents results from some robustness tests. Finally, section 7 concludes.

2. Related Literature

Studies looking at the immediate impact of the 2007-08 food price surge have primarily relied on versions of Deaton's (1989) net benefit approach to estimate the welfare impacts of high food prices (Wodon and Zaman, 2010). For example, Ivanic and Martin (2008) simulate the welfare impacts of the 2007 global food price increase for nine low-income countries on the assumption of perfect transmission between global and local prices. They find that high global food prices increase poverty with the impacts being greater in urban areas. Similar findings are also reported by De Hoyos and Medvedev (2011).

Another set of studies has focused on the long-run impacts by accounting for the indirect and second-order effects of high food prices. Examples of such studies are Minot and Dewina (2013) and Robles et al. (2010) who provide long-run estimates either by estimating the cross elasticities or relying on other studies to parametrize their simulations. Attanasio et al. (2013) estimate a Quadratic Almost Ideal Demand System (QAIDS) to account for the possible cross substitution across food commodities due to price increase. The demand system estimation approach is also adopted by Vu and Glewwe (2011) and Friedman and Levinsohn (2002) to estimate the welfare effects of high food prices. Vu and Glewwe (2011) go a step further and allow for a differential rate of increase in consumer and producer prices. Ivanic and Martin (2014) add a further layer to the net benefit approach by accounting for the direct response of output to price changes, the indirect effect through an induced change in wages, and the cross effects of price change on the amount of labor sold off the farm.

A parallel strand of literature has used reduced-form estimation approaches to study the welfare impacts of food price changes. Jensen and Miller (2008) find that the immediate nutritional impact of global food price increase for households in two provinces of China was minimal as households were able to switch to cheaper substitutes. D'Souza and Jolliffe (2012) and D'souza and Jolliffe (2013), using cross-sectional data from Afghanistan, find a large decline in real monthly per capita food consumption and reduced dietary diversity due to increase in prices of staple foods with higher losses for urban and landless households. Tandon (2015), using a DiD strategy and household data from India finds households most exposed to higher food prices have significantly reduced dietary diversity, lower investment in labor-saving productive assets, and schooling of children. Headey (2018), on the other hand, finds an inverse relationship between food prices and poverty for a panel of countries. Edmonds and Pavcnik (2005) show that higher rice prices were associated with a decline in child labor in Vietnam. More importantly, they observe that this decline in child labor was driven by greater returns in net producer households. Yamauchi and Larson (2019), for Indonesian households, find that rising food prices in 2007-08 had negative impacts on the child growth of only net consumer households.

Consistent with the literature studying the welfare impacts of the 2007-08 food price crisis, Cogneau and Jedwab (2012) study the effect of declining cocoa prices on schooling and health outcomes of children of cocoa producers in Côte d'Ivoire and find cocoa price crashes negatively affect schooling and health of children in cocoa producing households. Likewise, Kebede (2021), using household-level panel data from Ethiopia, shows that a decrease in international coffee prices has implications for household consumption and child health of coffee producer households. Moreover, he finds declining coffee prices leading to a decline in labor supply on own farm and more labor being supplied to plots growing other crops. Dube and Vargas (2013) show a sharp fall in coffee prices during the 1990s lowered wages and increased violence in coffee cultivating regions in Colombia. In a study motivated by the concerns of rising international demand and prices for quinoa hurting Peruvian consumers, Bellemare et al. (2018) show that rising quinoa prices were actually associated with an increase in welfare in regions with higher proportions of quinoa consumers.

The welfare impact of high food prices will also be influenced by government policies. In countries, such as India, producer prices and markets of staple foods may be heavily regulated by the government (Jensen and Miller, 2008; Aksoy and Hoekman, 2010). The Government of India sets Minimum Support Prices (MSP) for rice and wheat. The MSPs are price floors that are actively maintained by the government in domestic markets by buying excess food grains at pre-announced prices. The rationale for such policies is to protect domestic producers from global price shocks but they also end up attenuating the income-enhancing effects of high prices. Moreover, part of the staple food grains, mainly rice and wheat, purchased by the Indian government ends up being distributed at highly subsidized prices via the Public Distribution System (PDS) of India. The PDS is a large-scale in-kind food subsidy program that primarily targets poor households who are issued a Below Poverty Line (BPL) ration card and are entitled to fixed quantities of rice and wheat at highly subsidized prices (Balani, 2013). Other non-poor households are issued an Above Poverty

Line (APL) ration card. Although any household above the poverty line is entitled to the APL ration card, the main beneficiaries of the subsidy are the households with the BPL ration card.

There is some evidence that the PDS food subsidy in itself has an impact on household welfare and nutrition (Kaushal and Muchomba, 2015; Kaul, 2018; Rahman, 2016; Krishnamurthy et al., 2017). Moreover, the period of high global food prices also coincides with several state-level policy changes made to improve the scale and functioning of the PDS (Desai, 2015; Krishnamurthy et al., 2017; Gadenne et al., 2021). The availability of subsidized PDS rice and wheat during the global food price surge in 2007-08 means that poor and vulnerable households can use the subsidy to mitigate the welfare loss of high food prices. This means that households may maintain the real value of their consumption expenditure by consuming a greater quantity of PDS grains. Although PDS grains are of somewhat lower quality, for households at the margin, PDS grains may be substitutable with grains from the market. In a recent study, Gadenne (2020) shows that there are substantial insurance gains of PDS subsidy on staple foods and necessities which generally command a greater share of expenditure in poorer households. Gadenne et al. (2021), in the context of India, empirically establish the insurance role of targeted in-kind food subsidies. They use the policy-driven expansion in PDS as an exogenous variation to show that the increased generosity of PDS has led to a decrease in the sensitivity of household calorie consumption to food prices. In the context of this study, this means that the welfare-reducing effects of high food prices may also be attenuated, both because of availability, and improvement in access and generosity of cheap PDS rice and wheat.

3. Data and Summary Statistics

(i) Household and individual data

I use data from the Indian Human Development Surveys (IHDS) (Desai and Vanneman, 2010, 2018). The IHDS project is jointly managed by the National Council of Applied Economic Research (NCAER) India, the University of Maryland, Indiana University and the University of Michigan. The IHDS are designed to collect household and individual-level data on a wide variety of indicators ranging from household income, expenditure, assets, and employment to different indicators of human development like education, caste, gender relations, local infrastructure, availability of facilities, fertility, and health.

Two rounds of the IHDS are publicly available.[3] The first round of the survey was conducted in 2004-05 on more than 40,000 households and covered both urban and rural regions in all states of India. The second round was conducted in 2011-12. I treat the first IHDS survey as the baseline and the second survey as the endline. The most important aspect of these surveys is that 85% of the same households could be reinterviewed in 2011-12 making it the only large-scale and pan India household-level panel data. The panel aspect of the IHDS data is critical for this study as the empirical strategy relies on household fixed effects for netting out household-specific time-invariant observed and unobserved variables. Another important feature of these surveys is that data on agricultural activities of rural households were also collected. This included data on the cropping patterns and the production quantities of different crops. However, data on cropping patterns and crop production is only available for the baseline period. I use this data to identify the rice and wheat growing and net producer and net consumer households in the baseline period. I use this information to devise an empirical strategy that uses the share of cultivable area under rice and wheat to estimate the welfare impacts of high food prices on food-growing households. I use the net consumer and net producer status to show that these impacts would vary based on whether the household has a marketable surplus or not.

[3] See, https://ihds.umd.edu/ for details.

In the final dataset, I keep only the matched households in 20 major states of the country.[4] The final dataset has 33172 observations for 16586 households across 1565 villages/neighborhoods of the country. I also compile an individual-level dataset to study the workdays and activity participation for working-age adults within the age group of 15 to 65 years. The individual dataset has 89440 observations on 50632 individuals within 16442 households.

(ii) Food prices

I collect rice and wheat price data at three levels. The international price of rice and wheat comes from the International Monetary Fund's commodity prices dataset. I consider the price of Thai 5% broken rice and US hard red wheat in USD per metric ton as global prices of the two commodities. I also use state-level retail prices prevailing in the retail shops and government administered Minimum Support Prices (MSP) of rice and wheat. The MSP is a proxy for producer prices as the government is the largest buyer of rice and wheat in India. I calculate the weighted average of rice and wheat prices where the weights are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These expenditure shares are 0.60 for rice and 0.40 for wheat and are estimated from the baseline IHDS survey.

Figure 1 plots the global and domestic food prices in nominal terms for the period of analysis. Between 2004-05 and 2011-12, the global average price of rice and wheat increased from 221 to 457 USD per metric ton. This is more than double the increase in global food prices. A similar increase in food prices is also visible for domestic retail and producer prices. Both the MSP and the retail prices registered a 100% increase, or a doubling, from the

[4] These states are Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand, Haryana, Rajasthan, Uttar Pradesh, Bihar, Assam, West Bengal, Jharkhand, Orissa, Chhattisgarh, Madhya Pradesh, Gujarat, Maharashtra, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

baseline. With international prices increasing dramatically around 2007 the Indian government was unable to maintain stable price levels with the result that both the producer prices and the consumer prices of rice and wheat shot upwards in the domestic market as well (Mishra and Roy, 2012).

My empirical framework would partially rest on the assumption that rice and wheat cultivating households cannot influence global food prices. To argue that this assumption is reasonable in this context, I briefly document the events which led to the unprecedented surge in global food prices during 2007-08. In the case of rice, global markets are thin meaning that only a small proportion of global production is traded and most of the production and trade is concentrated in Asia. Although Thailand has been the major exporter of rice in global food markets, India has also emerged as a major exporter in recent years. On average, Thailand, India, and Vietnam account for around 60% of the total world exports. So India does not satisfy the assumption of a price taker in the global rice markets. It has been documented that export bans by Vietnam and India as a response to rising rice prices were major reasons for panic among major rice importers which further led to a surge in rice prices (Headey and Fan, 2008).

Global wheat markets are less thin than rice as the major producers and exporters of wheat are rich temperate countries. The rise in global wheat prices in 2007-08 was probably triggered by poor harvests experienced in many of the major exporters of wheat. Australia, The United States, Russia, and Ukraine all witnessed a decline in production during the period. Export bans by major wheat exporters triggered by low stocks and poor harvests created panic in global food markets (Headey and Fan, 2008; Abbott, 2011).

In general, the global food crises may have been triggered by the actions of a few countries but the unprecedented and sustained increase is mainly attributed to the contagion effect of panic in food markets and ensuing countercyclical trade policies (Timmer, 2008;

Mitra and Josling, 2009; Abbott 2011). Giordani et al. (2016) explicitly show that countercyclical trade policies especially in the staple food sector significantly contributed to increasing staple food prices in 2008–11.

I observe that global rice prices are negatively correlated with India's rice exports but global wheat prices show no significant correlation with Indian wheat exports and Imports (Appendix Table A1). These correlations corroborate the evidence available in the literature that India may have some market power in global staple food markets but it may be limited to rice (Sekhar, 2012). I argue that though the small country assumption in case of rice for India is violated, the global rice prices are still exogenous to the actions of the individual rice farming households. The Indian government's primary concern has been to maintain domestic food availability and therefore international trade in rice and wheat is heavily controlled by the government (Sekhar, 2012). This implies that from the point of view of individual rice and wheat farming households, global food prices are still exogenous.

Another set of prices important in this context are the highly subsidized price of rice and wheat distributed via the Public Distribution System (PDS) of India. Figure 2 shows that market purchased and PDS purchased weighted price of rice and wheat. The PDS price of rice and wheat is much lower than the market price in both surveys. Moreover, the market purchased rice and wheat shows an increase but the PDS price shows a decline during the two time periods. This is because many states either reduced prices or expanded the coverage making the PDS subsidies more generous (Gadenne, 2021).

4. Methodology

To estimate the passthrough of global food price surge on Indian households' consumption expenditure and other outcomes, I estimate the following equation

$$\mathbf{Y}_{ist} = \boldsymbol{\alpha}_i + \boldsymbol{\mu}_{st} + \boldsymbol{\delta}\,\mathbf{ln}(\mathbf{WPRW})_t \times \mathbf{SARW}_i + \boldsymbol{\varepsilon}_{ist} \qquad (1)$$

Where Y_{ist} is the outcome variable of interest for household *i* in state *s* for year *t*. WPRW is the weighted average of the international price of rice and wheat. The weights are the average proportion of expenditure on rice and wheat of the total spent on both. SARW is the share of area under rice and wheat in the baseline, i.e., 2004-05. An increase in food prices may itself lead to increased acreage under rice and wheat. By using households' rice and wheat acreage at the baseline, I rule the influence of endogenous acreage changes from my estimates. I include household fixed-effects α_i in Equation (1) to control for all observed and unobserved, time-invariant factors influencing household outcomes. The equation also includes state-specific time fixed effects μ_{st} which control for other macroeconomic shocks and state-level policy changes correlated with global food prices. State time fixed effects also control for state-level changes in prices hence their inclusion also takes care of an increase in consumption expenditures due to a general rise in prices.[5] Note that, WPRW and SARW are collinear with state-time and household fixed effects and will drop out from Equation (1).

The impact of food prices is captured by δ which reflects the net effect of food price increase on households based on their area under food cultivation. What should be the expected direction of δ? Since food is a necessity, an increase in food prices should lead to reduced real income or real consumption expenditure. For food producer households specifically, there will be an additional positive income effect due to higher food prices. δ, therefore, captures the net effect for food-producing households. I expect δ to have a positive sign indicating that higher food prices have a net positive effect on the welfare of food producer households.

[5] In general, consumer expenditures are deflated by state level consumer price indices (CPI), but with state time fixed effects, defalting with state specifc CPI is irrelevant.

A dimension of heterogeneity in δ worth highlighting is based on the net food consumer or producer status of households. Although δ is an average effect of high food prices for food cultivating households, it will vary based on whether the household is a net food producer or a net consumer. The net food producer or consumer status is not captured by the share of area under food cultivation. A household may have all cultivable areas under food cultivation but may still be a net food consumer. To capture such heterogeneity, I identify the net food producer or consumer status of households based on their rice and wheat consumption and production at the baseline. I identify a household as a net food producer if the household's total rice and wheat production was greater than its total rice and wheat consumption in 2004-05. Otherwise, the household is categorized as a net food consuming household. I estimate Equation (1) on subsamples of net food producing and net food consuming households.

I also look at the impacts of global rice and wheat prices separately for rice and wheat cultivators. I modify Equation (1) as follows

$$\mathbf{Y}_{ist} = \boldsymbol{\alpha}_{i} + \boldsymbol{\mu}_{st} + \boldsymbol{\delta}^{RICE}\,\mathbf{ln}(\mathbf{WPRICE})_{t} \times \mathbf{SARICE}_{i} + \boldsymbol{\delta}^{WHEAT}\,\mathbf{ln}(\mathbf{WPWHEAT})_{t} \times \mathbf{SAWHEAT}_{i} + \boldsymbol{\varepsilon}_{ist} \qquad (2)$$

Where everything remains the same except now I have two interaction terms. The first interaction is of global rice prices (WPRICE) with households' proportion of area under rice (SARICE) and the second interaction is of global wheat prices (WPWHEAT) with households' proportion of area under wheat (SAWHEAT). I also include household and state time fixed effects. The surge in global rice prices was much greater than wheat prices. By splitting the total impact into δ^{RICE} and δ^{WHEAT}, I can capture the heterogeneity due to this differential increase in prices of the two commodities. Moreover, if India has market power in global rice markets then it is useful to see whether the total effect δ in Equation (1) is driven by rice prices.

Finally, I also try to capture some of the indirect effects of high food prices. A rise in food prices may induce a supply response in the sense that, farmers may increase food production. This in turn may lead to higher demand for agricultural inputs. If the supply of inputs doesn't rise concurrently, input prices and farmers' cost of cultivation may go up. I test for whether agricultural expenditures increased due to a rise in food prices. I especially focus on agricultural labor use and intensity. I test for whether farm households' usage of hired and family labor increased with high food prices.

5. Results

(i) Effect of high food prices on food cultivating households

Table 1 presents the estimates from Equation (1) for three outcome variables - log of monthly per capita consumption expenditure, a dummy for whether the household is below the poverty line, and share of non-food in total consumption expenditure. I also report the averages of the dependent variable for the baseline period in the last row of the table. In specification 1, where the dependent variable is the log of monthly per capita consumption expenditure, the estimated coefficient on the interaction term is positive and statistically significant. This implies that a rise in food prices led to an increase in food cultivating households' consumption expenditure. In terms of magnitude, a doubling of global food prices between 2004-05 and 2011-12 led to a 5 percent or a 71 rupee increase in monthly per capita consumption expenditure for food cultivating households. A rise in food prices also translated into a reduction in headcount poverty and an increase in the share of non-food in total expenditure. In terms of magnitude, the doubling of food prices led to a 2 percentage point decline in headcount poverty and a 2 percentage point increase in the share of expenditure on non-food items for food cultivating households. These estimates are based on the average area under rice and wheat (around 50%) and the mean per capita consumption expenditure of rupees 1430 estimated for the baseline period. Note that, the marginal effect of global food prices is a function of the cultivated area under rice and wheat hence will vary with the rice and wheat area coverage.

Table 1 also presents estimates from specifications where I add household level additional controls variables in the regressions. I add operated area, cultivated area, and the proportion of irrigated area to control for any expansion as a supply response to high food prices. I also add the household's ownership of a BPL ration card, which would enable them to access subsidized rice and wheat, as controls. These income gains may also come about because of households' participation in government welfare schemes or wage work under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). The MGNREGA is India's large-scale anti-poverty rural workfare program. It was introduced in 2005 and provides 100 days per year of voluntary employment at minimum wages to individuals in the working-age group. The MGNREGA is mostly operational in rural areas and provides unskilled labor employment on local public work projects. The introduction of MGNREGA coincides with the baseline period, therefore, a positive δ may just be capturing higher rural incomes due to households participating in MGNREGA. All the regression include state time fixed effects which control for the introduction of changes in policies at the state level. However, household-level benefits from other government schemes and household participation in MGNREGA work control for the household's response to these variables. Although these responses are endogenous, the regressions with controls show that their inclusion has a minor effect on the original estimates.

On average, India has exported only 4% and 2% of its total rice and wheat production between 2000 and 2010. This is a very small proportion and would mainly be driven by surplus food production from states like Punjab and Haryana. In that sense, if Indian rice and wheat farmers can influence global prices then such farmers should most certainly be surplus producing farmers of these two states. To test whether surplus rice and wheat producing farmers from Punjab and Haryana are driving these estimates, the last specification for each dependent variable presents the estimates after removing the states of Punjab and Haryana from the sample (column 3, 6, and 9). The estimates for consumption expenditure and share of non-food register a minor decline but remain statistically significant and relevant.

Finally, I report standard errors estimated for three different levels of clustering: village, district, and state. These are nested within each other with village being the smallest and state being the largest geographical unit. The estimated coefficients for consumption expenditure and share of non-food remain statistically significant for all three standard error estimates.

In Table 2, along with the original specification in Equation (1), I also report two alternative specifications where I replace global rice and wheat prices with domestic consumer and producer prices. Since trends in producer prices more or less track government determined support prices in India, A direct passthrough of global prices to domestic prices is not obvious. Although, as Figure 1 shows, domestic prices were also on the rise during the period, it is useful to see how consumption and welfare responded to a rise in domestic prices. I find that the estimates are quite comparable across different specifications and replacing global prices with local prices does not make much of a difference.

(ii) Heterogeneity based on net producer or net consumer status of households

Table 3 presents the estimates of Equation (1) for subsamples of net food producer and consumer households. I find that all welfare gains of high food prices accrued to net food producer households. In terms of magnitude, a doubling of food prices during the period led to an 8 percent or 114 rupees increase in consumption expenditure, a 4.6 percentage point decline in headcount poverty, and a 5 percentage point increase in non-food share for net food producer households.[6]

Likewise, I find that in terms of agricultural and total income gains, it was only the net food producer household whose proportions declined in the poorest and lower income quantiles and increased in higher and richer income quantiles (Table 4). I use real income based quantiles rather than actual income because of noisy income estimates. Interestingly, the estimates in Tables 3 and 4 for net consumer sample are small in magnitude and statistically insignificant indicating that there were no welfare losses for such households. One possible channel through which households would have mitigated the welfare losses of high food prices is explored in the following sub-sections.

(iii) Differential effects of global rice and wheat prices

Table 5 presents the estimates from Equation (2) where I introduce two separate interaction terms of global rice price with area share under rice and global wheat price with area share under wheat. I observe that for net consumer households, all estimates are statistically insignificant. For net producer households, I find that both the estimated δ^{RICE} and δ^{WHEAT} are statistically significant but the magnitude of the effect for wheat seems larger than that for rice for consumption expenditure and headcount poverty. To see whether these estimates are statistically different, I conduct a t-test of differences in these estimates. Based on the results, I am unable to reject the null hypothesis that these estimates are different for all three measures of welfare.

[6] For comparability with estimates in Table 1, these estimates are based on average area share under rice and wheat (0.50) and average consumption expenditure (rupees 1430) for the entire sample in 2004-05.

As a placebo check, I interact weighted food prices with the share of area under millets at the baseline. I specifically select millet as its area has a negative correlation with the area under rice and wheat. This means that millet growing households would have less or no area under rice or wheat therefore high global rice and wheat prices should not have any differential effect on households based on their area under millet cultivation. Table 5 specifications 1, 3, and 5 show that the estimate on the interaction between rice and wheat prices and share of area under millets is either statistically insignificant or of the wrong sign for all three welfare measures.

(iv) In-kind food subsidies as insurance

A priori, one would expect net consumers to experience a welfare loss due to expensive food, but I do find evidence of this in Tables 3 and 4. One reason for this may be the possibility that households replaced expensive market-purchased rice and wheat with cheaper PDS grains or other cereals. To explore this, I regress per capita consumption of market purchased, PDS purchased, homegrown and other cereals on the interaction term with household and state time fixed effects. These estimates are presented in Table 6a.

I observe a decline in total per capita consumption of rice and wheat in net consumer households. This decline for net consumer households was driven by their reduced consumption of expensive market-purchased rice and wheat. This is the consumption effect of high food prices. The net consumer households substituted expensive market rice and wheat with homegrown and subsidized PDS rice and wheat but this was not enough to offset the decline in their total consumption of the two cereals. These households maintained their total cereal consumption by increasing the consumption of coarse cereals. In fact, in terms of magnitude, shifting to coarse cereals was the dominant strategy to offset the reduced consumption of market purchased rice and wheat for net consumer households.

A decline in market purchased rice and wheat is also observed for net producer households, but the magnitude of the decline is almost half of that for the net consumers. Moreover, net producer households were almost completely able to offset their decline in consumption of market purchased rice and wheat by increasing consumption of PDS rice and wheat. The insurance effect of PDS subsidy seems to be dominant for the net food producer households as they were able to recover almost all the decline in their total cereal consumption from higher consumption of PDS grains. Another interesting observation is that net producer households did not increase the consumption of homegrown rice and wheat to substitute for expensive market rice and wheat probably because of a higher opportunity cost of consuming home-produced grains and the availability of a cheaper substitute in the form of PDS grains. An increase in the coarse cereal consumption is observed for the net producer households also but the magnitude is much less than that for the net consumer households.

I also calculate the total calorie intakes for households using the item-wise food consumption available in the two rounds of the IHDS survey. I use the conversion tables in the National Sample Survey's Nutritional Intake in India reports for 2004-05 and 2010-11 to calculate the total calorie intakes. The last column of Table 6a reports the estimates with per capita per day calorie intakes as the dependent variable. I find that both net consumer and producer households were able to maintain their total calorie intakes during the period.

Although both net consumer and producer households relied on PDS to maintain their consumption of rice and wheat, net producer households were more successful in using PDS as a coping strategy. There is evidence that PDS became more generous during the period both in terms of expansion and efficiency in operations (Bhattacharya et al., 2017; Krishnamurthy et al., 2017; Gadenne, 2021). Desai (2015) reports that more people were using the PDS during 2004-05 and 2011-12. Table A2 in the appendix shows that this expansion in PDS happened disproportionately more for net food producer households as the food price increase is correlated with increased ownership of a BPL ration card only for the net food producer but not for the net consumer households. This implies that more net producer households gained access to a BPL ration card during the period. Table A2 shows another evidence supporting the argument that households' response of consuming more PDS rice and wheat was driven by the high market price of rice and wheat as consumption of other PDS subsidized items such as other cereals, sugar and kerosene is uncorrelated with global food prices.

The combined effect of substitution within food staples from different sources was that the monthly per capita expenditure on rice and wheat and cereals did not increase but actually registered a decline both for net consumer and net producer households (Table 6b). For net consumer households, this decline was probably due to switching to cheaper coarse cereals, but for net producers, this decline was because of switching to cheap subsidized PDS rice and wheat. Although the coping strategies for net producer and consumer households vary, the final result was that both groups were able to resist an increase in the total food expenditure (Table 6b).

(v) Some indirect effects

In Table 7, I explore whether higher food prices had a supply response in the form of an increase in area under cultivation and irrigation. I also see whether the indirect effects of higher food prices resulted in higher agricultural expenditures and wages paid to hired labor. I find that higher food prices did lead to greater operated and area under cultivation in both net producer and consumer households but the magnitude of increase was more than four times higher in net producer households. Moreover, net consumer households registered a decline in the irrigated area whereas there was no change in irrigated area for net producer households. A supply response can also lead to higher wage bill for the households. On the contrary, I find that the total wages paid to hired labor declined in both sets of households. The major decline, however, both in terms of magnitude and statistical significance is seen for the net food producer households. There is also no statistically significant change in the wage rate for the hired labor paid by the households. Overall, I find no evidence of an increase in the total agricultural expenditures and wages paid by the households. Interestingly, I observe that the likelihood of loan repayment and the amount of payment made as agricultural loans increased for net food producer households.

I also investigate the impact of high food prices on workdays and activity participation of working-age adults in net food producing and consuming households. Table 8 shows that the doubling of global food prices led to an average increase of 17 days (12 percent of the average annual workdays from the baseline) in the total annual workdays of working-age adult males for net food-producing households. Note that such effects are completely absent for either net consumer households or adult females in net food-producing households. In terms of activity participation, I observe increased participation in own farm work and reduced participation in wages and salary work for working-age adult males in only the net food producer households. It seems that higher global food prices did lead to higher demand for agricultural labor from the net food producer households which was essentially met by increasing family labor on their own farm. This effect was both in terms of an increase in the total workdays and a reallocation of labor from market wage employment to labor on own farm. Not only did the total days worked on own farm increase for net food producer households but the intensity of labor in terms of the hours per day worked on own farm also increased. This could explain why higher global food prices did not lead to a higher wage bill for the net food-producing households as higher labor demands were mostly met by increasing family labor on their own farm.

6. Robustness Checks

In this section, I present some additional results to establish the robustness of the key findings in this paper. The first test is to see whether these results are sensitive to weights used to construct the weighted global food price. Recall that the weights used are the all India average share of expenditure allocated by households on rice and wheat of the total spent on both, calculated from the baseline survey. Table A3 in the Appendix shows four different specifications of Equation (1) where I use different weights to construct the weighted global prices. These weights are arbitrarily chosen and are just to show that the results are not driven by the choice of weights but by the surge in global food prices. Table A3 shows that the estimate of the coefficient on the interaction term is not dependent on the choice of weights.

As seen in Appendix Table A2, there is evidence that more net producer households got access to a BPL ration card during the time period in question therefore more of them had access to PDS between 2004-5 and 2011-12. Likewise, I also observe that MGNREGA participation systematically increased for net producer households. This implies that the improvement in the functioning of both PDS and MGNREGA happened for net producer households and systematically varies with their area under rice and wheat cultivation. This leads to the possibility that a positive δ reflects higher real consumption expenditure due to greater access to subsidized PDS grains or MGNREGA work. This may lead to a positive income effect of higher food prices even when there is none. To test this, I introduce interactions of BPL ration card ownership status and MGNREGA participation with global food prices, the share of area under rice and wheat, and all other possible combinations. Table A4 in the Appendix presents the results. Even after controlling for all possible interactive effects of PDS and MGNREGA participation, the estimates on the interaction of global food prices with the area under rice and wheat for net food producer households remain positive and statistically significant.

Finally, to add more confidence that these estimates do reflect the impact of global food price surge during 2004-05 and 2011-12 for food cultivating households, I try the see whether such effects were also present when global food prices were not increasing and were more or less stable. A household panel dataset comparable to the richness of information collected and the size of sample for years before the 2004-05 IHDS survey is not available. Although a part of the sample for IHDS surveys was drawn from an earlier survey conducted in 1993-94, it collected limited information and does not have the crop cultivation and production data to estimate Equation (1). I resort to a district-level panel dataset of headcount ratio of poverty and log average monthly per capita consumption expenditure constructed by Topalova (2010). Topalova constructs this district-level panel using the National Sample Survey of India's Consumption and Expenditure Surveys for 1983, 1987-88, and 1999-2000. These are repeated cross-sections surveys with data on household consumption expenditures on food and non-food items. Compiling these surveys into a district panel is not straightforward due to limited concordance in the district identifiers across surveys and issues with comparability due to differences in recall periods. I use this dataset to estimate a district version of Equation (1) for the period of 1987-88 to 1999-2000. During this period, nominal weighted food price shows no increasing trend and was more or less stable. Note that, Topalova (2010) does not report item-wise consumption expenditure to construct the share of non-food, so I consider log of monthly per capita consumption expenditure and headcount ratio of poverty as the outcome variables. Table A5 in the Appendix shows that the estimated coefficients on the interaction terms are all close to zero in magnitude and are statistically insignificant.

7. Conclusion

This paper studies the welfare impacts of high food prices on households in India. The analysis also demonstrates the significant heterogeneity that may exist in such impacts. I observe that, overall, high food prices were beneficial for food cultivating households. I also find that this overall effect was driven by the strong and dominant positive income effect for net food producer households. Both net producers and consumers were able to resist a rise in their total expenditure on cereals and food budget but through different means. Net consumers substituted market purchased rice and wheat mainly with home-produced rice and wheat and other cereals but net producers substituted market purchased rice and wheat with PDS rice and wheat and other cereals. The role of subsidized PDS rice and wheat in stabilizing total food consumption was evident in both net consumer and producer households but it was dominant for net producer households. Finally, I also observe some second-order effects in net producer households in the form of increased use of family labor on own farm and reallocation of adult male family labor from market wage work to work on own farms.

These results can be seen from two dimensions. The first is that policies of in-kind food transfers do seem to insulate households from high food prices. What is important, however, is the right targeting of these subsidies. In this case, evidence shows that access to PDS improved disproportionately for net producer households who were not the worst affected by high food prices. A second point worth noting is that net consumer households, who were mostly small subsistence farmers, resorted to consuming home-produced food as a coping strategy. This is in line with evidence reported from other parts of the world which find that households rely on subsistence agriculture to insure against food price risk (Rudolf, 2019). However, my results demonstrate that such a strategy probably depends upon the scale of production, the opportunity cost of consuming homegrown food, and the availability of cheaper substitutes.

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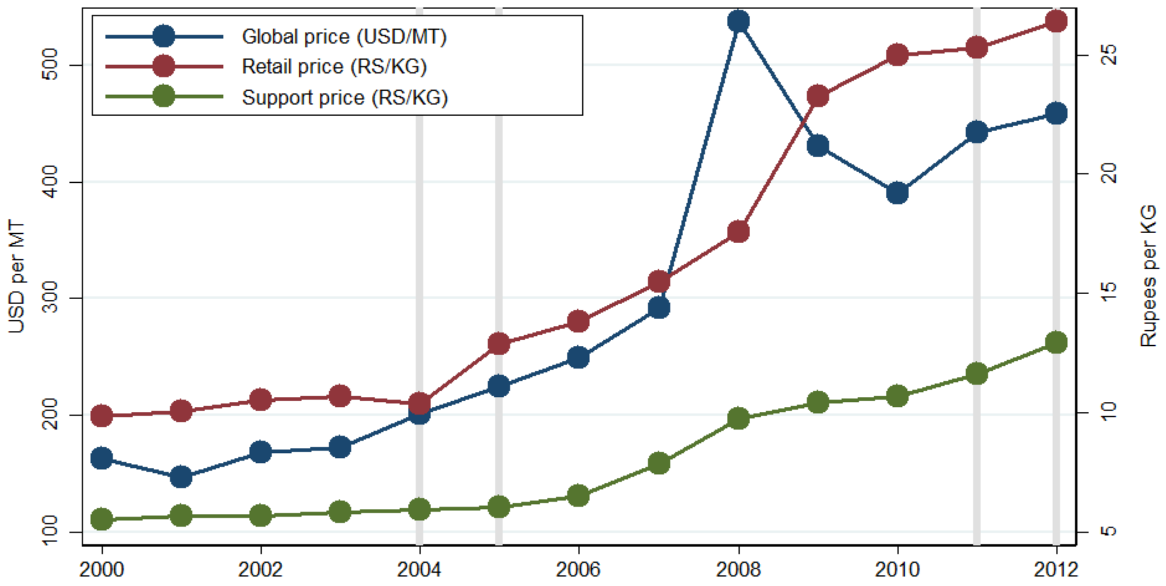
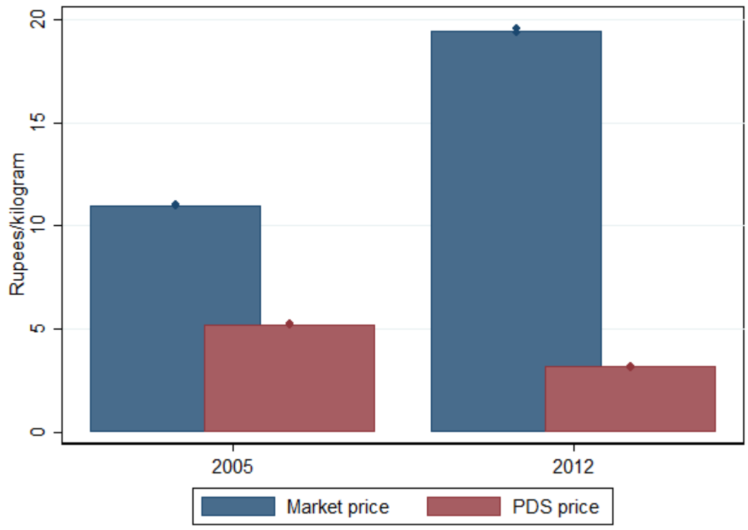
Figures

Figure 1. Weighted price of rice and wheat in global and domestic markets



Notes: I use the price of Thai rice and US wheat in USD per metric ton as global prices of the two commodities. The retail prices are prices of rice and wheat prevailing in the retail shops. Support prices are the minimum support prices of rice and wheat announced by the government of India every agricultural season. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat.

Figure 2. Weighted price of market purchased and PDS rice and wheat



Notes: Average weighted market and PDS price of rice and wheat reported in the IHDS surveys with 95% confidence intervals. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat.

Tables

Table 1. Monthly per capita consumption expenditure, headcount poverty and share of non-food expenditure and global food prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln(Monthly per capita consumption expenditure)			Headcount poverty			Share of non-food expenditure		
VARIABLES	All states	All states	Without Punjab and Haryana	All states	All states	Without Punjab and Haryana	All states	All states	Without Punjab and Haryana
Ln(WPRW)×SARW	0.103***	0.125***	0.096**	-0.047*	-0.043	-0.046*	0.044***	0.045***	0.038***
Standard errors clustered at village level	(0.039)	(0.042)	(0.041)	(0.026)	(0.029)	(0.028)	(0.011)	(0.012)	(0.011)
Standard errors clustered at district level	(0.049)	(0.052)	(0.050)	(0.035)	(0.036)	(0.037)	(0.013)	(0.014)	(0.014)
Standard errors clustered at state level	(0.042)	(0.042)	(0.044)	(0.038)	(0.037)	(0.040)	(0.016)	(0.017)	(0.018)
Operated land (ha)		-0.001			0.002			-0.001	
		(0.005)			(0.003)			(0.002)	
Proportion area irrigated		0.034*			0.003			0.001	
		(0.017)			(0.012)			(0.005)	
Cultivated area (ha)		0.014**			-0.007*			0.004**	
		(0.006)			(0.004)			(0.002)	
BPL ration card owner (0/1)		-0.040***			0.014			0.008**	
		(0.012)			(0.010)			(0.004)	
Benefit govt. programs (000 rs/person)		0.407***			-0.051**			0.079***	
		(0.062)			(0.025)			(0.012)	
Any member in MGNREGA work (0/1)		-0.026			-0.009			0.001	
		(0.017)			(0.014)			(0.005)	
Constant	6.881***	6.811***	6.870***	0.336***	0.321***	0.341***	0.359***	0.351***	0.378***
	(0.108)	(0.115)	(0.108)	(0.072)	(0.078)	(0.074)	(0.029)	(0.032)	(0.029)
Observations	33,070	25,778	31,084	33,106	25,802	31,116	33,070	25,778	31,084
R-squared	0.756	0.764	0.751	0.639	0.648	0.637	0.628	0.629	0.631
F stat	6.84	14.22	5.63	3.19	2.47	2.75	16.67	12.79	11.86
Mean Dependent Variable	1430	1430	1368	0.23	0.23	0.24	0.45	0.45	0.45

Notes: The dependent variables are the monthly per capita consumption expenditure in logs, a dummy variable for whether the household is below the official poverty line and the proportion of non-food expenditure in total consumption expenditure. WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. BPL stands for below poverty line and PDS stands for the Public Distribution System of India. MGNREGA stands for Mahatma Gandhi National Rural Employment Guarantee Act. Benefits from government programs include all the transfers to households from government welfare programs in 1000 rupees per person. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2. Passthrough of global, local retail and minimum support prices to household consumption expenditure, headcount poverty and share of non-food

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Ln(Monthly per capita consumption expenditure)			Headcount poverty			Share of non-food expenditure		
Ln(WPRW)×SARW	0.103***			-0.047*			0.044***		
	(0.039)			(0.026)			(0.011)		
Ln(RPRW)×SARW		0.087**			-0.045*			0.039***	
		(0.038)			(0.027)			(0.011)	
Ln(MSP)×SARW			0.099***			-0.045*			0.042***
			(0.038)			(0.025)			(0.010)
Observations	33,070	33,070	33,070	33,106	33,106	33,106	33,070	33,070	33,070
R-squared	0.756	0.756	0.756	0.639	0.639	0.639	0.628	0.628	0.628
F stat	6.841	5.208	6.776	3.194	2.887	3.139	16.67	13.39	16.39
Mean Dependent Variable	1430	1430	1430	0.23	0.23	0.23	0.45	0.45	0.45

Notes: The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. WPRW is weighted global rice and wheat prices, RPRW is weighted state level retail prices and MSP is weighted all India rice and wheat minimum support prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Monthly per capita consumption expenditure, headcount poverty and share of non-food of net consumers and producers of food and global food prices

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Monthly per capita consumption expenditure)	Headcount poverty	Share of non-food expenditure	Ln(Monthly per capita consumption expenditure)	Headcount poverty	Share of non-food expenditure
VARIABLES		Net consumers			Net producers	
Ln(WPRW)×SARW	0.027	-0.061	0.013	0.167***	-0.093**	0.095***
	(0.052)	(0.040)	(0.014)	(0.059)	(0.039)	(0.018)
Observations	17,108	17,120	17,108	15,464	15,480	15,464
R-squared	0.758	0.646	0.640	0.782	0.666	0.662
F stat	0.270	2.386	0.872	8.019	5.617	26.79
Mean Dependent Variable	1415	0.23	0.46	1456	0.22	0.44

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects, and dummies for the month of the survey. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Per capita income quantiles of net consumers and producers and global food prices

VARIABLES	(1) Poorest quantile Q1	(2) Second quantile Q2	(3) Middle quantile Q3	(4) Fourth quantile Q4	(5) Richest quantile Q5
			Net consumers		
Ln(WPRW)×SARW	-0.032	-0.014	0.024	0.042	0.011
	(0.039)	(0.039)	(0.039)	(0.035)	(0.027)
Monthly per capita total income (rupees)	297	561	828	1378	3446
			Net producers		
Ln(WPRW)×SARW	-0.104**	-0.080**	-0.015	0.146***	0.077*
	(0.042)	(0.038)	(0.041)	(0.043)	(0.040)
Monthly per capita total income (rupees)	350	614	856	1346	3469

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. The dependent variables are dummy variables that equal one if the household is in a particular per capita income quantile. The income quantiles are based on real incomes. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5. Interactions of global food prices with the proportion of household's area under rice, wheat and millets and household welfare

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Monthly per capita consumption expenditure)		Headcount poverty		Share of non-food expenditure	
VARIABLES			Net consumer			
Ln(WPRICE)×SARICE		0.030		-0.068		0.021
		(0.061)		(0.045)		(0.018)
Ln(WPWHEAT)×SAWHEAT		0.052		-0.073		-0.020
		(0.077)		(0.060)		(0.023)
Ln(WPRW)×SAMILLET	0.093		-0.066		-0.010	
	(0.078)		(0.062)		(0.020)	
Observations	17,126	17,158	17,138	17,170	17,126	17,158
R-squared	0.747	0.748	0.636	0.636	0.627	0.627
F stat	1.397	0.298	1.148	1.702	0.256	1.301
			Net producer			
Ln(WPRICE)×SARICE		0.138**		-0.061		0.113***
		(0.066)		(0.047)		(0.019)
Ln(WPWHEAT)×SAWHEAT		0.243**		-0.132*		0.066**
		(0.107)		(0.068)		(0.029)
Ln(WPRW)×SAMILLET	-0.209		0.124		-0.179***	
	(0.188)		(0.122)		(0.061)	
Observations	15,480	15,500	15,496	15,516	15,480	15,500
R-squared	0.768	0.768	0.652	0.651	0.641	0.643
F stat	1.237	3.902	1.033	2.472	8.656	18.23

Notes: The regressions include household fixed effects and dummies for the month of the survey. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. WPRICE stands for world rice price, WPWHEAT stands for world wheat price and WPRW stands for global weighted rice and wheat price. SARICE, SAWHEAT and SAMILLET stand for the household's proportion of area under rice, wheat and millets respectively. All others are defined as net consumer households. Net Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6a. Monthly per capita rice-wheat and other cereals consumption of net consumers and producers of food and global food prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Rice and wheat total	Rice and wheat homegrown	Rice and wheat PDS (kg/person)	Rice and wheat market	Other cereals	Total cereals	Calories consumed (person/day)
				Net consumer			
Ln(WPRW)×SARW	-1.803***	0.123***	0.680**	-2.606***	1.085***	-0.718	54.80
	(0.414)	(0.045)	(0.333)	(0.485)	(0.202)	(0.449)	(83.10)
Mean Dependent Variable	11.15	0.69	2.14	8.32	2.16	13.31	2326
				Net producer			
Ln(WPRW)×SARW	-0.459	0.024	1.067***	-1.550***	0.727***	0.268	31.17
	(0.473)	(0.047)	(0.259)	(0.493)	(0.221)	(0.523)	(105.53)
Mean Dependent Variable	11.72	0.51	0.66	10.55	0.96	12.68	2364

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. Rice and wheat total include market purchased, homegrown and PDS rice and wheat. Other cereals include cereals other than rice and wheat. Total cereals include all cereals including rice and wheat. Total calories consumed are estimates using food items data reported in the IHDS survey. The food conversion factors used are extracted from the ones reported in the National Sample Survey's, Nutritional Intakes in India Reports for 2004-05 and 2010-2011. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6b. Monthly per capita rice-wheat, cereals and food expenditure of net consumers and producers of food and global food prices

	(1)	(2)	(3)	(4)	(5)	(6)
	Rice and wheat	Cereals	Food expenditure	Rice and wheat	Cereals	Food expenditure
			(rupees/person)			
VARIABLES		Net consumers			Net producers	
Ln(WPRW)×SARW	-44.28***	-29.74***	24.86	-30.67***	-24.07**	-66.12
	(8.44)	(9.52)	(33.27)	(9.95)	(11.31)	(45.59)
Mean Dependent Variable	161	201	636	179	206	684

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7. Cultivable area, irrigation and agricultural expenditures of net consumers and producers of food and global food prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Operated area (hectare)	Cultivated area (hectare)	Irrigated area (hectare)	Hired labor exp. (rupees)	Wage (rupees/day)	Agricultural exp. (rupees)	Agricultural loan repaid (rupees)	Loan repaid (dummy)
				Net consumers				
Ln(WPRW)×SARW	0.361*	0.379**	-0.344***	-959.5*	49.9	-3,311.6*	335.2	0.000
	(0.210)	(0.153)	(0.094)	(541.3)	(71.0)	(1,812.9)	(479.7)	(0.034)
Mean dependent variable	1.35	1.25	0.31	2532	116	12425	1271	0.15
				Net producers				
Ln(WPRW)×SARW	1.558***	1.298***	0.264	-5,419.6***	-65.2	-11,316.3	5,891.9**	0.127***
	(0.257)	(0.254)	(0.198)	(2,052.7)	(53.9)	(8,630.4)	(2,987.5)	(0.040)
Mean dependent variable	1.88	1.88	1.24	5604	179	36473	4017	0.14

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. Hired labor and total agricultural expenditures are for the whole year. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Total work and work participation categories for net consumers and producers of food and global food prices

	(1)	(2)	(3)	(4)
VARIABLES	Net consumers		Net producers	
	Male	Female	Male	Female
	Total work days (annual)			
Ln(WPRW)×SARW	5.367	-1.946	35.635***	-0.430
	(9.823)	(9.077)	(11.258)	(10.610)
	Farm work participation (dummy)			
Ln(WPRW)×SARW	0.012	0.004	0.074**	-0.049
	(0.036)	(0.039)	(0.037)	(0.047)
	Animal work participation (dummy)			
Ln(WPRW)×SARW	-0.011	0.024	0.048	-0.063
	(0.038)	(0.039)	(0.040)	(0.040)
	Non-farm work participation (dummy)			
Ln(WPRW)×SARW	-0.033	0.010	0.015	0.001
	(0.022)	(0.015)	(0.027)	(0.019)
	Market wage work participation (dummy)			
Ln(WPRW)×SARW	0.034	-0.002	-0.060*	-0.032
	(0.032)	(0.032)	(0.033)	(0.028)
	Farm work days (annual)			
Ln(WPRW)×SARW	-3.605	1.974	27.653***	4.085
	(8.043)	(7.395)	(10.243)	(9.669)
	Farm work hours (daily)			
Ln(WPRW)×SARW	0.058	0.083	0.631**	-0.167
	(0.261)	(0.240)	(0.313)	(0.301)

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. These regressions also include age and squared age of the individual as controls. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix

Table A1. Correlation between food prices and Indian rice and wheat exports/imports during the period 1990 to 2020

	(1)	(2)	(3)	(4)
VARIABLES	Ln(Rice price $/mt)		Ln(Wheat price $/mt)	
Liner trend	0.047***	0.025***	0.015***	0.015***
	(0.011)	(0.006)	(0.005)	(0.005)
Ln(Indian rice exports)	-0.063**			
	(0.026)			
Ln(Indian rice imports)		-0.021		
		(0.025)		
Ln(Indian wheat exports)			-0.005	
			(0.011)	
Ln(Indian wheat imports)				-0.015
				(0.012)
Constant	-87.82***	-43.38***	-25.46**	-24.35**
	(21.289)	(11.372)	(10.567)	(10.106)
Observations	31	31	31	31
R-squared	0.495	0.403	0.231	0.269
F stat	13.73	9.448	4.210	5.146

Notes: Estimates based on time series data from 1990 to 2020. I use the price of Thai 5% broken rice and US hard red winter wheat in USD per metric ton as global prices of the two commodities. Indian rice and wheat exports and imports data is from the Food and Agriculture Organization's statistics division and is in tonnes.

Table A2: Ration card holding households, MGNREGA participation and global food prices

	(1)	(2)	(3)	(4)	(5)
VARIABLES	BPL ration card	PDS other cereals (kilogram/person)	PDS sugar	PDS kerosene (liters/person)	MGNREGA participation
		Net consumers			
Ln(WPRW)×SARW	0.049	-0.002	-0.025	-0.039	0.008
	(0.039)	(0.005)	(0.022)	(0.045)	(0.032)
Observations	17,138	17,136	17,136	17,136	17,136
R-squared	0.687	0.529	0.762	0.664	0.637
F stat	1.582	0.259	1.227	0.777	0.0702
Mean Dependent Variable	0.39	0.00	0.15	0.51	0.008
		Net producers			
Ln(WPRW)×SARW	0.214***	0.003	0.014	-0.040	0.078**
	(0.049)	(0.005)	(0.022)	(0.051)	(0.036)
Observations	15,496	15,496	15,496	15,496	15,496
R-squared	0.666	0.560	0.727	0.646	0.641
F stat	19.01	0.370	0.437	0.608	4.786
Mean Dependent Variable	0.25	0.00	0.07	0.50	0.010

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A3. Different weights for averaging global rice and wheat prices

VARIABLES	(1)	(2)	(3)	(4)	**(5)**	**(6)**	**(7)**	**(8)**	(9)	(10)	(11)	(12)
	Ln(Monthly per capita consumption expenditure)				Headcount poverty				Share of non-food expenditure			
Ln(PRICE1)×SARW	0.103***				-0.047*				0.043***			
	(0.039)				(0.026)				(0.011)			
Ln(PRICE2)×SARW		0.103***				-0.047*				0.043***		
		(0.039)				(0.026)				(0.011)		
Ln(PRICE3)×SARW			0.103***				-0.047*				0.044***	
			(0.039)				(0.026)				(0.011)	
Ln(PRICE4)×SARW				0.103***				-0.047*				0.044***
				(0.040)				(0.026)				(0.011)
Observations	33,070	33,070	33,070	33,070	33,106	33,106	33,106	33,106	33,070	33,070	33,070	33,070
R-squared	0.756	0.756	0.756	0.756	0.639	0.639	0.639	0.639	0.628	0.628	0.628	0.628
F stat	6.994	6.937	6.887	6.801	3.272	3.243	3.217	3.174	16.63	16.65	16.66	16.67

Notes: The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. PRICE1=[0.3*RICE+0.7*WHEAT], PRICE2=[0.4*RICE+0.6*WHEAT], PRICE3=[0.5*RICE+0.5*WHEAT], and PRICE4=[0.7*RICE+0.3*WHEAT]. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A4. Estimates of equation (1) with additional interactions of BPL ration card ownership and participation in MGNREGA

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Monthly per capita consumption expenditure)	Headcount poverty	Share of non-food expenditure	Ln(Monthly per capita consumption expenditure)	Headcount poverty	Share of non-food expenditure
VARIABLES		Net consumers			Net producers	
Ln(WPRW)×SARW	0.082	-0.012	0.008	**0.130***	**-0.073***	**0.080*****
	(0.061)	(0.046)	(0.017)	**(0.074)**	**(0.043)**	**(0.022)**
BPL	-0.093	-0.334*	-0.105	-0.264	0.223	-0.191
	(0.266)	(0.182)	(0.075)	(0.652)	(0.437)	(0.183)
Ln(WPRW)×BPL	0.007	0.061*	0.019	0.049	-0.039	0.036
	(0.046)	(0.031)	(0.013)	(0.113)	(0.076)	(0.032)
SARW×BPL	0.274	1.151***	-0.156	-0.085	0.233	-0.112
	(0.508)	(0.403)	(0.143)	(0.817)	(0.581)	(0.225)
Ln(WPRW)×SARW×BPL	-0.042	-0.198***	0.026	-0.002	-0.035	0.018
	(0.089)	(0.070)	(0.025)	(0.141)	(0.100)	(0.039)
MGNREGA	-3.671**	1.668	-1.091*	-5.388	0.517	0.577
	(1.782)	(2.395)	(0.609)	(5.318)	(2.914)	(1.292)
Ln(WPRW)×SARW×MGNREGA	0.605**	-0.279	0.178*	0.865	-0.077	-0.090
	(0.292)	(0.392)	(0.100)	(0.869)	(0.477)	(0.211)
SARW×MGNREGA	2.785	-0.713	0.987	4.712	-0.348	-0.645
	(2.438)	(3.249)	(0.849)	(6.013)	(3.552)	(1.560)
Ln(WPRW)×SARW×MGNREGA	-0.475	0.123	-0.165	-0.754	0.041	0.101
	(0.401)	(0.533)	(0.139)	(0.984)	(0.582)	(0.255)
BPL×MGNREGA	3.076	-2.248	0.094	4.011	4.182	-1.469
	(2.196)	(2.178)	(0.708)	(5.771)	(4.621)	(1.895)
Ln(WPRW)×BPL×MGNREGA	-0.502	0.366	-0.015	-0.665	-0.687	0.237
	(0.360)	(0.357)	(0.116)	(0.944)	(0.758)	(0.310)
SARW×BPL×MGNREGA	-1.686	-0.918	0.163	-3.087	-6.027	1.473
	(3.011)	(3.309)	(0.945)	(6.540)	(5.607)	(2.268)
Ln(WPRW)×SARW×BPL×MGNREGA	0.283	0.167	-0.026	0.522	1.006	-0.232
	(0.495)	(0.544)	(0.155)	(1.071)	(0.920)	(0.371)
Observations	17,108	17,118	17,108	15,464	15,480	15,464
R-squared	0.763	0.648	0.641	0.781	0.667	0.665
F stat	1.671	1.963	3.093	2.496	1.421	8.145

Notes: WPRW is the weighted average of the global rice and wheat prices. The weights used in aggregating rice and wheat prices are the proportion of expenditure of Indian households on rice and wheat of the total spent on both. These weights are 0.60 for rice and 0.40 for wheat. SARW is the proportion of cropped area under rice and wheat by the household. BPL stands for below poverty line and PDS stands for the Public Distribution System of India. MGNREGA stands for Mahatma Gandhi National Rural Employment Guarantee Act. The regressions include household fixed effects, state-time fixed effects and dummies for the month of the survey. Standard errors are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A5. Estimates of equation (1) using district-level data from Topalova (2010)

	(1)	(2)
VARIABLES	Ln(Monthly per capita consumption expenditure)	Headcount poverty
Ln(WPRW)×SARW	0.004	0.004
	(0.006)	(0.005)
Observations	715	715
R-squared	0.947	0.814
F stat	0.372	0.765

Notes: The regressions include district fixed effects and state-time fixed effects. These regressions are estimated on data from two years of 1987-88 and 1999-2000 extracted from dataset compiled by Topalova (2010). The district-level area under rice and wheat is for 1987-88. The regressions include district fixed effects and state-time fixed effects. Standard errors are clustered at the district level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.