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Coping Strategies in Response to Rising Food Prices: Evidence From India

Sharad Tandon and Maurice Landes

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Abstract

Food prices across the world rose dramatically between 2006 and 2008. The causes of the price rise were complex, and the event has led to heightened concerns regarding the implications of rising food prices on the prevalence of food insecurity and household welfare, particularly in developing countries. Given widespread and chronic malnutrition in India and the country's large share of the world's total food-insecure population, this report estimates how Indian households coped with the rise in domestic food prices that accompanied global price patterns in 2006-08. Exploiting differential spikes in rice and wheat prices, we find that households affected the most by rising food prices significantly decreased dietary diversity, delayed medical expenditures, and delayed purchases of clothing and durable goods. Given the existence of significant food and nonfood coping mechanisms, findings suggest that the rise in food staple prices in India had wide-ranging effects on household welfare.

Keywords: Food security, India, food price crisis, nutrition

Acknowledgments

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Coping Strategies in Response to Rising Food Prices: Evidence From India

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What Is the Issue?

Global food prices increased dramatically between 2006 and 2008. The rise in prices was not uniform across food categories. Cereal prices showed an especially large increase, and the average increase in rice prices was nearly twice as large as that of wheat prices. Causes of the high prices included low stocks, droughts in food-producing countries, rising oil and fertilizer prices, the expansion of biofuels made from feedstocks, and growing food and feed demand associated largely with rising incomes and urbanization in developing countries. The rise in food prices led to heightened concerns regarding the implications for the prevalence of food insecurity and household welfare, particularly among vulnerable low-income consumers in developing countries.

This study examines how households in India coped with rising domestic food prices that accompanied global price patterns. Given widespread and chronic malnutrition in India, the response of Indian households to rising food prices is of particular concern. Cereal prices in India surged during and after the period of the 2008 global food price crisis due to developments in India's domestic market, as well as the runup in world prices. Certain large regions in India consume either rice or wheat as the staple food, but not both. Because the increase in rice prices was large relative to the increase in wheat prices, the Indian setting provides an opportunity to compare both food and nonfood responses between the two regions and isolate household coping strategies in response to the rising food staple prices.

What Did the Study Find?

An analysis of changes in consumption across India between 2004-05 and 2009-10 and a comparison of food and nonfood coping strategies between rice-eating regions and wheat-eating regions during the same period demonstrated the following:

- Households maintained consumption of their staple cereal as cereal prices spiked but reduced consumption of calories from all other sources. As a result, overall calorie consumption significantly decreased across India during the period.

- Consumption of calories from noncereal sources (legumes, fruits, vegetables, and animal products) dropped 13 percentage points more in rice-eating regions than in wheat-eating regions, which were less affected by the rising prices. This change resulted in a less diverse diet and worse nutritional outcomes in terms of total consumption of a number of beneficial nutrients for households in rice-eating regions. However, there was little difference in the decline of overall calorie consumption between rice-eating and wheat-eating regions because households in both regions maintained consumption of their staple cereal while adjusting expenditures for other foods.

- Regions worse hit by rising food prices also decreased expenditures on medical care and durable goods relative to other regions of the country.

- These relative changes in consumption in India only appeared after the rise in cereal prices, and there is little evidence that the changes were driven by national policy changes and other shocks during the period.

These findings suggest that higher prices for staple foods affected nutrition in India. However, findings also suggest that higher food prices affected Indians' health status by reducing access to health care at the same time that households faced increasing rates of malnourishment. Furthermore, decreased spending on clothing and durable goods potentially increased domestic labor requirements for mending and repair work, which has implications for time allocations to work outside the home and education.

Despite India's substantial food security investments and trade restrictions on cereals, cereal prices still increased substantially between 2006 and 2010. The study's findings suggest that effective policies to strengthen household food access and security may also need to address availability and access to important nonstaple foods.

How Was the Study Conducted?

ERS researchers used data from consumer expenditure surveys conducted by the Government of India in 1999/2000, 2004/05, and 2009/10 to estimate how food consumption, other measures of nutrition, and overall household expenditures changed across India as prices of staple cereals spiked. Measures of nutrition were calculated using the quantity of each food item consumed by Indian households and the average nutritional content of Indian foods. Researchers then compared changes in food security and expenditures in rice-eating regions and in wheat-eating regions to account for shocks or changes in national policy that might have contributed to the observed trends. Consumption changes prior to the food price crisis between 1999/2000 and 2004/05 were used to demonstrate that the estimates were due to the differential increases in wheat and rice prices and not other unrelated factors.

Coping Strategies in Response to Rising Food Prices: Evidence From India

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Introduction

Despite widespread improvements in the availability and stability of global food supplies, recent estimates suggest there are between 490 million and 870 million food-insecure people in the world (FAO, 2013; Fan, 2012; Meade and Rosen, 2014). Given the difficulties faced by many households in obtaining adequate sustenance, considerable attention has been devoted to measuring different aspects of malnourishment (FAO, 2012), analyzing methods to better deliver food and nutrition assistance,[1] and analyzing how households cope with food insecurity.[2]

Food insecurity is an especially important concern in India. Despite rapid growth in income in India over the past two decades, a large segment of the population remains food insecure (e.g., Deaton and Dreze, 2009). Analysis of calorie consumption using household food expenditure data from 2004/05 reveals that between 404 million and 577 million people in India consumed below the nutritional threshold of 2,100 calories per day (e.g., Tandon and Landes, 2011). Though evidence shows that a large share of the country's population does not have adequate access to food, it is difficult to develop rigorous quantitative assessments of household coping strategies in response to food insecurity because of the complex array of factors inside and outside the household that may influence decisionmaking (e.g., Barrett, 2002).

This report focuses on household coping strategies in response to recent food price spikes in India. Food prices across the world began to increase in 2006 but then dramatically spiked in 2007 and the first half of 2008. However, the rise in prices was not uniform across all food categories. Cereal prices especially surged during the period, and the average increase in rice prices was nearly twice as large as that in wheat prices (e.g., Viatte et al., 2009). The causes of the price shocks were complex and included low stocks, droughts in key food-producing countries, rising oil and fertilizer prices, the expansion of biofuel demand, and growing food and feed demand associated largely with rising incomes and urbanization in developing countries (e.g., Trostle, 2008; Viatte et al., 2009).

Although the scale and immediacy of the crisis were mitigated in India due to Government intervention (Childs and Kiawu, 2009), cereal prices in India surged during the period following the 2008 spike in global cereal prices. Similar to the global patterns, rice prices in India increased

[1] See Behrman and Deolalikar (1988) and Barrett (2002) for summaries.

[2] See Barrett (2002) for summary.

more than wheat prices. Additionally, some regions of the country consume rice almost exclusively as the primary staple food, while other regions primarily consume wheat as the staple food. Given that cereals account for a high proportion of the diet in both types of regions (e.g., NSSO, 2007), it is likely that the rice-eating regions were affected more by rising prices of staple foods than wheat-eating regions.[3] Thus, the Indian setting provides an opportunity to compare both food and nonfood coping strategies of the two types of regions and isolate household coping strategies in response to the rising food staple prices.

Investigating potential food-based coping strategies, this report focuses on the effect of the rise in food prices on both total calorie consumption and noncereal consumption—specifically, consumption of pulses (legumes), animal-based protein, and produce (fruits and vegetables). Based on recommended dietary allowances in India, households on average have greater deficiencies in noncereal consumption than in cereal consumption (National Institute of Nutrition, 2010). A higher level of noncereal consumption would imply higher scores on most diet quality indices, which are associated with better health outcomes (Wirt and Collins, 2009).

The baseline empirical specifications define rice-eating regions as those where average household consumption of wheat was less than 5 percent of overall calories and wheat-eating regions as those where average consumption of rice was less than 5 percent of overall calories. Households in rice-eating regions reduced their consumption of noncereal foods by approximately 13 percent more than households in wheat-eating regions. However, there was not a significant difference in overall calorie consumption, as both types of households maintained their cereal consumption while adjusting other expenditures. Despite the lack of a calorie response to the crisis, the larger decrease in diet diversity in rice-eating regions points to worse nutritional outcomes.

In addition to analyzing food-based coping strategies in response to the food price crisis, this report also investigates nonfood coping strategies. In particular, households in rice-eating regions had a larger drop in expenditures on health, which can be associated with worse outcomes later in life (e.g., Schultz 2010). Additionally, households in rice-eating regions decreased expenditure on new durable goods and new clothes longer than households in wheat-eating regions, which potentially increased domestic repair and mending costs. This, in turn, has potential implications for household labor and education decisions.

These results help to better describe the nutrition costs of the world food price crisis and also the costs of increases in the relative price of food staples more generally. These results are most similar to D'Souza and Joliffe (2012), who find that dietary diversity decreased in Afghanistan following the rise in food prices but that calorie consumption did not significantly change. However, the results presented here generalize earlier findings to a nonconflict setting and are also similar to Jensen and Miller (2008), who find that households in rural China did not significantly decrease calorie consumption in response to the initial rise in noncereal food prices in 2006.[4]

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[3] The Public Distribution System (PDS) provides subsidized cereals to meet some household needs, and this portion of consumption would be less exposed to increases in the market price of cereals. Consistent with the appeal of PDS cereals during the time of rising prices, Krishnamurthy et al. (2014) demonstrate that PDS cereal consumption increased between 2004/05 and 2009/10. However, the ration of PDS cereals provides significantly less rice or wheat than that consumed by Indian households, on average (e.g., Deaton and Dreze, 2009). Furthermore, a number of Indian States had significant trouble delivering PDS cereals to households (e.g., Khera, 2011).

[4] These results are also related to a number of articles analyzing the nutritional response to negative income shocks (e.g., Brinkman et al., 2004; McKenzie, 2006; Block et al., 2009). The setting analyzed here involves both substitution and income effects.

These results also better describe the nonhealth impacts of the food price crisis. Models have long presented potential links between food security and health issues aside from malnourishment (e.g., Barrett, 2002), but little robust empirical evidence has supported these links. These links are particularly important given that food-insecure households are in need of more medical attention (e.g., Wirt and Collins, 2009). Additionally, the delay in the replacement of durable goods and clothing likely increased the amount of domestic work to be done in the form of repair, mending, and also the potential of domestic work being more labor intensive without the aid of working durable goods. This raises the possibility that household labor and education decisions might have been affected, which in certain cases could limit the efficacy of coping strategies, such as foregone income from market work as household members performed more domestic work and decreased lifetime earnings following a potential decrease in schooling (Tandon, 2014).

Rice and Wheat Markets in India

Although the effects of the food price crisis were somewhat mitigated in India, the price of cereals rose significantly following the spike in world prices, with the domestic price of rice surging far more than that of other cereals (Childs and Kiawu, 2008). Figure 1 presents average world wheat (U.S.) and rice (Thai) prices between 1999 and 2014, along with average prices of each commodity in India during the same period. The data reveal three important patterns. First, similar to global patterns, the price of rice in India increased far more than the price of wheat in India between 2006 and 2010. Second, also similar to global patterns, wheat prices in India started to spike in 2006 before decreasing. And lastly, rice prices in India started to surge in the beginning of 2008 and continued to surge past 2010. This last pattern differed from that of world rice prices, which plummeted in the second half of 2008.

Just as the causes of the world food price crisis are complex and unclear, the causes of the price rises in India are also unclear. Historically, India has been successful in maintaining relatively stable domestic rice and wheat prices, but market and policy developments have led to noticeably higher prices for both commodities since the mid-2000s. Between the late 1970s and the mid-2000s, the stability of domestic prices was associated with moderate increases in domestic support prices (minimum support prices, or MSPs), subsidized distribution and stockholding (the Public Distribution System), and occasional imports of wheat when buffer stocks proved inadequate. The direct influence of world prices on the domestic market was minimized by restrictions on imports and exports that limited private trading in wheat and rice (Jha et al., 2007).

However, as demonstrated in figure 1, domestic rice and wheat prices began to rise markedly in the mid-2000s.[5] The relatively large rise in rice prices, compared with wheat prices, appears to stem partly from larger relative increases in the MSP for rice (fig. 2). According to the guidelines used by India's Commission for Agricultural Costs and Prices (CACP), MSPs are intended to reflect changes in underlying costs of production, as well as other market factors, including international price conditions. Aside from the much larger spike in international rice prices relative to wheat prices, the CACP reports document significant recent increases in agricultural production costs. In particular, labor costs in India have increased sharply and are more likely to adversely affect rice markets than wheat markets given the higher labor intensity in rice production (e.g., Jayasuriya and Shand, 1986; Westcott and Trostle, 2013).

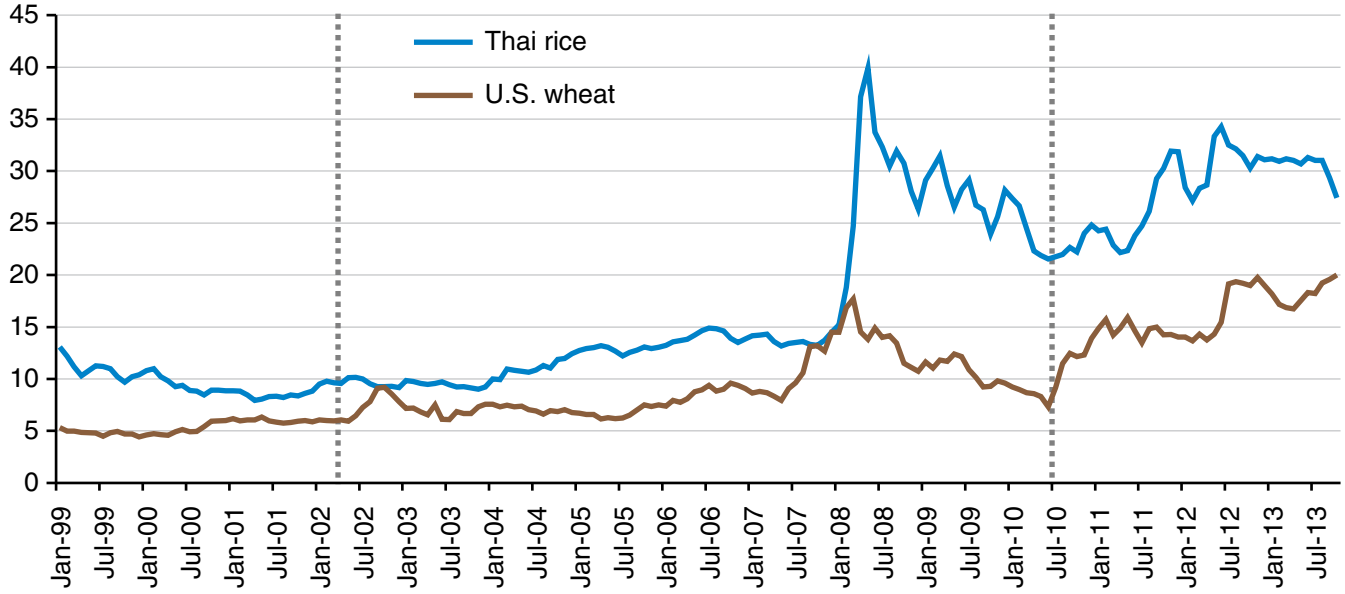
Additionally, there was more potential for transmission of the spike in world cereal prices into the domestic rice markets than was the case for wheat. International trade was highly regulated during this time period for both wheat and rice. Indian wheat exports were effectively banned between 2006 and 2011, whereas Indian exports of basmati rice and some amounts of common rice varieties were still allowed to Bangladesh and Sub-Saharan Africa. Given the positive exports of rice and the larger spread between international and domestic prices for rice than for wheat, the potential for international prices to be transmitted to the domestic market was greater for rice than for wheat (fig. 2).

[5] Prices of other food groups also began to rise in India during the period. However, the price increases were often less than the increases in rice and wheat prices. Additionally, other food items are more uniformly consumed across India and account for a much smaller share of consumption.

Figure 1
Rice and wheat prices

World prices

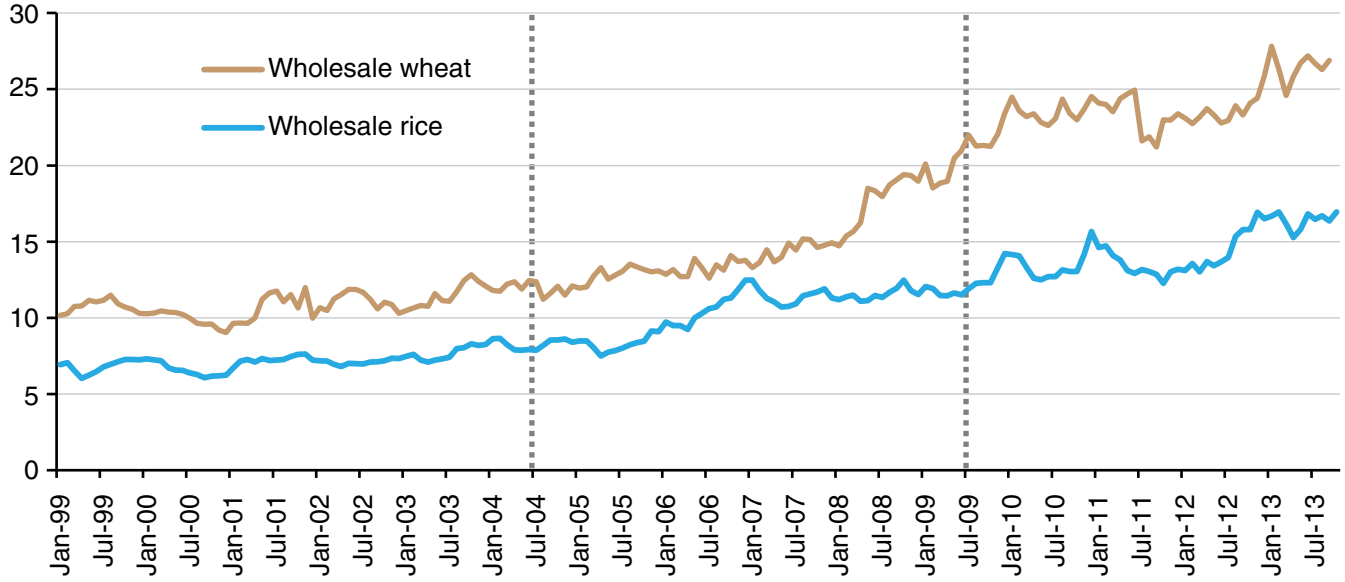
Rupees per ton (thousands)



Source: USDA, Economic Research Service.

Indian prices

Rupees per ton (thousands)



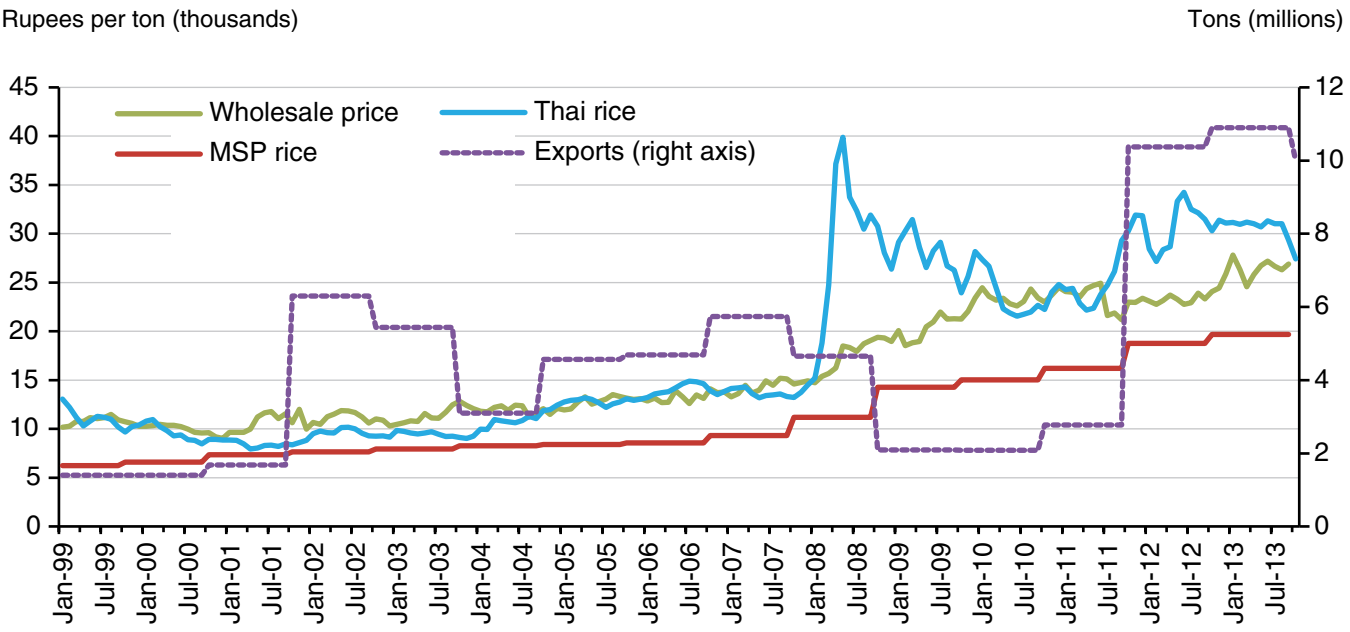
Note: The top panel of this figure plots average world prices for rice and wheat, as proxied by the prices in Thailand and the United States, respectively. The bottom panel plots average prices for rice and wheat in India.

Source: USDA, Economic Research Service using data from Government of India, Ministry of Agriculture, Directorate of Economics and Statistics.

Figure 2

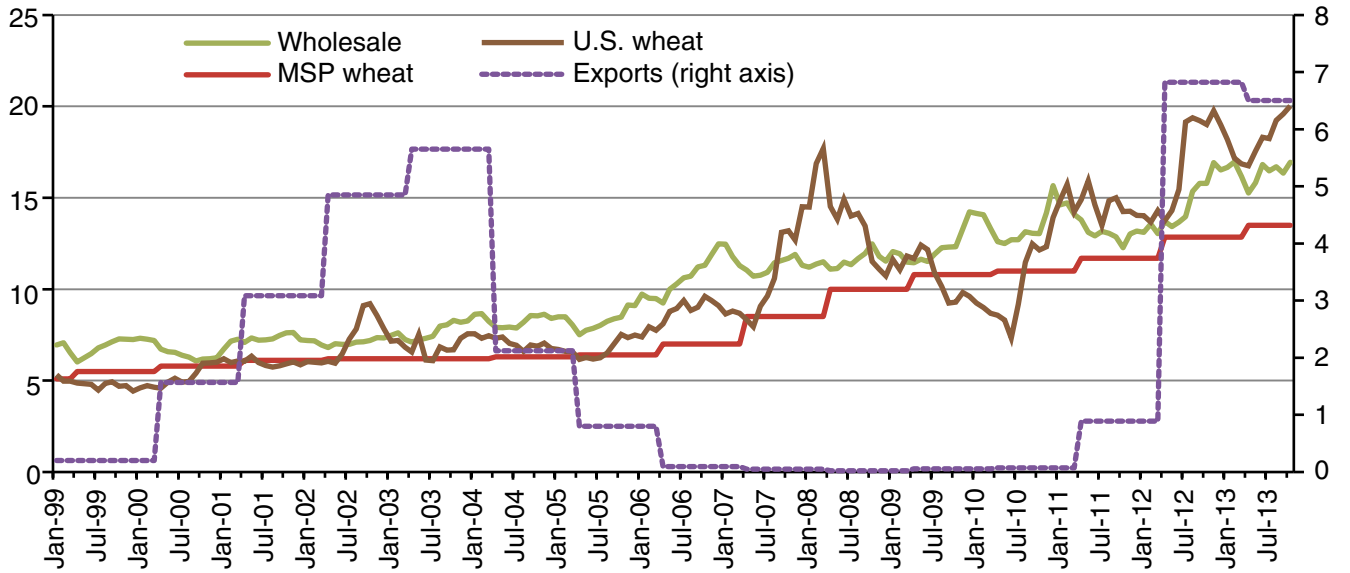
Minimum Support Prices (MSP), exports, and prices of rice and wheat in India

Indian and world rice prices



Sources: USDA, Economic Research Service using data from Government of India, Ministry of Agriculture, Directorate of Economics and Statistics; USDA, Foreign Agricultural Service.

Indian and world wheat prices



Sources: USDA, Economic Research Service using data from Government of India, Ministry of Agriculture, Directorate of Economics and Statistics; USDA, Foreign Agricultural Service.

Data and Methods

To assess the impact of rising rice and wheat prices on Indian households, this report analyzes changes in diet choice and calorie consumption in response to the price increases between 2006 and 2010. While this comparison provides suggestive evidence of how households respond to food price shocks, some of the measured change in consumption might be due to other secular trends or shocks common to the country as a whole. To account for such trends, this analysis takes advantage of the differential increases in wheat and rice prices across the country and compares the diet changes in rice-eating regions to diet changes in wheat-eating regions to discern the impact of the price changes. This approach establishes a natural experiment that helps control for factors that might be driving changes in household behavior aside from the differential increase in cereal prices.

This study relies on household estimates of consumption obtained from consumer expenditure surveys conducted by India's National Sample Survey Organization (NSSO). The NSSO conducts annual surveys on a range of topics and conducts a more detailed survey of both consumption and employment every 5 years. This report uses 3 of these larger consumption surveys—the 55th (1999/2000), 61st (2004/5), and 66th (2009/10) rounds—each of which surveys over 100,000 households across India.[6] Consumption surveys from the NSSO are available in the years between the large surveys used in this analysis, but the samples are much smaller and the sampling methodology differs between the small and large surveys.

Each consumption survey provides data on the quantity and value of consumption of approximately 170 separate food items, along with the sources of each food item (e.g., homemade, purchased), and information on the number of meals consumed outside the home. Importantly, each survey reports quantities and values of all goods consumed separately. Additionally, the survey reports a range of household and individual characteristics, including the number of household members, the location of the household, and the education and age of household members. To convert quantities of food consumed to calorie values, this analysis uses the average calories contained in each of these food items as reported in Gopalan et al. (1989).[7] Thus, these surveys yield simple estimates of overall calories consumed, calories by source (e.g., cereals, pulses, vegetables), and total consumption of a number of beneficial nutrients (e.g., protein, calcium, iron, fiber).

However, a number of factors make it difficult to estimate overall household calorie consumption. First, inaccuracies may arise in converting purchases of processed foods into calories consumed. Many of the processed food categories, such as "Salted Refreshment," "Cake/Pastry," and "Other Processed Food," are not easily matched to precise nutritional information. Additionally, because some of these vague food items come in a variety of different forms that make it difficult to report quantities, the data set only reports the value of a number of processed food categories. To assign a calorie value to processed foods, this analysis follows Deaton and Subramanian (1996) and assumes that calories from processed foods are more expensive than calories from foods prepared at home. Thus, the analysis calculates calories per rupee spent on nonprocessed foods for each household

[6] For details on the survey methodology, see box "Data Concerns."

[7] In certain instances, it is difficult to match the survey code to the more detailed foods that are recorded in *Nutritive Value of Indian Foods*. However, in most cases, the difference in calories is likely to be small (e.g., matching up particular forms of rice, nearly all calorie values are identical, so any error is likely inconsequential).

Box 1: Data Concerns

The National Sample Survey Organization consumer expenditure surveys are not based on a random sample but are stratified by household location (rural or urban area) and relative household affluence. Population estimates for both rural and urban areas can only be constructed at the state and national levels; the data do not allow construction of population estimates for the groups of districts that primarily consume rice or wheat in any of the rounds used for this analysis.

Although calorie consumption varies significantly based on household income and household location, the objective of this study is to detect *changes* in consumption rather than provide estimates of overall consumption. Thus, if the stratification is identical across surveys, it is not necessary to reweight observations to arrive at a population estimate of consumption. However, the relative size of the rural/urban sample is determined by the share of the population that is rural in the 1991 Census for the 55th round and by the 2001 Census for the 61st and 66th rounds. Thus, differential trends in growth of urban areas could potentially drive differences in average consumption across a pooled sample of rural and urban households. Furthermore, the stratification on relative affluence is slightly different between the 55th round and the other 2 surveys.

Despite these differences in sampling procedure, all trends discussed in the main text are identical when divided by rural and urban areas, and all patterns discussed in the text are identical if the analysis is restricted to particular second-stage strata within which there is random sampling of households (i.e., nonaffluent households in the rural sector, nonaffluent households in the urban sector, affluent households in the rural sector, etc.). Thus, for simplicity, estimates are derived from the pooled sample throughout the study.[1]

[1] All results broken up by rural/urban households and further broken up by the second-stage income stratification are available from the authors by request.

and assumes that households receive half the calories per rupee spent on nonprocessed foods when consuming processed foods.[8]

Second, household members consume meals outside the home, and the calories consumed in these meals must be accounted for to accurately compute the actual number of total calories consumed by household members. For example, if members of poorer households are more likely to eat meals at their places of employment, an estimate that considers only food items purchased is likely to understate total caloric intake. While the NSSO data set provides detailed information on the number of meals consumed by household members outside of the home, it is still necessary to devise a method to accurately assign a caloric value to those meals.

Following the methodology introduced by Deaton and Subramanian (1996), the calories contained in meals consumed outside the home are estimated by calculating how many fewer calories are consumed within the household for every additional meal consumed outside the home. Using regression techniques, the most complete estimate presented in the appendix suggests that households

[8] All results are identical if calories from processed foods are excluded from total calorie consumption.

consume 475 fewer calories for each meal consumed outside the home, and this figure is added to household calorie consumption for each meal that is consumed outside the home. Although the approach is far from ideal and introduces a significant amount of measurement error into estimates of food insecurity (e.g., Tandon and Landes, 2011), a number of other studies use similar approaches (e.g., Deaton and Dreze, 2009).

Lastly, one cannot account for calories in foods prepared by a household but consumed by nonhousehold members. Although the 61st and 66th rounds of the consumption survey report the number of such meals, the 55th round does not. Thus, to ensure a consistent estimate of calorie consumption, this analysis ignores the number of meals given to nonhousehold members. Although this approach may make it difficult to accurately estimate household calorie consumption, the majority of households do not give any meals to nonhousehold members. This is especially true for poorer and food-insecure households.[9]

Estimates of total household calorie consumption are obtained by adding up the estimates of nonprocessed calories consumed, processed calories consumed, and calories consumed in meals outside the home. Once the baseline estimates of total calorie consumption are calculated, calorie intake totals for individuals are computed to enable comparisons with individual consumption benchmarks. Table 1 reports daily consumption per person in India, separated by survey.[10]

Consistent with other estimates of calorie consumption in India, data presented in table 1 suggest that calorie consumption decreased and food insecurity increased between 1999 and 2009 (e.g., NSSO, 2007; Deaton and Dreze, 2009). However, this was not necessarily the case. The amount of

Table 1
Estimates of average calories consumed in India

Item	Average daily sample of household calorie consumption, by survey		
Variable	(1) Average per capita calories per day	(2) Share of sample that consumes less than 2,100 calories per day	Observations
1999-2000 (55th round)	2,296.0 (65.2)	.561 (.008)	119,544
2004-05 (61st round)	1,994.4 (15.3)	.641 (.009)	123,745
2009-10 (66th round)	1,848.2 (13.3)	.675 (.008)	100,855

Note: Standard errors clustered by district are reported in parentheses.

Source: USDA, Economic Research Service estimates using the 55th, 61st, and 66th rounds of the National Sample Survey.

[9] All results discussed in later sections are identical if we estimate calories consumed by nonhousehold members in the 61st and 66th round households similar to the way we estimate calories consumed in meals outside the home but ignore such meals in the 55th round households. In such estimations, time dummies across all households would help to absorb the difference in estimation strategies across rounds. However, for simplicity, we focus on the results using the estimation strategy discussed in the text.

[10] These estimates are not intended to be interpreted as population estimates. The surveys are stratified by whether a household resides in a rural or urban area and further stratified by income group. Rather than weighting each household appropriately to arrive at a population estimate, we simply report the sample average pooled across rural and urban areas, as well as pooled across income stratification.

calorie consumption that is essentially unobservable to researchers—consumption of processed food and food away from home—also increased over this time period. Small changes in assumptions used to derive calorie consumption from these sources could result in large changes to overall calorie consumption and, thus, it is difficult to discern whether food security improved, worsened, or did not change over this time period (Tandon and Landes, 2011).

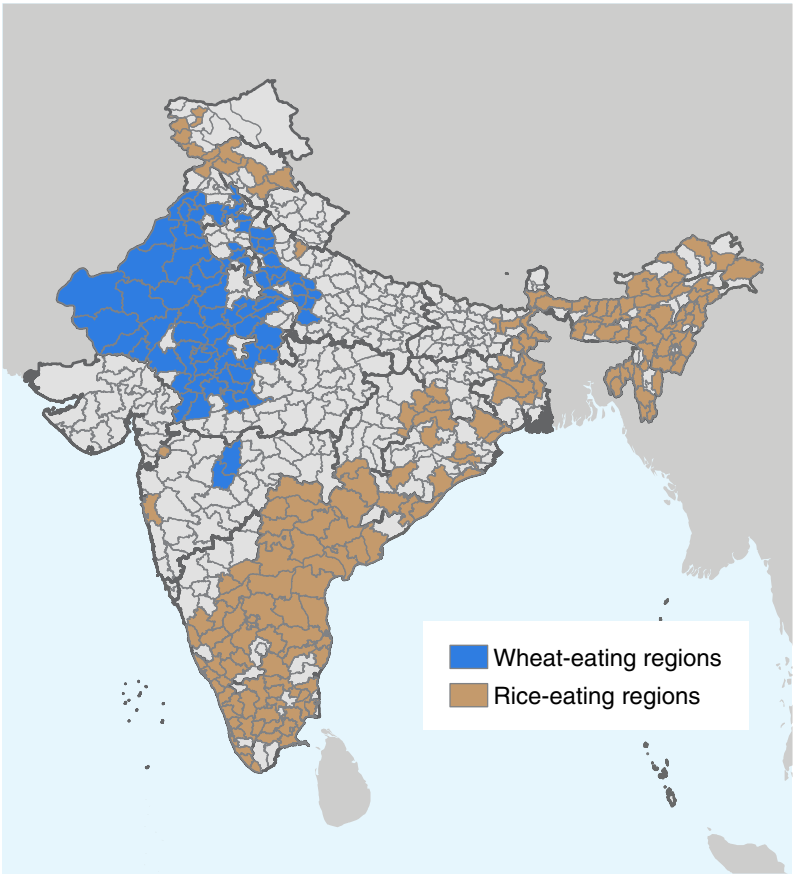
This study also examines other measures of nutrition, particularly at-home consumption of nonprocessed foods broken out by calories from cereal and noncereal sources. Based on recommended dietary allowances in India, households on average have greater deficiencies in noncereal consumption than in cereal consumption (National Institute of Nutrition, 2010). A higher level of noncereal consumption would imply higher scores on most diet quality indices, which are associated with better health outcomes (e.g., Wirt and Collins, 2009). Additionally, the study analyzes total per capita consumption of protein, calcium, iron, and fiber.

Rice- and Wheat-Eating Regions in India

This analysis exploits regional differences in diet to infer the effects of increases in cereal prices. As noted earlier, the baseline specifications define a region as wheat eating if average consumption of rice in 1999/2000 was less than 5 percent of total calorie consumption; rice-eating regions are defined as those where wheat consumption in 1999/2000 was less than 5 percent of total calorie consumption.[11] As shown in figure 3, rice-eating regions in India are primarily located in the south and the east of the country; wheat-eating regions are primarily located in the northwest.[12]

Importantly, consumption of the nondominant grain in these regions changed little between 2004-05 and 2009-10 (fig. 4). Households in rice-eating regions did not substitute wheat for rice in their

Figure 3
Rice- and wheat-eating regions of India



Note: This map highlights districts in India in which average consumption of wheat and rice were less than 5 percent of the overall diet in 1999-2000.

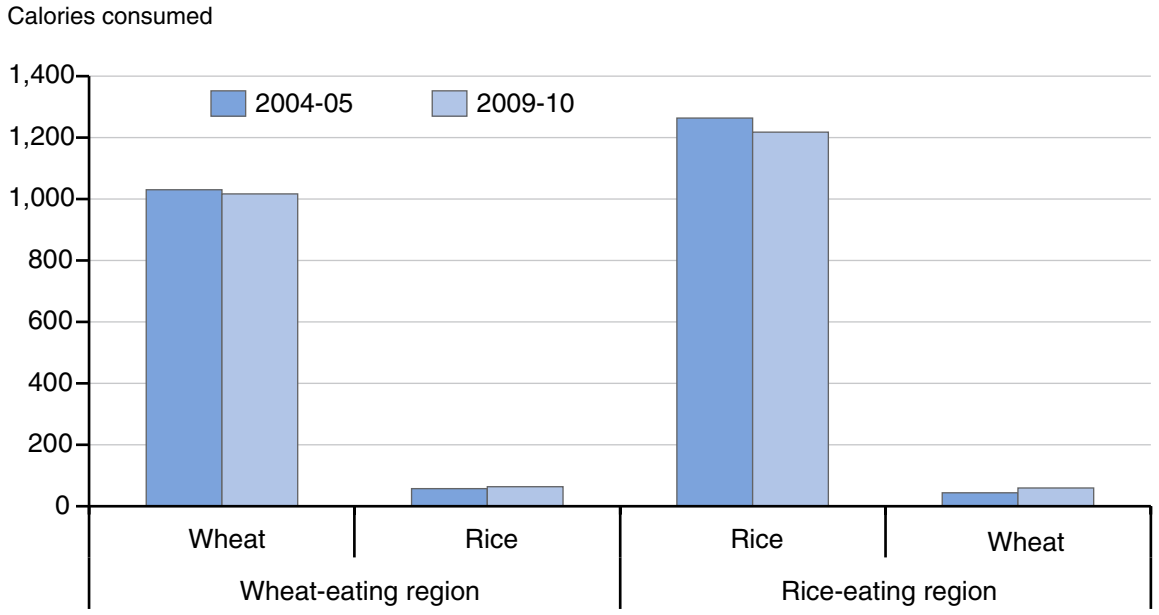
Source: USDA, Economic Research Service using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

[11] Although one could define rice- and wheat-eating regions based on the share of total calories consumed that are composed of rice and wheat, respectively, such a measure could capture a measure of cereals in the overall diet and lack of diet diversity. Such a measure could capture other household characteristics, such as relative affluence.

[12] In addition to analyzing rice- and wheat-eating regions, the study also analyzes variations in consumption across India based on average rice consumption before the financial crisis.

Figure 4

Average daily per capita calories consumed from rice and wheat by region in India



Note: In rice-eating regions, the dominant cereal is rice and the nondominant cereal is wheat; in wheat-eating regions, the dominant cereal is wheat and the nondominant cereal is rice.

Source: USDA, Economic Research Service using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

diets, even though the price of rice rose significantly more than the price of wheat. If households had substituted wheat for rice, it would be difficult to argue that households in rice-eating regions were affected more by the increases in food prices, and it would be difficult to estimate the magnitude of the responses of households to rising cereal prices between 2004-05 and 2009-10.

Empirical Strategy Used To Estimate Food-Based Coping Strategies

Table 2 presents overall calorie consumption and noncereal consumption between 2004-05 and 2009-10. Each of the two panels of the table reports a "difference-in-difference" estimate of average consumption. A difference-in-difference estimate indicates how much more consumption fell in rice-eating regions relative to wheat-eating regions. This approach of comparing changes in the two regions helps to control for changes that may have occurred due to national and regional trends in consumption that are unrelated to the differential increases in cereal prices.

Specifically, the table reports average consumption for 2004-05 and 2009-10 separately for each region in columns (1) and (2). Column (3) of each panel reports the difference between the average consumption in each time period for each region, whereas the third row of each panel reports the difference between average consumption in rice-eating regions and wheat-eating regions for each individual survey. The column's bottom right cells presented in bold font report the difference-in-difference estimate of consumption. That is, it represents the difference in the growth in consumption between each region. For example, in the first panel, the difference-in-difference estimate reports that daily per capita consumption in rice-eating regions decreased by 53.0 (-145.6 less -92.6) more calories than daily consumption decreased in wheat-eating regions.

A number of patterns emerge from the trends in overall and noncereal consumption. First, there are significant baseline differences between rice-eating and wheat-eating regions. Although a number of rice-eating regions in the south of India tend to be wealthier and have higher per capita consump-

Table 2
Differences in daily household calorie consumption in selected regions of India

	(1)	(2)	(3)	(4)
Overall daily per capita calorie consumption	2004-5	2009-10	Difference 1: (Column 2 – Column 1)	Observations
Rice-eating regions	1,938.2 (30.5)	1,792.6 (22.0)	-145.6*** (27.2)	80,381
Wheat-eating regions	2,114.9 (24.4)	2,022.3 (18.8)	-92.6*** (21.0)	21,705
Difference (Row 1 – Row 2)	-176.7** (39.0)	-229.7*** (28.9)	**-53.0 (34.2)**	-
Daily per capita calories noncereals sources	2004-5	2009-10	Difference 1: (Column 2 – Column 1)	Observations
Rice-eating regions	348.6 (18.3)	277.3 (7.9)	-71.2** (17.9)	80,381
Wheat-eating regions	507.9 (16.1)	494.3 (16.0)	-13.6 (13.2)	21,705
Difference (Row 1 – Row 2)	-159.4*** (24.3)	-217.0*** (17.8)	**-57.6*** (22.2)**	-

Notes: This table reports consumption broken up by region and survey, as well as the differences in consumption over time (column 3) and also the differences between the growth between regions in the bottom right-hand cell in bold. *** Denotes significance at the 10-percent level. ** Denotes significance at the 5-percent level. *** Denotes significance at the 1-percent level. Standard errors clustered by district are reported in parentheses.

Source: USDA, Economic Research Service estimates using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

tion than wheat-eating regions, a number of poor regions in the east of the country also primarily consume rice. Thus, overall calorie consumption and noncereal consumption were significantly lower in rice-eating regions both before and after the rise in prices.

Second, although overall calorie consumption did decrease more in rice-eating regions than in wheat-eating regions, the difference is not statistically significant at conventional significance levels. The lack of a robust decrease in calorie consumption is driven by households in both regions maintaining cereals consumption (see fig. 4). Lastly, despite maintaining overall calorie consumption, households in rice-eating regions decreased noncereal consumption more than households in wheat-eating regions. Such a change likely resulted in poorer nutritional outcomes (Wirt and Collins, 2009).

Accounting for Household Characteristics and the Baseline Empirical Strategy

It is important to make sure that the patterns identified above are robust to specifications accounting for differences in household and regional characteristics. To accomplish this, one may re-create these difference-in-difference estimates by estimating the following Ordinary Least Squares regression:

$$log(Calories_{irt}) = \gamma_r + \beta_1 RiceEating_{irt} + \beta_2 Post_{irt} + \beta_3 (Post_{irt} * RiceEating_{irt}) + \beta_4 ControlVars_{irt} + \varepsilon_{irt}$$

where *log*(*Calories)* refers to natural logarithm of daily per capita calories for household *i*, in region *r*, at time *t*; *RiceEating* denotes an indicator equaling one if the household resided in a region that primarily consumed rice; *Post* denotes an indicator equaling one if the observations come after the observed increases in rice and wheat prices; *ControlVars* denotes household control variables;[13] and ε denotes an error term that captures all factors that affect consumption that are not already included in the equation.

Based on this empirical specification, we can re-create estimates of the differences in consumption changes between rice- and wheat-eating regions displayed in table 2. Based on the time periods used in the estimation, estimates of β_3 represent the difference-in-difference estimate (i.e., the change in consumption in rice-eating regions less the change in consumption in wheat-eating regions).

Specifically, if only households from the 2004-05 and 2009-10 surveys are included, and the households from the 2009-10 survey are considered the "Post" survey (i.e., Post=1 if the household comes from the 2009-10 survey and Post=0 for households from the 2004-05 survey), then β_3 is an estimate of the difference in consumption growth between rice-eating and wheat-eating regions between 2004-05 and 2009-10. This estimation strategy is flexible and enables one to compare growth in consumption between rice-eating and wheat-eating regions over multiple time periods. The advantage of the above specification relative to table 2 is that the more complete specification with district fixed effects, time dummies, and household-level control variables helps absorb unobserved heterogeneity and can further provide evidence that these differences are not being driven by some other sort of household, time, or regional characteristic. In all comparisons discussed in the rest of the study, variants of the above specification are estimated.

Estimates of the baseline specification are presented in table 3. Columns (1) and (2) provide estimates of specifications using the natural logarithm of total calorie consumption as the dependent variable, and columns (3) and (4) show estimates from specifications using the natural logarithm of total noncereals consumption as the dependent variable. Similar to table 2, data in table 3 reveal that households in rice-eating regions had a similar decrease in overall calorie consumption to households in wheat-eating regions. In the most complete specification in column (2), which absorbs unobserved and time-invariant characteristics and a number of time-varying household characteristics, households in rice-eating regions decreased calorie consumption by 2.7 percentage points more than households in wheat-eating regions. However, the estimate is imprecisely estimated and is not statistically significant at conventional significance levels.

[13] Control variables include household size, the natural logarithm of nonfood expenditure, indicators for whether the household resides in a rural area and for whether the household is self-employed, two indicators for whether the household belongs to a Scheduled Caste or a Scheduled Tribe, and six indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist).

Table 3

Differences in growth of calorie consumption between rice- and wheat-eating regions in India

Item	log(daily per capita calorie consumption)		log(daily per capita calories from noncereal sources)			
	(1)	(2)	(3)	(4)	(5)	(6)
RiceEating* post	-0.031 (0.011)	-0.027 (0.020)	-0.161*** (0.035)	-0.178*** (0.033)	-0.161*** (0.036)	-0.229*** (0.044)
District fixed effects and control variables	N	Y	N	Y	Y	Y
Sample restricted to rural households	N	N	N	N	Y	N
Sample restricted to urban households	N	N	N	N	N	Y
Observations	102,086	102,086	102,086	102,086	65,061	37,025

Notes: This table estimates the difference-in-difference estimator for consumption between 2004-05 and 2009-10. Control variables include household size, the natural logarithm of nonfood expenditure, indicators for whether the household resides in a rural area and for whether the household is self-employed, two indicators for whether the household belongs to a Scheduled Caste or a Scheduled Tribe, and six indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist). Standard errors clustered by district are reported in parentheses. * Denotes significance at the 10-percent level. ** Denotes significance at the 5-percent level. *** Denotes significance at the 1-percent level.

Source: USDA, Economic Research Service estimates using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

Alternatively, columns (3) and (4) continue to find that households in rice-eating regions significantly decreased noncereal consumption more than households in wheat-eating regions. In the most complete specification in column (4), households in rice-eating regions decreased noncereal consumption by 17.8 percentage points more than households in wheat-eating regions. The coefficient estimate is statistically significant at the 1-percent level. Furthermore, the estimate continues to be statistically significant at the 1-percent level between columns (3) and (4), which further suggests that the difference is not likely being driven by omitted household or regional characteristics.[14] Lastly, columns (5) and (6) demonstrate that the results are similar when the sample is restricted to rural and urban households, respectively.

The relative decrease in noncereal consumption in rice-eating regions relative to wheat-eating regions suggests that nutrition declined in rice-eating regions.[15] To help examine this hypothesis more carefully, table 4 presents estimates of the baseline specification using the total consumption of a number of beneficial nutrients as the dependent variable. The results suggest that the decrease in nongrain consumption did affect household nutrition. In particular, columns (2)-(4) demonstrate that overall consumption of calcium, dietary fiber, and iron decreased in rice-eating regions relative to wheat-eating regions.[16]

[14] The time-varying control variables and district fixed effects are correlated with a number of other characteristics that are not directly observed in the data set. Thus, given that the point estimates of the difference-in-difference estimate change little between the specifications, the estimates suggest that the patterns are likely not being driven by these other directly and indirectly observable characteristics.

[15] See Wirt and Collins (2009) for an analysis of 25 separate measures of diet quality used in nutritional studies and their effects on health outcomes.

[16] Consumption of protein did not decrease more in rice-eating regions than in wheat-eating regions because households in rice-eating regions primarily decreased consumption of fruits and vegetables by more than households in wheat-eating regions.

Table 4
Differences in nutrition changes between rice- and wheat-eating regions in India

	Dependent variable:			
	log(per capita consumption of protein)	log(per capita consumption of fiber)	log(per capita consumption of calcium)	log(per capita consumption of iron)
	(1)	(2)	(3)	(4)
RiceEating 5%* post	0.008	-0.294***	-0.204***	-0.177***
	(0.027)	(0.043)	(0.046)	(0.033)
Observations	102,086	102,086	102,086	102,086

Notes: This table estimates the difference-in-difference estimator for consumption of nutrients between 2004-05 and 2009-10. Control variables include household size, the natural logarithm of nonfood expenditure, indicators for whether the household resides in a rural area and for whether the household is self-employed, two indicators for whether the household belongs to a Scheduled Caste or a Scheduled Tribe, and six indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist). Standard errors clustered by district are reported in parentheses. *Denotes significance at the 10-percent level. ** Denotes significance at the 5-percent level. *** Denotes significance at the 1-percent level.

Source: USDA, Economic Research Service estimates using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

To help validate the finding from the baseline specification, table 5 presents estimates from a number of robustness checks to verify that the observed patterns are being driven by the differential spike in cereals prices. First, columns (1) and (2) provide estimates from specifications that vary the definition of rice- and wheat-eating regions to demonstrate that the results are not driven by how the regions have been defined. Specifically, the columns define rice- and wheat-eating regions using cutoffs of consumption of the nondominant grain of 1 percent and 10 percent of overall pre-crisis consumption. In all specifications using alternate definitions of rice- and wheat-eating regions, the results are qualitatively identical. Regions that are primarily composed of rice-eating households reduced noncereal consumption by significantly more than regions primarily composed of wheat-eating households. The estimates of the extra decrease in noncereal consumption in rice-consuming regions range from 17.8 to 28.4 percentage points.

Additionally, column (3) of table 5 presents estimates of household responses to the differential spike in food prices, using average total rice consumption prior to the period of increasing rice and wheat prices from the entire country. In particular, the following specifications are estimated:

$$log(Calories_{irt}) = r_r + \beta_1 ShareRice_{irt} + \beta_2 Post_{irt} + \beta_3 (Post_{irt} * ShareRice_{irt}) + \beta_1\ ControlVars_{irt} + \varepsilon_{irt}$$

where *ShareRice* is the share of rice in overall household calories, and all other variables are identical to the baseline specification. In this specification, if a higher share of rice in the diet (and conversely, a lower share of wheat) leads to greater exposure to a hike in cereal prices, one would expect β_3 to be negative. When using the share of rice consumed by all households across India prior to the price crisis, an increase in the share of rice in the diet by 10 percent led to an extra decrease in noncereal consumption of 2.26 percentage points.

Additionally, a small number of regions in India consume neither rice nor wheat as their staple good but rather consume coarse grains. The price increase in rice was significantly higher than the increase for these other types of cereals as well (e.g., Viatte et al., 2009). Thus, column (4) of table 5 presents estimates of a specification that includes these other types of households by comparing rice-eating regions to non-rice-eating regions where pre-crisis consumption of non-rice cereals was less

Table 5
Robustness checks of baseline specification

	Dependent variable: log(daily per capita calories from noncereal sources)						
	Alternate cutoff for definition of regions			Compares rice-eating regions to regions that consume any other staple grain	Excludes households from states that implemented PDS reforms	Excludes households employed in industries most affected by global financial crisis	Excludes households involved in agricultural production
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RiceEating 1%* post	-0.284*** (0.064)	-	-	-	-	-	-
RiceEating 10%* post	-	-0.191*** (0.026)	-	-	-	-	-
ShareRice* post	-	-	-0.226*** (0.050)	-	-	-	-
RiceEating 5%* post	-	-	-	-0.166*** (0.027)	-0.169*** (0.035)	-0.210*** (0.044)	-0.176*** (0.032)
Observations	27,256	148,854	224,350	99,422	92,315	79,814	63,843

Notes: This table estimates the difference-in-difference estimator for consumption between 2004-05 and 2009-10. Control variables include household size, the natural logarithm of nonfood expenditure, indicators for whether the household resides in a rural area and for whether the household is self-employed, two indicators for whether the household belongs to a Scheduled Caste or a Scheduled Tribe, and six indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist). Standard errors clustered by district are reported in parentheses. * Denotes significance at the 10-percent level. ** Denotes significance at the 5-percent level. *** Denotes significance at the 1-percent level. PDS = Public Distribution System

Source: USDA, Economic Research Service estimates using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

than 5 percent of consumption. The estimate is qualitatively identical to the baseline estimate and demonstrates that there was a decrease of noncereal consumption in rice-eating regions that was 16.6 percentage points larger than the decrease in non-rice-eating regions.

Furthermore, a number of significant national policy changes and shocks affected Indian households between 2004 and 2009. Although the comparison of consumption changes between rice-eating households and wheat-eating households should capture the effects of national and sectorwide developments, it is possible that each event might have affected rice- and wheat-eating regions differently. However, estimates presented in columns (5)-(6) of table 5 suggest that two important events—the implementation of PDS reforms in some States and the global financial crisis in 2008—do not appear to be driving the baseline results. Column (5) shows the effect of restricting the sample to households residing in States that did not implement major PDS reforms during the time period,[17]

[17] States were identified as having made major PDS reforms according to Khera (2011). The states that implemented PDS reforms were Chhattisgarh, Madhya Pradesh, Orissa, and Uttar Pradesh.

and column (6) shows the results when the sample is restricted to households employed in industries that were least affected by the global financial crisis.[18, 19]

Also, it is possible that overlap between production and consumption of particular types of cereals might be causing agricultural income to diverge between the two types of regions. Thus, it could be the case that these changes in consumption are being driven by differential trends in agricultural income, as opposed to the higher food prices. Alternatively, 2009/10 was a drought year, and although that should affect agricultural production in both rice-eating and wheat-eating regions, it might have affected the two types of regions differently. Column (7) of table 5 presents the baseline estimate when the sample is restricted to households that are not primarily employed in agricultural cultivation. The results are nearly identical to the baseline estimate in column (4) of table 3, suggesting that neither differential trends in agricultural nor impacts from the 2009/10 drought are likely to have influenced the differences in household food consumption in rice- and wheat-eating regions.

Table 6 presents estimates of additional robustness checks that demonstrate that the results are not likely driven by baseline differences between rice-eating and wheat-eating regions. In particular, the estimates in column (1) demonstrate that the results are identical when excluding households from the relatively wealthy States of Andhra Pradesh, Kerala, and Tamil Nadu, all of which contain a number of rice-eating regions. The results in columns (2)-(5) of table 5 demonstrate that neither overall consumption nor consumption of noncereals was trending differently in the years preceding the rise in domestic cereal prices, and that the differential trends in diet choice between rice-eating and wheat-eating regions only appeared after the differential spike in cereal prices between 2004-05 and 2009-10.

[18] Households most affected by the global financial crisis were those that worked in primarily exporting industries (Bajpai, 2011). Over the year immediately prior to the global financial crisis between 2007 and 2008, the top five exporting sectors in India were petroleum products, manufacturing of machinery, gems and jewelry, pharmaceuticals, and cotton (Ministry of Commerce, 2009). Thus, households where the head of the household was employed in any of these industrial codes were excluded from the baseline specification.

[19] Although the social safety net in India was significantly expanded by the implementation of a national employment program (MNREGA) during this time period, the NSSO consumer expenditure surveys do not capture participation in the program. Thus, it is not possible to exclude households that received benefits from MNREGA. However, in analyzing the effects the world food price crisis had on education in India using the National Sample Survey Organization employment surveys, which do capture MNREGA participation, Tandon (2014) demonstrates that all results are identical when excluding households that receive benefits through MNREGA.

Table 6

Further robustness checks of baseline specification

Item	log(daily per capita calories from noncereal sources)			log(daily per capita calorie consumption)	
	(1)	(2)	(3)	(4)	(5)
RiceEating*post$_t$	-0.209*** (0.040)	-	-0.117*** (0.040)	-	-0.006 (0.031)
RiceEating*post$_{t-1}$	-	0.024 (0.029)	0.013 (0.030)	0.031 (0.029)	0.037 (0.026)
Exclude households from the relatively wealthy States of Andhra Pradesh, Kerala, and Tamil Nadu	Y	N	N	N	N
Observations	81,681	106,641	152,518	106,641	152,518

Notes: This table estimates a number of robustness checks of the baseline specification. Column (1) re-estimates the baseline specification but excludes households from the relatively wealthy States of Andhra Pradesh, Kerala, and Tamil Nadu; and columns (2)-(5) estimate differential trends in consumption prior to the food price crisis. All specifications include district fixed effects and time-varying control variables. Control variables include household size, the natural logarithm of nonfood expenditure, indicators for whether the household resides in a rural area and for whether the household is self-employed, two indicators for whether the household belongs to a Scheduled Caste or a Scheduled Tribe, and six indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist). Standard errors clustered by district are reported in parentheses. * Denotes significance at the 10-percent level. ** Denotes significance at the 5-percent level. *** Denotes significance at the 1-percent level.

Source: USDA, Economic Research Service estimates using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

Nonfood Coping Strategies

In addition to analyzing food-based coping strategies in response to the food price crisis, this study investigates possible nonfood coping strategies, including household adjustments to expenditures in categories such as health, clothing, and durable goods. The baseline specification is re-estimated using the natural logarithm of expenditure on health,[20] and expenditure on clothing[21] and durable goods[22] as the dependent variable. Table 7 presents the estimates.[23]

Findings reveal that in addition to sacrificing dietary diversity in response to rising rice and wheat prices, households also reduced health expenditures and expenditures on clothing and durable goods. Column (1) in table 7 shows that households in rice-eating regions reduced expenditures on clothing and durable goods by 23.7 percent more than households in wheat-eating regions; column (2) demonstrates that households in regions with higher average pre-crisis consumption of rice had larger drops in expenditures on clothing and durable goods than other households across India. Alternatively, column (3) shows that households reduced expenditures on health by 24.4 percent more than households in wheat-eating regions; column (4) demonstrates that households in regions

Table 7
Nonfood coping strategies in response to rising food prices

Item	log(monthly household expenditure on clothing and durable goods)		log(monthly household expenditure on medical care)	
	(1)	(2)	(3)	(4)
RiceEating*post$_t$	-0.237*** (0.118)	-	-0.244** (0.123)	-
ShareRice* post	-	-0.094* (0.052)	-	-0.266** (0.130)
Observations	102,086	224,350	102,086	224,350

Notes: This table re-estimates the baseline specification but uses different forms of expenditure. Columns (1) and (2) analyze the natural logarithm of expenditure on clothing and durable goods; and columns (3) and (4) analyze the natural logarithm of expenditure on medical care. All specifications include district fixed effects and time-varying control variables. Control variables include household size, the natural logarithm of nonfood expenditure, indicators for whether the household resides in a rural area and for whether the household is self-employed, two indicators for whether the household belongs to a Scheduled Caste or a Scheduled Tribe, and six indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist). Standard errors clustered by district are reported in parentheses. * Denotes significance at the 10-percent level; ** Denotes significance at the 5-percent level; *** Denotes significance at the 1-percent level.

Source: USDA, Economic Research Service estimates using 55th, 61st, and 66th rounds of the consumer expenditure surveys conducted by India's National Sample Survey Organization.

[20] Health expenditures include expenditures on medicine, x-rays and other medical tests, doctor fees, hospital and nursing home charges, medicine, and family planning. Additionally, the survey also includes a category for "other medical expenses."

[21] Clothing expenditures include expenditures on all clothing articles, bed sheets, rugs and blankets, pillows and other bedding material, cloth for upholstery, and footwear.

[22] Durable goods include beds, dressing tables, chairs, suitcases, rubber cushions, carpets, paintings, other furniture, radios, televisions, cameras, other goods for recreation, jewelry, crockery and utensils, cooking and household appliances, cars, bicycles, computers, and phones.

[23] The specifications are identical except for the exclusion of the natural logarithm of nonfood expenditure from the list of control variables. This is necessary given that the dependent variable is a subset of that total spending.

with higher average pre-crisis consumption of rice had larger drops in expenditures on medical care than other households across India.[24]

Importantly, these findings show that food insecurity potentially has a direct effect on health and health spending, as opposed to an indirect effect through poorer performance of malnourished individuals at work or at school (e.g., Glewwe and Miguel, 2008). Additionally, the reduced expenditure on clothing and durable goods has potential effects on household labor. As households with deteriorating food security are delaying the purchase of new clothing and durable goods, the amount of domestic work potentially increases in the form of mending clothes and repairing existing durable goods. Also, labor-intensity of household tasks has the potential to increase without the aid of labor-saving durable goods (e.g., washing machines, sewing machines).

[24] Although the point estimates are large, the standard errors are also large, and one cannot reject the hypothesis that the estimate is lower in magnitude.

Conclusion

This study analyzes how Indian households responded to an increase in staple food prices that occurred due to developments in both the global and domestic market during the late 2000s. Observations of different price increases for rice and wheat allow for comparison of coping strategies of rice-eating regions and wheat-eating regions. Findings document the nature of household adjustments to food consumption when there is a relative increase in the price of food staples. Higher relative staple food prices affect nutritional status by reducing diet diversity and consumption of nonstaples. This pattern is consistent with how households in other countries responded to rising prices during the 2008 global food price crisis and generalizes these results to a country not engaged in conflict and one in which there have been large increases in the price of staple goods.

Further, the study finds that households more severely affected by the food price crisis also reduced health expenditures, which demonstrates a link between food security and health issues aside from malnourishment. Additionally, households reduced expenditures on durable goods and clothing, which likely increased the amount of domestic work to be done in the form of repair and mending and also increased the potential for domestic work to be more labor intensive without the aid of working durable goods. Consistent with the global food price crisis having significant effects on household labor decisions, a related article demonstrates that children in regions worse affected by the crisis were less likely to attend school and more likely to primarily be engaged in domestic labor relative to children from regions less affected by the crisis (Tandon, 2014).

The study's findings further underscore the high priority often given to policy measures aimed at maintaining price stability for food staples in developing countries. In the case of India, the findings put in perspective its substantial past and ongoing investments in food grain procurement, public distribution, and storage systems to ensure consumer access to food staples, as well as planned investments under the recently enacted National Food Security Act. The results further demonstrate that despite India's substantial food security investments and trade restrictions on cereals, cereal prices still increased substantially between 2006 and 2010. This suggests that effective policies to strengthen household food access and security may also need to address availability and access to important nonstaple foods.

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Appendix—Estimating Calories Contained in Meals Consumed Outside the Home

Estimates of the amount of calories consumed in each meal outside the home are obtained by estimating the following specification:

$$Calories_{irt} = \tau_r + \beta MealsReceived_{irt} + \gamma ControlVars_{irt} + \varepsilon_{irt}$$

$Calories_{ir}$ denotes the total amount of processed and nonprocessed calories consumed over the past 30 days by household *i*, in district *r,* at time *t;* τ_r denotes a district fixed effect to help absorb unobserved characteristics shared by all households within a district; *MealsReceived* denotes the total number of meals eaten by household members outside the home over the past 30 days; and *ControlVars* denotes control variables, which include time dummies and a number of household characteristics that help absorb unobserved variation in calories purchased.[25, 26] Estimates of β will describe the decrease in calories purchased for every meal consumed outside the home and, under very restrictive assumptions, provide an estimate of how many calories are consumed in such meals on average.

The results of the above specification are reported in the appendix table. The estimate suggests that households consume 475 fewer calories for each additional meal consumed outside the home. Thus, estimates of calorie consumption add 475 calories to household consumption for every meal consumed outside the home.

Appendix table
Calories purchased per meal consumed

Item	Total household calories consumed (3)
Meals received	-475.0*** (22.6)
Observations	343,843

Notes: *** Denotes significance at the 1-percent level. Standard errors clustered by district are reported in parentheses. All specifications include district fixed effects, time dummies, and control variables. Control variables include the natural logarithm of monthly per capita expenditure as calculated by the NSSO, household size, and indicators for whether the household resides in a rural area, for whether the household purchased any type of commodity from the Public Distribution System, for whether the household had a below-poverty-line card in the 2004/05 round, for whether the household is self-employed, two indicators for whether the household belongs to a "Scheduled Caste or a Scheduled Tribe," and six indicators for household religion (for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist).

Source: USDA, Economic Research Service.

[25] Control variables include the natural logarithm of monthly per capita expenditure, and indicators for whether a household resides in a rural area, for whether a household is self-employed, for whether a household has consumed any PDS commodity over the past 30 days, for whether the household has a below-poverty-line ration card in the 2004/05 round, six separate indicators for household religion (Hindu, Muslim, Christian, Sikh, Jain, and Buddhist), and two separate indicators for whether a household belongs to a "scheduled caste" or a "scheduled tribe."

[26] This approach differs from the methodology reported by NSSO (2007), which provides the number of calories used to estimate both the number of calories contained in meals eaten outside of the home, meals given to nonhousehold members, and calories contained in processed foods. However, NSSO (2007) does not provide an explanation of the source of these values. Furthermore, its methodology differs in that it assumes that processed foods purchased by high-income households cost the same as processed foods purchased by low-income households.