How much do Experiential Measures of Food Security Tell us About Nutrition?

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ABSTRACT

World grains prices dramatically increased between 2007 and 2008, and previous research demonstrated that the corresponding price spike in India caused nutrition to worsen. However, experiential measures of food security collected by the Gallup World Poll and the government of India were unable to detect a significant decline in food security. Alternatively, households reported more negative feelings such as stress, and fewer positive experiences such as enjoyment. Thus, households were able to express negative feelings about food insecurity, but standard experiential measures of food security were too noisy to uncover the decline in nutrition.

Keywords: Nutrition; World Food Price Crisis; India

JEL classification: D12, I25, J24 O12, O53

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This article assesses the extent to which rising food prices during the world food price crisis affected experiential measures of food security and well-being in India collected by the Gallup World Poll. Rising food prices have been a pressing concern in both India, and the rest of the developing world, since food prices began to steadily increase in the late 1990’s (e.g., FAO 2013a; IMF 2014). In addition to the overall rise in food prices, there have been periods of volatility in agricultural markets. The most extreme example is the world food price crisis, during which grains prices dramatically increased between 2007 and 2008 (e.g., Viatte et al. 2009). However, grains prices again spiked following the world food price crisis, suggesting that households in developing countries must cope both with steadily rising food prices and volatility in grains prices (e.g., Trostle et al. 2011).

Despite the increasing volatility in world agricultural markets, India intervenes in grains markets in a number of ways to try to stabilize prices. Specifically, the government purchases a large amount of rice and wheat directly from farmers at the Minimum Support Price (MSP) to supply subsidized rations for poor households through the country’s large food assistance program, occasionally sells some of its stockpiles of rice and wheat on the open market to regulate market prices, and restricts imports and exports of rice and wheat to try to limit the effect world prices have on the domestic markets (Jha, Srinivasan, and Landes 2007). Despite this intervention in grains markets, the price of grains significantly increased during the latter half of the 2000’s in India, and the price of rice especially increased following the world food price crisis (e.g., Childs and Kiawu 2009). The spike in grains prices significantly impacted household behavior, where Tandon (2014) demonstrates that the spike in grains prices adversely affected household nutrition and a wide range of other household choices.

Given the significant impact the spike in grains prices had on food security and household behavior in India, this article gauges how well changes in standard experiential measures of food security status might capture the changes in overall household nutrition during this period. In particular, this article utilizes experien-
tial measures collected by the Gallup World Poll, which are based on the number of times the respondent had difficulty purchasing food in the past year.

Researchers are increasingly using experiential measures of food security to perform quantitative assessments of food security in both developed and developing countries (e.g., National Sample Survey Organization 2007; Deaton and Dreze 2009; Coleman-Jensen, Nord, and Singh 2013, etc.). Despite the increasing use of experiential measures, it is difficult to ascertain how experiential measures relate to actual household behavior and nutrition. Many experiential measures ask questions that use particular reference points, such as peoples’ expectations or standards regarding nutritional content of food (e.g., Coleman-Jensen, Nord, and Singh 2013). The Gallup survey used in this article inquires whether respondents had difficulty purchasing food that the family ”needed,” where respondents might interpret the questions differently based upon their frame of reference and add a significant amount of noise to the measure. Such ambiguity might have a significant impact on the prevalence of food insecurity estimated from experiential measures, where reference dependence has been shown to significantly influence household responses in slightly different contexts (e.g., Kahneman and Tversky 1979; Levin et al. 1998).

Related to this article, Headey (2013) estimated how the world food price crisis affected the experiential food security status of households, and demonstrated that in a number of countries, including India, the Gallup measure of food security actually improved between 2005 and 2008. However, it is difficult to simply compare experiential measures of well-being before and during the crisis, as there were a number of factors affecting well-being in India during the latter half of the 2000’s. The country was experiencing a sustained period of high economic growth (e.g., Kapur and Mohan 2014), the global financial crisis significantly affected employment across the country (e.g., Bajpai 2011), there was a significant expansion in the social safety net through a national employment program (MNREGA) which further affected labor markets (e.g., Azam 2012), and there were significant
state-level initiatives to improve food aid through the Public Distribution System (PDS) in a number of states (e.g., Khera 2011).

Thus, rather than simply comparing the change in the experiential measures of household well-being prior to the increase in grains prices to later periods, it is necessary to create a believable counterfactual as to what the change in well-being would be in households that were less affected by the price shock. This article implements an empirical strategy similar to Tandon (2014), and utilizes the much higher spike in rice prices than other grains prices. In particular, this article compares households from states that primarily consume rice as the staple food to households from states that consume other grains as the staple food. All states are exposed to the higher growth and a number of other factors that independently affect measures of well-being, but households in rice-eating states were worse affected by the rise in grains prices.

Similar to Headey (2013), this article demonstrates that there was not an overall decline in the Gallup experiential food security status as the price of grains surged. However, when accounting for national trends in development and policy changes, this article demonstrates that the Gallup experiential food security status of households worse affected by the rising grains prices had a slightly larger decrease in food security relative to households that were less affected. However, the estimated standard error of the estimate is large relative to the estimate, and one cannot reject the hypothesis that households more exposed to the price increases had an identical change in experienced food insecurity to less-exposed households. This pattern is consistent with the experiential measure of food security being a noisier measure of food security than other measures of observed household behavior given differences in how respondents interpret and answer questions about their experience with food insecurity.

The lack of a robust response of experiential food security status to the rising grains prices might be an artifact of the Gallup World Poll as opposed to difficulties in standard measures of experiential food security status uncovering changes in
nutrition. Thus, this article also estimates specifications using a nearly identical measure of experiential food security status collected by the government of India in a much larger consumption survey performed every five years. The response of the experiential measure in this survey is similar to the response of the Gallup measure, where we cannot rule out the hypothesis that food security did not change in response to the rising grains prices.

Importantly, the survey conducted by the Government of India includes a wide variety of household-level characteristics that are not reported in the Gallup World Poll. These data can help to absorb unobserved variation in food security status, and help to account for a number of policy changes and economic shocks that might affect rice and non-rice eating regions differently, which might be obfuscating the true relationship between experiential food security status and the spike in grains prices. However, in all specifications using the survey conducted by the government of India that account for many of these other factors, one still cannot reject the hypothesis of no relationship between experiential food security status and the spike in grains prices.

Alternatively, utilizing other measures of well-being collected by the Gallup World Poll, households worse affected by the spike in grains prices did report being adversely affected. Households residing in states where pre-crisis rice consumption was higher reported significantly higher increases in negative feelings such as stress, and significantly higher decreases in positive experiences such as enjoyment. These results suggest that other experiential measures without explicit reference points are consistent with the negative impacts of the crisis on household behavior (Tandon 2014), and can rule out the possibility of no relationship between household well-being and the spike in grains prices. Thus, these results suggest that self-reporting of food security status is possible, but that the standard questions utilized by the Gallup World Poll and the NSSO might not be precise enough to precisely track changes in nutrition over time and in response to policy changes and economic shocks.
There are three primary contributions of this article. First, this article demonstrates that standard experiential measures of food security status give a very limited snapshot of how households cope with food insecurity. It is likely that questions that involve reference points, such as asking if households were able to purchase all the food that the family "needed," are interpreted differently by respondents and do not give as accurate an estimate as other measures based on observable household behavior. Experiential measures might give a more precise estimate of food insecurity if they were based off of questions that were free of reference points, and rather were based on questions that ask about behaviors that are less likely to be interpreted differently by respondents. Additionally, experiential measures might also give a more complete description of food insecurity if they were designed to focus on more aspects of food insecurity than whether households had difficulty in purchasing food in the past year.

Second, contrary to the slightly improving food security situation found in Headey (2013), this article demonstrates that experiential measures of well-being other than food security did decline in India in response to the spike in grains prices when accounting for national trends and policy changes. And lastly, this article demonstrates that there are significant differences between two different experiential measures of food security, even when using a nearly identical question to elicit food security status. Thus, the simple question used in the Gallup World Poll and the survey conducted by the government of India might be inadequate to accurately assess the total number of food-insecure households.

The World Food Price Crisis and its Effect on India

Food prices across the world dramatically rose between 2006 and 2008. However, the rise in food prices was not uniform. Grains prices especially surged, and the average increase in rice prices was nearly twice as large as the prices of other grains (e.g., Viatte et al. 2009). The causes of the price shock are complex and unclear, but droughts, rising oil and fertilizer prices, the expansion of biofuels, and
increasing demands of a rising global population have all been offered as potential explanations (e.g., Trostle 2008; Viatte et al. 2009). Whatever the causes, the effects have been dramatic, where as many as 44 million people were driven into food insecurity (Mitchell 2008).²

In assessing the impact of the world food price crisis in India, this article exploits the dramatic jump in grains prices. Although the scale and immediacy of the crisis was muted in India due to government intervention (Childs and Kiawu 2009), the combination of rising global prices and domestic policy factors led to an increase in food staple prices beginning in the mid-2000s. Overall food prices increased, but the prices of grains especially surged (Childs and Kiawu 2008).

Figure 1 here

Figure 1 presents average prices of rice and wheat, which is the primary alternative to rice as the staple grain.³ Specifically, Figure 1 presents the price of rice in Thailand and wheat in the U.S., which are good proxies for world prices (e.g., Westcott and Trostle 2014), as well as the average prices of each commodity in India during the time of the world food price crisis. Three important patterns emerge from these average prices. First, similar to global patterns, the price of rice in India increased far more than the price of other grains between 2008 and 2010. Second, also similar to global patterns, wheat prices started to spike in 2006 before decreasing. And lastly, rice prices started to surge in the beginning of 2008 and continued to surge past 2010. This last pattern is different from world rice prices, which fell dramatically in the second half of 2008 before settling at a significantly higher average price than before the crisis.

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

²A number of other articles projected the effects of the price spikes on nutrition based on simulations, and find that food security worsened over the time period (e.g., Ivanic and Martin 2008; Ul Haq et al. 2008; Wooden et al. 2008; Simler 2010; and Robles and Terero 2011).

³Some other households consume coarse grains as the staple grain, but similar to the price patterns showed in Figure 1, the price of rice surged much more than the price of coarse grains.
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), distribution of subsidized grains 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 (Srinivasan, Jha, and Landes 2007).

However, as demonstrated in Figure 1, domestic rice and wheat prices began to rise dramatically in the mid-2000’s -along with a smaller increase in prices of other food groups. One factor behind the relatively large rise in rice prices compared to wheat appears to be larger relative increases in the MSP for rice (Tandon 2014). According to the guidelines used by the Commission on 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 as opposed to wheat prices, the CACP reports document significant recent increases in production costs. In particular, labor costs have increased dramatically, which are more likely to adversely affect rice markets than wheat given the higher labor intensity in rice production (Westcott and Trostle 2014).

Additionally, there was likely more room for transmission of the spike in world grains prices to rice markets than other grains. International trade was highly regulated during this time period for both rice and non-rice grains. Wheat exports (the primary non-rice grain) were effectively banned between 2006 and 2011, whereas exports of basmati rice and some amounts of common varieties were still allowed to Bangladesh and Sub-Saharan Africa (Childs and Kiawu 2009). Given the positive exports of rice and the larger spread between international and domestic rice prices than for wheat, there was more potential for international rice prices to be transmitted to the domestic market than was the case for other grains
The spike in grains prices significantly affected household diet and behavior in India. In a traditional model of consumption of normal goods, an increase in the price of staple grains would cause households to substitute towards goods made relatively less expensive, such as more nutritious foods and all other goods. Thus, in such a model, we might expect to observe a significant decline in calories given the substitution away from calorie-rich foods to those with far less caloric content.

However, this is not the only possibility. Adapting the traditional model to include a penalty on individuals who choose to consume less of the staple food than their minimum daily energy requirement could reverse the traditional prediction of a decrease in calorie consumption (Jensen and Miller 2008b, Tandon 2014). Given the penalty of consuming below subsistence, households cannot substitute away from grains after a large increase in the price of grains, and must cut consumption of other types of goods. Such a model can help to explain how, in response to the dramatic spike in the price of staple grains, households might sacrifice more nutritious types of calories than grains that have much lower caloric content, and overall calorie consumption would decrease by much less than predicted in the traditional model.

Based on the predictions of this adaptation to the traditional model of consumption, Tandon (2014) analyzes both food and non-food coping strategies in response to the spike in grains prices by comparing household choices in regions where the primary staple good is rice to regions where the primary staple food are other types of grains. In particular, households worse affected by the spike in grains prices are shown to significantly sacrifice nutrition, as well as consumption of a number of other types of goods. However, there was not a significant decline in overall calorie consumption. Additionally, the article finds that the share of children attending school increased less and the share of children primarily performing domestic work decreased less in regions worse affected by the spike in grains prices.
This article utilizes data from the Gallup World Poll and data from the Consumer Expenditure surveys conducted by the National Sample Survey Organization (NSSO) in India, which is part of the government of India. The Gallup World Poll interviews households in approximately 150 countries and collects detailed information about a household’s experiences over the past year. In India, Gallup surveyed between 2000 and 6000 houses each year between 2006 and 2010, from which nationally representative estimates of well-being can be estimated. This article focuses on the surveys performed between 2008 and 2010 given that surveys in prior years did not collect information on the state in which the respondent resided. However, as demonstrated in Figure 1, the price of rice significantly surged during this time period, while the prices of other grains only slightly increased.

Interviews were conducted face-to-face, and the majority of questions were either ”yes or no” responses so as to minimize cultural differences and allow cross-cultural comparisons. The survey measures key indicators of household well-being and opinions on the political and economic climate of the country. These measures include questions on law and order, food and shelter, job creation, migration, financial life, personal health, civic engagement, and other measures of well-being. This article focuses on the food, negative experience, and positive experience indices.

The food index asks if there have been times in the past twelve months when the household did not have enough money to buy food that the family needed. And if there has been a time when the family was not able to purchase food, there are five different responses based on the frequency of the deprivation. The indexes of positive and negative experiences are based on questions about whether the respondent felt particular emotions on the day before the survey. The negative experience index focusses on feelings of stress, whereas the positive experience index focuses on feelings of enjoyment.

Each index score is the share of the number of positive or affirmative responses
multiplied by 100. For example, the Food Index is divided into six questions. Thus, the index will take on a value of 0, 16.7, 33.3, 50, 66.7, or 100 for each household. For this particular question, a higher index score corresponds to a higher level of food security and a lower number of instances in which the household was unable to purchase food in the previous twelve months.

In addition to the Gallup World Poll, this article also analyzes the experiential measure of food security collected in the consumer expenditure surveys conducted by the NSSO. Each survey is a repeated cross-section and samples the entire country. The survey is stratified by whether a household resides in a rural or urban area, and is further stratified by relative household affluence. This article utilizes the “thick” rounds conducted in 2004/2005 (61’st Round) and 2009/2010 (66’th Round).4

The primary variable of interest from these surveys is the experiential measure of food security. The household head is asked if there was ever a time in the past year that the household was not able to afford food, and then was asked the month in which the deprivation occurred. Additionally, this article replicates a result from Tandon (2014) to verify that nutrition declined more in states that had higher pre-crisis consumption of rice. Tandon (2014) demonstrates this result at the district-level, while this article shows that the result is identical when utilizing the baseline empirical strategy utilized in this article that identifies pre-crisis rice consumption at the state level.

Data on diet choice are obtained from the consumer expenditure surveys. Each consumer expenditure survey provides data on quantities and values of food items consumed over the past thirty days. From this data, household calorie consumption from each source is estimated by utilizing nutritional information provided by Gopalan, Rama Sastri, and Balasubramanian (1989). All food items consumed at home are combined into the following groups: grains, pulses, sources of animal-based protein (dairy and meat), and produce (fruits and vegetables).

4The rounds are referred to as “thick” due to the higher number of households surveyed than those in the annual “thin” surveys.
The primary measures of nutrition that are used in the replication are non-grains consumption, overall calorie consumption, and total consumption of protein, calcium, fiber, and iron. Based on recommended dietary allowances in India, households on average have greater deficiencies in non-grains consumption than in grains consumption (National Institute of Nutrition 2010). A higher level of non-grains consumption would imply higher scores on most diet quality indices, which are associated with better health outcomes.5

The primary focus of this article is to analyze how experiential food security changed in response to the spike in grains prices by allowing the changes in responses to vary based on average pre-crisis consumption of rice. All measures of pre-crisis rice consumption are obtained by the NSSO survey conducted in 2004/2005, the last "thick" survey conducted prior to the base period in the analysis (2008). However, specifications are also estimated that allow the response to the spike in grains prices to vary by the share of total consumption that is composed of non-rice grains as well, which is a measure of how much better a household might have been sheltered from the dramatic rise in the price of staple grains.

Figure 2 presents a map of India which describes the share of pre-crisis consumption that is composed of rice. The states that consume the most rice are primarily located in the south and the east of the country. Although some of the rice-eating states in the south of the country are relatively wealthy (e.g., Andhra Pradesh, Kerala, and Tamil Nadu), a number of rice-eating states in the east of the country are less well-off (e.g., Assam, Orissa, etc). On the other hand, the states with the least amount of rice consumption are located in the northwest of the country, where the majority of households consume wheat as the staple grain.

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5See Wirt and Collins (2009) for an overview of studies analyzing the relationship between diet quality and health outcomes, and for definitions of 25 separate measures of diet quality used in the literature.
Figure 3 here

Most important to the analysis, households in rice-eating states did not substitute towards non-rice consumption as the price of rice rose significantly more than the price of wheat between 2008 and 2010. If this did occur, it would be difficult to argue that households in rice-eating states were more hurt by the increases in food prices, and it would be difficult to estimate the magnitude of the response households had in response to the spike in grains prices. Defining rice-eating states as those where pre-crisis consumption of rice represented more than forty percent of overall consumption, Figure 3 demonstrates that there was very little change in the consumption of the non-dominant grain in either rice-eating or non-rice eating states.

Table 1 here

Table 1 presents the definition of each Gallup index and summary statistics by survey. A number of interesting patterns emerge from these summary statistics. First, the Food Index demonstrates that households not only experienced times where it is difficult to purchase food, but experienced the event repeatedly. The table also presents summary statistics for a variable that transforms the Gallup Food Index into an indicator equal to one if the respondent had enough money to purchase food all days of the previous year (Food Affordable). Based on this variable, over twenty percent of households reported not having enough money to buy food that the family needed in the past year in each of the Gallup surveys. This is in direct contradiction to the less than 2 percent of surveyed households that reported not having enough food to eat in the NSSO survey in 2004/2005, and the less than 1 percent of households in the NSSO survey in 2009/2010.\(^6\)

This difference between the NSSO and Gallup measures is even more striking given that the two measures are based off of nearly identical questions. The

\(^6\)The summary statistics for the NSSO food security variable is separated by rural and urban areas because the survey’s stratification allows only for the construction of population estimates for the rural and urban sectors separately. Alternatively, the Gallup data does not report whether households reside in urban or rural areas.
only difference between the two questions is that the Gallup measure asks if the households had trouble purchasing food that was "needed," whereas the NSSO survey asked if households had trouble purchasing food. The addition of the reference point using the word "needed" seems to cause households to interpret the question significantly different in the two surveys.

Additionally, there is very little change in the Food Index during the time of rapidly rising rice prices between 2008 and 2010, and the NSSO measure of experiential food security actually improved. This is similar to the analysis presented in Headey (2013), which analyzes the change in the Food Index between 2005 and 2008. However, this simple difference is difficult to interpret given the rapid income growth during this period, the onset of the global financial crisis, and a number of significant national policy changes. Additionally, there is very little change in the other two Gallup indexes.

However, as discussed in the introduction, one cannot identify the effect of the world food price crisis on food security by analyzing the simple differences in experiential food security given all the other shocks and policy changes during this time period. For example, the high income growth during the time period, or the implementation of the national employment guarantee (MNREGA), could potentially cause experiential measures of food security to improve across the entire country. Thus, this article accounts for these other factors by utilizing the differential spike in grains prices during the world food price crisis and compares the household response of those that consume primarily rice to those that primarily consume other grains.

Table 2 here

Defining regions as rice-eating based on pre-crisis consumption of rice representing at least forty percent of total consumption, table 2 presents the basic identification strategy in a difference-in-difference table. The table analyzes changes in experiential food security status and the other Gallup Indexes in response to
the rising grains prices. Columns (1) and (2) demonstrate that there is little evidence that the experiential measures of food security responded to the differential spike in grains prices. Specifically, column (1) demonstrates that both rice and wheat-eating regions had small declines in the Gallup Food Index, but one cannot reject the hypothesis that there is no difference in the response between the two types of regions; and column (2) similarly demonstrates that one cannot reject the hypothesis that the change in the NSSO experiential measure is identical in rice and non-rice eating regions. However, the point estimate for the NSSO measure presented in column (2) has a different sign than the Gallup estimate presented in column (1).

Alternatively, when analyzing other Gallup Indexes of positive and negative feelings, the pattern completely changes. Column (3) demonstrates that respondents in rice-eating states had significantly fewer positive experiences the day before the survey; and column (4) demonstrates that respondents in rice-eating states had significantly more negative experiences. The point estimates presented in columns (3) and (4) are larger than the point estimates in columns (1) and (2), and are much more precisely estimated.

**Replicating the Response of Household Nutrition to the Spike in Grains Prices**

Prior to estimating the response of experiential measures of food security to the spike in grains prices, this article verifies that nutrition declined more in states where pre-crisis rice consumption was higher. In particular, this section replicates the nutrition estimates presented in Tandon (2014), and demonstrates that the results at the state level are identical to the district-level results presented in Tandon (2014). Specifically, this section estimates the following specification:

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7 The average differences in rows (1) and (2) of table 2 do not match the average change in table 1 given that the summary statistics in table 1 weight observations to make the sample nationally representative. However, the primary estimates of interest in table 2 are presented in row (3), and since the stratification is nearly identical between surveys, there is no need to weight the observations to detect the difference-in-difference. However, all estimates are qualitatively identical when the weights are used in the empirical analysis.
(1) \( \ln(\text{NonGrains\_Calories}_{ist}) = \kappa_s + \gamma \text{RiceShare}_{ist,t-1} \times \text{Post}_{ist} + \beta X_{ist} + \epsilon_{ist} \)

where \( s \) denotes districts according to 2004 boundaries; \( t \) denotes the time period \( (t = 2004, 2009) \); \( \kappa_s \) denotes state fixed effects; \( \text{NonGrains\_Calories} \) denotes daily per capita calories consumed from pulses, sources of animal-based protein, and produce; \( \text{RiceShare} \) denotes the share of consumption that was composed of rice in 2004/2005; \( \text{Post} \) denotes an indicator equal to one if the household observation is taken from the 2009/2010 survey; and \( X \) contains the lower-order terms \( \text{Post} \) and \( \text{Riceshare} \).\(^8\) The coefficient of interest is \( \gamma \), which estimates how the change in non-grains consumption varied based on pre-crisis rice consumption. If the increased grains price led to lower consumption from more diverse calorie sources, then estimates of \( \gamma \) should be negative and significant.

Table 3 here

The estimates of \( \gamma \) are presented in table 3. All estimates suggest that households from states where pre-crisis rice consumption was higher had significantly larger declines in non-grains consumption. Column (1) estimates the baseline specification, and suggests that an increase in the share of pre-crisis rice consumption of ten percent corresponded to an approximately 2.5 percent larger decline in non-grains consumption. Alternatively, column (2) estimates a similar specification, but interacts the share of pre-crisis consumption that is composed of non-rice grains with a post indicator. As expected, the sign changes between specifications, and households from states with higher pre-crisis non-rice grains consumption had smaller decreases in non-grains consumption.

\(^8\)In order to make this specification comparable to the specification estimating how the Gallup Indexes changed in response to the spike in grains prices, no control variables are included in the specification. The Gallup surveys do not report household-level information that might help absorb some of the unobserved variation in experiential food security status. However, in specifications analyzing the NSSO experiential measure of food security, all results are identical when including household characteristics that might be correlated with the consumption of non-grains calories.
Table 3 also more fully examines the nutritional implications of lower non-grains consumption, and further demonstrates that the change in diet choice resulted in worse nutritional outcomes in rice-eating regions. Column (3) demonstrates that the change in total calorie consumption was not significantly different based on the pre-crisis consumption of rice. However, columns (4)-(7) demonstrate that regions more hurt by the rising grains prices had larger decreases in total consumption of a number of macronutrients. In particular, the larger decrease in non-grains consumption in rice-eating states translated into significantly larger decreases in the total consumption of calcium, dietary fiber, and iron. Given significant deficiencies in the average Indian diet in all of these macronutrients (e.g., National Institute of Nutrition 2010), these estimates are consistent with evidence that higher non-grains consumption is associated with better nutritional outcomes (Wirt and Collins 2009).

Alternatively, Tandon (2014) demonstrates that these results are robust to a number of concerns. First, the results do not appear to be driven by households employed in agricultural sectors, which suggests that the results are being driven by the spike in grains prices and not changes to agricultural income during a tumultuous period in agricultural markets. Second, the difference in consumption changes do not appear until after the spike in grains prices, and thus the results do not appear to be capturing unrelated trends in non-grains consumption and nutrition. Third, the differences cannot be explained by the potentially significant pre-crisis differences between rice and non-rice-eating regions, as the small share of rice-eating households in non-rice eating regions have the same nutritional response as households in rice-eating regions. And lastly, although the comparison of households that consume less rice to households that consume more likely captures a significant amount of the policy changes and shocks that occurred during this time period, the patterns in nutrition do not appear to be driven by the possibility of any of these shocks affecting rice and non-rice eating states differently. In particular, the results do not appear to be driven by the relatively wealthy states.
in the south of the country, such as Andhra Pradesh, Kerala, and Tamil Nadu, the results do not appear to be driven by households that were most adversely affected by the global financial crisis, the results are not driven by households that receive assistance through the national employment program (MNREGA) that was being implemented during this time period, and the results do not appear to be driven by states implementing PDS reforms during the time period.\footnote{The Gallup World Poll does not report enough demographic information to perform most of these additional robustness checks. However, all results utilizing the NSSO experiential measure of food security status are identical when accounting for these different scenarios.}

**Baseline Empirical Strategy**

This section formalizes the identification strategy summarized in table 2. In particular, it is assumed that the latent and continuous measure of food security has the following specification:

\[ F_{ist}^* = \gamma \text{RiceShare}_{is,t-1} \times P_{ost_{ist}} + \beta X_{ist} + \epsilon_{ist} \]

where \( s \) denotes the state; \( t \) denotes the time period (\( t=2008, 2010 \)); \( F^* \) denotes the latent measure of experiential food security, where a higher measure corresponds to more food security; \( \text{RiceShare} \) denotes the share of pre-crisis consumption composed of rice; and \( Post \) denotes an indicator equal to one if the observation is taken from the 2010 Gallup survey; and \( X \) contains the lower-order terms of \( Post \) and \( \text{RiceShare} \).\footnote{The Gallup surveys do not report household-level information that might help absorb some of the unobserved variation in the Food Index, and thus there are no control variables to be added to the specification. However, specifications that utilize the experiential measure of food security status collected by the NSSO do report a number of household-level variables, and all results are identical whether control variables are included or not in specifications using the NSSO measure as the dependent variable.}

However, the latent experiential food security status is unobserved, and summarized by the observable Gallup Food Index as follows:
Given the discrete structure of the index, this article estimates the following ordered probit specification to assess how the change in experiential food security status varied based on pre-crisis consumption of rice:

\[
\begin{align*}
\Pr(\text{FoodIndex}_{ist} = 0) &= \Phi(\mu_1 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}), \\
\Pr(\text{FoodIndex}_{ist} = \frac{100}{6}) &= \Phi(\mu_2 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}) - \Phi(\mu_1 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}), \\
\Pr(\text{FoodIndex}_{ist} = \frac{200}{6}) &= \Phi(\mu_3 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}) - \Phi(\mu_2 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}), \\
\Pr(\text{FoodIndex}_{ist} = 50) &= \Phi(\mu_4 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}) - \Phi(\mu_3 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}), \\
\Pr(\text{FoodIndex}_{ist} = \frac{400}{6}) &= \Phi(\mu_5 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}) - \Phi(\mu_4 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}), \\
\Pr(\text{FoodIndex}_{ist} = \frac{500}{6}) &= \Phi(\mu_6 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}) - \Phi(\mu_5 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist}), \\
\Pr(\text{FoodIndex}_{ist} = 100) &= 1 - \Phi(\mu_6 - \gamma \text{RiceShare}_{ist-1} \times \text{Post}_{ist} + \beta \text{X}_{ist})
\end{align*}
\]

where \(\Phi\) is the cumulative distribution function of the Normal distribution, and all other variables are as described above.\(^{11}\) The coefficient of interest is \(\gamma\), which estimates how the change in experiential food security status, as captured by the Gallup food index, varied based on pre-crisis consumption of rice. If the increased grains price led to more food insecurity, then estimates of \(\gamma\) should be negative and significant.

There are a number of important points to note in estimating the baseline specification. First, in addition to the ordered probit specification described above, this article also estimates the following linear probability specification:

\(^{11}\)Ordered Probit specifications employ a Maximum Likelihood Estimator to estimate the parameters of the model.
where all variables are as described above. Although the parameter estimates are poor approximations for the marginal effect of each variable when the predicted probability of observing the Gallup Food Index is close to zero or one, for intermediate predicted probabilities, the approximation is well-behaved. Such a specification can better incorporate state fixed effects that cannot be incorporated in the ordered probit specification due to the incidental parameters bias (e.g., Greene 2004).

Second, all baseline results are robust to using a different definition of exposure to the differential spike in grains prices. In particular, specifications are estimated which interact the share of pre-crisis non-rice grains consumption with the post indicator. Additionally, this article also estimates a specification that restricts the sample to households residing in states where the vast majority of households are either rice-eating (defined as states where average pre-crisis non-rice consumption was less than ten percent of overall consumption) or non-rice eating (defined as states where average pre-crisis rice consumption was less than ten percent of overall consumption). These specifications limit the possibility of households substituting away from rice and towards non-rice grains consumption in states with a higher mix of rice and wheat-eating households.

Third, the baseline specification does not weight observations based on the probability a household has of being sampled. The stratification was nearly identical between the 2008 and 2010 surveys, and thus weighting observations is not necessary to detect differences in the change of experiential food security status. Such a specification has the advantage of being able to cluster the standard errors at the state level. However, a specification is estimated that weights the

\[ FoodIndex_{i,t} = \gamma RiceShare_{i,t-1} \times Post_{i,t} + \beta X_{i,t} + \epsilon_{i,t} \]
observations based on the survey stratification, and robust standard errors are reported.

Fourth, it is possible that the survey methodology utilized by the Gallup World Poll is unable to uncover the increase in food insecurity with its experiential measure of food security, but similar experiential measures of food security from other survey methodologies might uncover the household nutritional response to the spike in grains prices. Thus, specifications are estimated that analyze the nearly identical measure of experiential food security status collected by the NSSO in a much larger survey.\textsuperscript{13,14} Additionally, specifications are estimated that modify the Gallup Food Index to make the question exactly identical to the NSSO experiential food security status.

Fifth, given the richness of the NSSO survey, specifications that use the NSSO experiential food security status as the dependent variable are better able to account for a significant amount of unobserved heterogeneity. In particular, household-level control variables are added to the baseline specification. Additionally, given the significant number of other shocks and policy changes that happened during the time period, it is possible that these events differentially affected rice and non-rice eating states, and these factors are obfuscating the true relationship between experiential food security status and the spike in grains prices. Thus, specifications are estimated that restrict the sample to households that do not derive income

\textsuperscript{13}Given the identical stratification between the rounds, the empirical analysis that analyzes changes across surveys does not weight observations based on the probability of being sampled. However, all empirical results are qualitatively identical if the empirical sections utilize the probability weights.

\textsuperscript{14}This article also investigated matching methods in the NSSO specifications using the richer demographic data reported in the NSSO survey. Specifically, this article investigates estimators proposed by Smith and Todd (2005) and Blundell and Costa-Dias (2000) to estimate the effects higher grains prices had on experiential food security status. This estimator is the difference between the matching estimator in rice-eating states and the matching estimator in non-rice eating states, which each use a post indicator to define treatment. The standard error is calculated with the bootstrap. However, Abadie and Imbens (2008) demonstrate that standard errors calculated with the bootstrap fail to perform well in even the most simple matching estimator, which suggests such an estimator might be inappropriate. Alternatively, when using the matching estimator proposed by Abadie et al. (2004) to estimate treatment separately in rice and non-rice eating regions (using the post indicator to define treatment and matching on the household-level control variables used in Tandon (2014)), the difference is small and qualitatively identical to the estimates discussed in the main text and the confidence intervals on the two matching estimates overlap.
from tumultuous agricultural markets, that restrict the sample to households least likely to be affected by the global financial crisis, and specifications are estimated that restrict the sample to states that did not implement PDS reforms.\footnote{15}

Lastly, it is possible that although households might not report to being more food-insecure given different interpretations of what types of foods are required for the household, they might exhibit a number of other signs of struggling in response to the spike in grains prices that do not rely on the reference point of the diet that households might be expecting. Thus, specifications are estimated that analyze the Positive Experience Index and the Negative Experience Index that are also collected by the Gallup World Poll.

**Results and Discussion**

There is very little evidence of a strong relationship between experiential food security status and the differential spike in grains prices. Table 4 presents estimates of how the changes in the Gallup Food Index varied based on pre-crisis consumption of rice. Column (1) estimates the baseline specification; column (2) estimates a linear probability specification; columns (3) and (4) estimate specifications that allows the change in the Gallup Food Index to vary based on pre-crisis consumption of non-rice grains; column (5) estimates a specification that simply compares the difference in the Gallup Food Index between primarily rice and non-rice eating states so as to limit the possibility of households substituting away from rice consumption in states with a larger mix of the two types of households; and column (6) estimates a specification that weights observations according to the survey stratification.

\footnote{15}Although the national employment program MNREGA was implemented during this time period and household participation was documented in the Type-1 Consumer Expenditure survey, the experiential food security status was only documented in the Type-2 Consumer Expenditure survey. Thus, one cannot analyze how experiential food security status varied in response to the spike in grains prices separately for households that participated in MNREGA and households that did not. However, the program was a national change and likely affected rice and non-rice eating states similarly. Alternatively, if some states are better able to provide MNREGA benefits to households, much of this variation would be captured by the state fixed effects in the linear probability specification.
Most point estimates suggest that experiential food security declined more in states where pre-crisis consumption of rice was higher, where the sign flips when comparing respondents in primarily rice-eating states to respondents in primarily non-rice eating states in column (5). However, one is not able to reject the hypothesis of no relationship between the measures and the variable of interest at standard levels of significance in any specification. Although that does not rule out the possibility of either a large negative effect, or a potential positive effect, the results contrast sharply with the precision of the estimates in table 3, which found overwhelming evidence of a relative decline in nutrition in regions where pre-crisis consumption of rice was higher.

Although there is little evidence that the change in the Gallup Food Index varied in response to the spike in grains prices, table 4 also investigates how other experiential food security measures might respond. In particular, column (7) of table 4 estimates specifications analyzing the change in experiential food security status collected by the NSSO surveys between 2004/2005 and 2009/2010. However, similar to the specifications analyzing the change in the Gallup Food Index, the estimate is not statistically significant at standard levels of significance. However, the sign of the estimate is different from most of the estimates analyzing the Food Index, and the estimate suggests that experiential food security actually had smaller declines in regions where pre-crisis rice consumption was higher. This result is again in stark contrast to the overwhelming evidence of a relative decline in nutrition in regions where pre-crisis consumption of rice was higher presented in table 3.

Furthermore, column (8) estimates a specification that uses an adaptation of the Gallup Food Index that makes the Gallup question that elicits food security status from respondents identical to the NSSO question. In particular, the modified variable equals one if the household had enough money to purchase food at all times in the previous year, and the variable equals zero otherwise. The estimate
is still statistically insignificant at standard significance levels, and continues to have a sign opposite from the specification using the NSSO experiential measure as the dependent variable.

Table 5 here

Table 5 presents a number of robustness checks of the baseline specification using the NSSO measure of experiential food security status to make sure that unobserved heterogeneity or major policy changes and shocks are not obfuscating the relationship. Column (1) adds control variables to help absorb unobserved variation in food security status, and all other specifications include the same control variables;\textsuperscript{16} column (2) restricts the sample to households that did not primarily work in agriculture, so as to rule out the possibility that changes in agricultural income are driving the results; column (3) restricts the estimation to households that reside in states that did not implement PDS reforms during the time period;\textsuperscript{17} column (4) excludes households that were most likely affected by the global financial crisis;\textsuperscript{18} and column (5) excludes households from the relatively wealthy rice-eating states of Andhra Pradesh, Kerala, and Tamil Nadu. All results are qualitatively identical to the baseline specifications estimated in table 4, where each estimated coefficient is still a different sign than most of the estimates from specifications analyzing the Gallup Food Index, and the standard error is still too large to rule out the possibility of no relationship between experiential food security and the differential price spike in grains.

\textsuperscript{16} The controls are the same as those utilized in Tandon (2014), and include the natural logarithm of non-food expenditure, an indicator if the household resided in a rural area, indicators for household religion (Hindu, Muslim, Christian, Jain), indicators for social status (Scheduled Caste, Scheduled Tribe, Other Backward Class), the number of sons in the household, and the number of daughters.

\textsuperscript{17} States are identified as implementing PDS reforms according to the classification in Khera (2011). The reforming states include Chhattisgarh, Orissa, and Madhya Pradesh.

\textsuperscript{18} Based on Bajpai (2011), the sectors most affected by the global financial crisis were those that were primarily export-oriented. Over the year immediately prior to the global financial crisis between 2007-2008, 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.
Despite evidence of the spike in grains prices having an adverse effect on nutrition in India, the results in tables 4 and 5 suggest that there is too much noise in the response to questions about the experiences of households with food insecurity to adequately uncover a relationship with the spike in grains prices. These results are consistent with respondents interpreting the food security questions differently, and answering accordingly. In particular, some households might be answering whether they had trouble affording any food in the previous year, whereas other households might be answering whether they had trouble affording food with a sufficient nutritional quality.

Table 6 here

However, even though one cannot reject the hypothesis that changes in the Gallup and NSSO experiential measures of food security are not correlated with the spike in grains prices, it is possible that households reported other types of negative experiences in response to the dramatic rise in grains prices when there is not any overt reference point implied by the question. In particular, table 6 re-estimates the baseline specification, but utilizes the other Gallup Indexes of well-being. Column (1) analyzes the Positive Experience Index; and column (2) analyzes the Negative Experience Index.

The results in both specifications are consistent with the spike in grains prices having an adverse effect on households, where the estimates are both precise enough to rule out no the hypothesis of no relationship between household well-being and the spike in grains prices. In regions where pre-crisis rice consumption was higher, households had relatively fewer positive experiences the day before the survey, and relatively more negative experiences. These results are consistent with the results presented in table 3, where households were adversely affected by the dramatic rise in grains prices.

Conclusion

This article investigates the effect the dramatic rise in grains prices following
the world food price crisis had on experiential measures of food security of Indian households by utilizing differences in the size of the price increase between rice and other grains. To infer the causal effect of the rise in grains prices on experiential measures of food security, regions that primarily consumed rice as the staple grain are compared to regions that primarily consumed other grains. This article finds one cannot reject the hypothesis that regions that had higher pre-crisis rice consumption, and thus were worse affected by the rise in grains prices, had an identical change in experiential food security status to regions that had lower pre-crisis consumption of rice. This is despite the decline in nutrition in rice-eating regions relative to non-rice eating regions reported in Tandon (2014), and replicated at the level of analysis in this article.

Despite the noise in the estimates analyzing experiential food security status, estimates analyzing other measures of household well-being that did not have an overt reference point implied in the question were much more precisely estimated. Households in regions with more pre-crisis rice consumption reported to having fewer positive experience and more negative experiences, relative to regions with lower pre-crisis consumption of rice. These results suggest that self-reporting of food security status is likely possible, but that the standard questions utilized by the Gallup World Poll and the NSSO might not be precise enough to adequately track changes in other types of food security and nutrition over time and in response to policy changes and economic shocks.

These findings have implications for how surveys should design questions eliciting food security status directly from households. In particular, experiential measures might give a more precise estimate of food insecurity if they were based off of questions that were free of reference points, but rather were based on questions that ask about behaviors that are less likely to be interpreted differently by respondents. Additionally, experiential measures might also give a more complete description of food insecurity if they were designed to focus on more aspects of food insecurity than whether households had difficulty in purchasing food in the
past year. Although the experiential measures of food security analyzed in this article- the Gallup Food Index and the NSSO measure of experiential food security status- have been widely used (e.g., National Sample Survey Organization 2007; Deaton and Dreze 2009; Heady 2013; etc.), there are other surveys that design a more complete battery of questions that might capture more dimensions of food security directly from households (e.g., Coleman-Jensen, Nord, and Singh 2013).

These results also help illustrate the costs of the world food price crisis. A number of articles have found that nutrition and a number of other household choices changed in response to the dramatic rise in grains prices (e.g., Jensen and Miller 2008; D’Souza and Joliffe 2012; D’Souza and Joliffe 2014; Tandon 2014; etc.). However, these results corroborate the adverse effects the crisis had on emotional well-being and feelings of happiness, stress, etc. Additionally, these results help to better illustrate how the world food price crisis affected India - a country that contributes nearly forty percent of the world’s food-insecure population (e.g., FAO 2013b; Meade and Rosen 2013), but also was better shielded from the turbulence of the world agricultural markets than many other countries (Childs and Kiawu 2009).
References


Jensen, Robert, and Nolan Miller. 2008a. The Impact of Food Price Increases on


Viatte, Ferard, Jacques De Graaf, Mulat Demeke, Takashi Takahatake, and Marie


Table 1. Summary Statistics of Gallup Indexes and NSSO Self-Reported Food Security Status

<table>
<thead>
<tr>
<th>Gallup World Poll Indexes</th>
<th>Definition</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Index</td>
<td>Based off whether respondent did not have enough money to purchase food in the past 12 months, and if so, the frequency of the event. Index of 100 implies no food insecurity, and an index of 0 implies the highest frequency of food insecurity.</td>
<td>32.8 (1.81)</td>
<td>27.4 (1.95)</td>
<td>32.6 (0.60)</td>
</tr>
<tr>
<td>Food Affordable</td>
<td>An indicator variable equal to one if the household had enough to eat at all times over the past year</td>
<td>0.781 (0.015)</td>
<td>0.720 (0.012)</td>
<td>0.727 (0.007)</td>
</tr>
<tr>
<td>Positive Experience</td>
<td>Respondents were asked a number of questions about the day preceding the interview, such as whether they experienced enjoyment, whether they smiled or laughed a lot, whether they felt well-rested, etc. Higher index scores imply more positive experiences.</td>
<td>59.1 (2.94)</td>
<td>67.1 (0.95)</td>
<td>62.5 (0.73)</td>
</tr>
<tr>
<td>Negative Experience</td>
<td>Respondents were asked a number of questions about the day preceding the interview, such as whether they experienced stress, worry, sadness, anger, etc. Higher index scores imply more negative experiences.</td>
<td>26.2 (2.11)</td>
<td>28.8 (0.93)</td>
<td>26.7 (0.62)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observations</th>
<th>202000</th>
<th>3010</th>
<th>6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>--------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>NSSO Self-Reported Food Security Status</td>
<td>An indicator equal to one if the household reported having enough food to eat at all times during the previous year.</td>
<td>0.975 (0.001)</td>
<td>0.987 (0.001)</td>
</tr>
</tbody>
</table>

| Observations             | - | 79,158 | 45,288 | 59,049 | 41,672 |

Notes: This table presents index scores collected by the Gallup World Poll between 2008 and 2010, and also presents self-reported food security status collected by the NSSO in 2004/2005 and 2009/2010. All data have been weighted so as to make the summary statistics nationally representative of the population of India.
Table 2. Differences in Self-Reported Food Security Status and other Gallup Indexes between 2008 and 2010

<table>
<thead>
<tr>
<th></th>
<th>Difference in the Food Index</th>
<th>Difference in the NSSO Self-Reported Food Security Status</th>
<th>Difference in the Positive Experience Index</th>
<th>Difference in the Negative Experience Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice-Eating States</td>
<td>-12.6</td>
<td>0.016</td>
<td>-10.9</td>
<td>9.98</td>
</tr>
<tr>
<td></td>
<td>(6.37)</td>
<td>(0.008)</td>
<td>(2.59)</td>
<td>(2.41)</td>
</tr>
<tr>
<td>Non-Rice Eating States</td>
<td>-3.94</td>
<td>0.004</td>
<td>3.37</td>
<td>1.14</td>
</tr>
<tr>
<td></td>
<td>(3.64)</td>
<td>(0.002)</td>
<td>(2.56)</td>
<td>(1.86)</td>
</tr>
<tr>
<td>Difference (Row 1 – Row 2)</td>
<td>-8.62</td>
<td>0.011</td>
<td>-14.3***</td>
<td>8.84***</td>
</tr>
<tr>
<td></td>
<td>(6.96)</td>
<td>(0.008)</td>
<td>(3.51)</td>
<td>(2.91)</td>
</tr>
<tr>
<td>Observations</td>
<td>8000</td>
<td>225,167</td>
<td>8000</td>
<td>8000</td>
</tr>
</tbody>
</table>

Notes: The first two rows report changes in the self-reported food security status and other Gallup World Poll Indexes presented in Table 1 following the dramatic rise in grains prices. Estimates are separated by whether the respondent resided in a state that primarily consumed rice as the staple grain. Rice-eating states have been defined as states in which pre-crisis consumption of rice was greater than forty percent of total consumption. The third row presents the differences in the growth of the indexes between rice and non-rice eating states. Standard errors clustered by state are presented in parentheses. For the differences presented in the third row, statistical significance is reported where *** denotes statistical significance at the 1% level, ** denotes statistical significance at the 5% level, and * denotes statistical significance at the 10% level.
<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>ln(per Capita Consumption of non-Grains Calories)</th>
<th>ln(per Capita Total Calorie Consumption)</th>
<th>ln(per Capita Total Consumption of Protein)</th>
<th>ln(per Capita Total Consumption of Fiber)</th>
<th>ln(per Capita Total Consumption of Calcium)</th>
<th>ln(per Capita Total Consumption of Iron)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>Pre-Crisis Share of Rice in Diet&lt;sub&gt;e&lt;/sub&gt;*Post&lt;sub&gt;e&lt;/sub&gt;</td>
<td>-0.252*** (0.061)</td>
<td>-</td>
<td>0.027 (0.051)</td>
<td>-0.001 (0.045)</td>
<td>-0.396*** (0.072)</td>
<td>-0.390*** (0.070)</td>
</tr>
<tr>
<td>Pre-Crisis Share of non-Rice Grains in Diet&lt;sub&gt;e&lt;/sub&gt;*Post&lt;sub&gt;e&lt;/sub&gt;</td>
<td>-</td>
<td>0.297*** (0.063)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: This table replicates results from Tandon (2014) and presents estimates of how non-grains consumption and nutrition changed between 2004/2005 and 2009/2010 based on the pre-crisis consumption of rice and wheat. Column (1) and columns (3)-(7) present estimates for how nutrition varies based on pre-crisis consumption of rice, and column (2) presents an estimate for how nutrition changed based on pre-crisis consumption of wheat. All specifications include state fixed effects. Standard errors clustered by state are reported in parentheses. * Denotes significance at the 10% level; ** Denotes significance at the 5% level; *** Denotes significance at the 1% level.
Table 4. Differences in Self-Reported Food Security Changes based on pre-Crisis Consumption of Rice and Wheat

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>Gallup Food Index</th>
<th>Modified Gallup Food Index to Make the Question Identical to NSSO Self-Reported Measure of Food Security</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Pre-Crisis Share of</td>
<td>-0.477</td>
<td>-0.726</td>
</tr>
<tr>
<td>Rice in Diet\textsubscript{Post}</td>
<td>(0.433)</td>
<td>(12.8)</td>
</tr>
<tr>
<td>Pre-Crisis Share of</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>non-Rice Grains in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet\textsubscript{Post}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice-Eating State\textsubscript{Post}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value of a joint</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>test of higher-order</td>
<td></td>
<td></td>
</tr>
<tr>
<td>terms equaling zero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>8000</td>
<td>8000</td>
</tr>
</tbody>
</table>

Notes: This table presents estimates of how self-reported measures of food security changed between 2008 and 2010 based on the pre-crisis consumption of rice and wheat. Column (1) and Columns (3)-(8) each present estimates of an ordered probit specification, and column (2) presents estimates of a linear probability model. Column (6) weights observations based on the probability of being sampled, whereas all other specifications do not weight the sample. All specifications include lower-ordered terms (a post indicator and the share of pre-crisis rice or wheat in the diet). Columns (1)-(6) estimate specifications using the Gallup Food Index as the dependent variable; column (7) estimates a specification using the NSSO self-reported measure of Food Security as the dependent variable; and column (8) estimates a specification that uses a modification the Gallup Food Index that makes the question identical to the NSSO measure as the dependent variable. Standard errors clustered by state are reported in parentheses for all columns except for (6), which reports robust standard errors. * Denotes significance at the 10% level; ** Denotes significance at the 5% level; *** Denotes significance at the 1% level.
## Table 5. Robustness Check of the Baseline Specification Using the NSSO Measure of Self-Reported Food Security

<table>
<thead>
<tr>
<th>Dependent Variable: NSSO Self-Reported Food Security Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes Household Characteristics to Absorb Unobserved Heterogeneity</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>**Pre-Crisis Share of Rice in Diet$_t$**Post$_t$</td>
</tr>
<tr>
<td>(0.277)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
</tr>
</tbody>
</table>

Notes: This table presents a number of robustness checks of the baseline specification using the NSSO self-reported food security status as the dependent variable. Each column estimates an ordered probit specification. All columns include lower-ordered terms and control variables, which includes the pre-crisis share of rice consumption, a post indicator, the natural logarithm of non-food expenditure, the number of sons in the household, the number of daughters in the household, an indicator equaling one if the household resided in a rural area, indicators for household religion (Christian, Hindu, and Muslim), and indicators for social group (Scheduled Caste, Scheduled Tribe, and Other Backward Class). Standard errors clustered by state are reported in parentheses. * Denotes significance at the 10% level; ** Denotes significance at the 5% level; *** Denotes significance at the 1% level.
Table 6. Differences in Other Well-Being Indexes between Rice Eating States and the Rest of India

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>Gallup Positive Experience Index (1)</th>
<th>Gallup Negative Experience Index (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Crisis Share of Rice in Diet *Postt</td>
<td>-0.895**</td>
<td>0.599**</td>
</tr>
<tr>
<td></td>
<td>(4.02)</td>
<td>(0.300)</td>
</tr>
<tr>
<td>Observations</td>
<td>8000</td>
<td>8000</td>
</tr>
</tbody>
</table>

Notes: This table presents estimates of how non-food Gallup Indexes of well-being changed between 2008 and 2010 based on the pre-crisis consumption of rice. Each column presents estimates of an ordered probit specification, and all specifications include lower-ordered terms (a post indicator and the share of pre-crisis rice or wheat in the diet). Column (1) estimates a specification using the Gallup Positive Experience Index as the dependent variable; and column (2) estimates a specification using the Gallup Negative Experience Index as the dependent variable. Standard errors clustered by state are reported in parentheses. * Denotes significance at the 10% level; ** Denotes significance at the 5% level; *** Denotes significance at the 1% level.
Figure 1. Rice and Wheat Prices, 1999-2013

Note: This figure plots both world prices and Indian prices for rice and wheat between 1999 and 2013.
Figure 2. Pre-Crisis Rice Consumption in India

Note: This map presents average pre-crisis consumption of rice by state. The consumption data is derived from the 61’st Round of the Consumer Expenditure survey conducted by the National Sample Survey Organization in 2004/2005.
Figure 3. Grains Consumption in Rice and Non-Rice Eating States between 2004/2005 and 2009/2010

Note: This figure graphs consumption of dominant and non-dominant grains in rice and non-rice eating states between 2004/2005 and 2009/2010, where rice-eating states are defined as those where pre-crisis consumption of rice was more than forty percent of total consumption. The data are obtained from the 61’st (2004/2005) and 66’th (2009/2010) rounds of the Consumer Expenditure Survey conducted by the National Sample Survey Organization.