Food Security and Wheat Prices in Afghanistan:
A Distribution-sensitive Analysis of Household-level Impacts

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Abstract: We investigate the impact of increases in wheat flour prices on household food security using unique nationally representative data collected in Afghanistan from 2007 to 2008. We use a new estimator, the Unconditional Quantile Regression (UQR) estimator, based on influence functions to examine the marginal effects of price increases at different locations on the distributions of several measures of food security. UQR estimates reveals that the negative marginal effect of a price increase on food consumption is two and a half times larger for households that can afford to cut the value of food consumption (75th quantile) relative to those households at the bottom (25th quantile) of the food-consumption distribution. Similarly, households that can afford to cut caloric intake do so in a meaningful way, but those at the bottom of the calorie distribution (25th quantile) make very small changes in intake as a result of the price increases. Households at the bottom of the distribution of dietary diversity make the largest adjustments in the quality of their diets, since such households often live at subsistence levels and cannot make large cuts in caloric intake without suffering serious health consequences. These results indicate that when faced with staple-food price increases, food-insecure households sacrifice quality (diversity) in order to protect calories. The large differences in behavioral responses of households that lie at the top and bottom of these distributions suggest that policy analyses that rely solely on OLS techniques, which estimate the mean marginal effects, may be misleading.

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Introduction

Wheat is the staple food in Afghanistan, contributing approximately 54 percent of total caloric intake. It is also a major production crop; about 70 percent of cultivated crop area is devoted to wheat (Chabot & Dorosh, 2007). In 2008 due to a combination of international (increasing global food prices), regional (export bans in key trading partners like Pakistan), and domestic (drought) factors, domestic wheat grain and flour prices approximately doubled. These sharp price increases constituted a serious economic shock to Afghan households, who spend the majority of their budgets on food. D'Souza and Jolliffe (2010) find that the price shock had a measurable impact on household food security across Afghanistan. They show that households reduced the value of food consumption in response to wheat flour price increases, and this reduction in the value of consumption is the result of reducing the quality (dietary diversity) and quantity (calories) of food consumed in approximately equal proportions. Such declines in consumption and nutrition indicators can have serious implications. Even short bouts of poor nutrition can have long-term repercussions, particularly for vulnerable populations such as children, lactating women and the elderly and those on the cusp of poverty and/or poor health (UNICEF, 2009). These bouts may exacerbate already high levels of malnutrition; for example, Afghanistan has the highest prevalence of stunting in the world among children under five years old (UNICEF, 2009).[1]

A limitation of D'Souza and Jolliffe (2010) is that the analysis is based on OLS estimation, which constrains the behavioral response of households to be constant over the entire distribution. For the purposes of examining food security, or indeed any measure where the policy focus is on a particular portion of the distribution (such as the lower tail), or a particular threshold on the range of values (such as a poverty line or some fixed nutritional benchmark), the OLS estimator can be a potentially misleading tool. Specifically, OLS analysis provides an estimate of the (constant) partial derivative of the mean of the dependent variable with respect to changes in the independent variable. However, if we believe that households at different points of the distribution employ different coping strategies to deal with shocks, then it is essential to disaggregate the estimated behavioral responses in thinking about policy prescriptions.

[1] Estimates are based on data from the 2004 National Nutrition Survey.

The Quantile Regression (QR) estimator is frequently used to relax the assumption of a constant marginal response by allowing the responses to vary across the distribution of the dependent variable after conditioning on the observed covariates (for example, see Chamberlain (1994)). A disadvantage of this estimator is that it is based on the conditional population distribution and typically policymakers want to know the response over the unconditional distribution. For example, policymakers may be interested in knowing how price shocks affect caloric intake for households at the bottom 25th percent of the caloric distribution of the total population, before conditioning on factors such as location (rural, urban) or socio-economic status. Such information can be valuable in targeting safety net and poverty-alleviation programs, as well as allocating resources more generally.

In this analysis we utilize a recent innovation in quantile regression analysis – the Unconditional Quantile Regression (UQR) estimator proposed by Firpo, Fortin and Lemieux (2009b) – to examine the impact of the wheat flour price shocks on several measures of food security. The UQR estimator uses influence functions to estimate the behavioral responses at specific quantiles of the unconditional distribution of the dependent variable. We compare OLS estimates to the UQR estimates at the 25th, 50th, 75th quantiles to examine whether the effects differ in informative ways across the distribution. We also examine the marginal effects at quantiles corresponding to thresholds that are policy or nutritional relevant, e.g., the commonly used nutritional benchmark of 2,100 kilocalories per person per day. Measuring responses at these thresholds can help to better inform policymakers of how households on the cusp of poverty and/or poor health are affected by price increases. Such information may be particularly salient in a conflict-ridden country like Afghanistan, where a large portion of the population lives close to subsistence levels or in poverty; the national poverty rate for 2007-08 was 36% (M. o. E. Islamic Republic of Afghanistan, and the World Bank Economic Policy and Poverty Sector, 2010).

We find disparities in the behavioral responses of households to increases in the price of wheat flour based on where the household lies on the unconditional distribution of the particular food security measure of interest. While the OLS estimates demonstrate the basic quality-quantity tradeoff that households must make (i.e., reducing dietary diversity in order to buffer the impact of declining purchasing power on caloric intake), they mask important differences across households. Households at the top of the real, food consumption and caloric intake distributions experience the largest declines in each of these measures, as might have been expected given that these households can afford to cut back. In contrast, households at the bottom of the caloric intake distribution cannot afford to make substantial cuts to caloric intake since they are close to the minimum daily energy requirements; accordingly, we see a very small effect of the price increases for these households. Finally households at the bottom of the dietary diversity distribution – often very poor households – experience large declines in dietary diversity as a result of the wheat flour price increases. Since households living at subsistence levels cannot make major cuts to caloric intake, they must adjust the compositions of their diet in order to maintain energy levels.

The current analysis extends the previous literature in several dimensions. It represents one of a handful of empirical analyses that use nationally-representative household data collected prior to and during a significant price shock. Since such data are extremely rare, most empirical analyses rely on data collected during earlier periods and utilize simulation models to look at the potential impact of the price shock on household welfare. To the best of our knowledge, this paper is the first to utilize the UQR estimator to examine the impact of food price shocks on household food security. Finally, we seek to inform local and national policymakers and development agents working in Afghanistan by providing systematic quantitative analyses of household responses to food price shocks.

Data

We use consumption and price data from the National Risk and Vulnerability Assessment (NRVA) 2007/08, conducted by the Government of Afghanistan Central Statistics Organization and the Ministry of Rural Rehabilitation and Development. The survey was administered between August 2007 and September 2008 and covered over 20,500 households (over 150,000 individuals) in 2,572 communities in all 34 provinces of Afghanistan. The long time frame made it possible to obtain seasonally-adjusted estimates of household food security and allowed for coverage of conflict-affected areas.

The sample was selected according to a stratified, multi-stage design. The survey was stratified explicitly geographically and implicitly over time. In the first stage, the population frame was stratified into 46 domains or strata.[2] The 11 provinces with the most populous provincial centers were each stratified into urban and rural areas. The remaining provinces were treated as separate strata and identified as rural areas. The nomadic Kuchi population was treated as a separate stratum. There were 2,441 primary sampling units (PSU) from urban and rural settled populations and 131 PSUs from Kuchi populations. In the second and final stage, eight households were selected from each PSU.

The implicit stratification over time is a key element of the survey design. The population frame was sorted both spatially and temporally to ensure that (with a systemic interval selection) the selected sample would be seasonally representative. (See Kish (1965, pp. 235-236) for a discussion of implicit stratification.) Thus each quarterly sample of the NRVA survey is representative at the national level. In a country where agriculture is an important form of livelihood, seasonal variations in consumption patterns are to be expected; thus it is critical to capture nationally-representative measures of household food security throughout the year. (Appendix table A1 displays key demographic, educational and health, and infrastructure indicators across the four quarters. While we observe some statistical differences in means, there is little evidence of systematic differences in the samples across quarters.) Additionally, the year-long fieldwork enabled enumerators to access households in conflict zones without compromising the survey design. Specifically, enumerators would try to secure permission informally from local leaders; when a PSU was considered too insecure to interview at the scheduled time, it would not be immediately replaced, but would be reconsidered at a later date within the quarter.

The NRVA consists of household and community questionnaires and a district market price survey.[3] In this analysis, we exploit two key elements – the food consumption data and the price data. The former includes the frequency and quantity of consumption of 91 food items consumed over the previous week, including food bought on the market, produced, or obtained through other methods like food aid and gifts. The NRVA's broad coverage of foods, including seasonal varieties, allows for better calculation of calorie and nutrient intake than surveys with fewer items. The latter includes prevailing prices of the

[2] The population frame is based on a 2003-05 national household listing.
[3] The household questionnaire includes 20 sections – 6 administered by female interviewers to female household members and 14 administered by male interviewers to the male household head. In Afghanistan, it is important that interviews be conducted among individuals of the same sex.

food items included in the consumption section, as well as domestic and imported grains and fuel. The local price data are important to obtain accurate estimates of price effects in a mountainous country with poor infrastructure, where transportation and transaction costs may vary greatly.

Measures of food security

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Food and Agricultural Organization, 2008, p. 1). It includes four main factors: availability, access, utilization, and stability. Availability refers to the physical existence of food, which relates to production, stocks and trade. Access refers to a household's ability to obtain food, which depends on income, prices, and market access. Utilization refers to an individual's ability to process nutrients and energy from food, which depends on many factors including dietary diversity and nutrient absorption, intra-household allocation of food, and hygienic preparation. And stability refers to the stability of the other three factors over time (Food and Agricultural Organization, 2008).

We construct three measures of household food security to be used as dependent variables in the regression analysis: the value of per capita monthly food consumption; per capita daily caloric intake; and household dietary diversity. The first two relate to the access to food and the last one relates to the utilization of food. The value of food consumption is a core component of poverty indictors. Caloric intake is a widely used measure of health; however recent literature suggests that it is not a sufficient indicator of nutritional status, therefore we also include a measure of dietary diversity (See, for example, Deaton & Dreze, 2009).

The value of monthly food consumption (in Afghani) is constructed by mapping district price data to food quantity data.[4] Since not all food items were available in all district markets at all times of the year, we imputed the missing elements to obtain a complete price matrix, which provides prices for those items that households may have been producing at

[4] Households are asked for the quantity of foods consumed over the past seven days; these quantities are multiplied by 4.2 to get monthly values.

home, as well as goods that households may have obtained from more distant markets.[5] The survey includes questions on the percentages of imported wheat and rice the household consumes; we use these responses to calculate price averages for domestic and imported varieties separately, given large differences in price and quality. Finally, we convert nominal values to real values using a consumer food price index.[6]

We use the FAO Food Composition Tables for the Near East to convert daily food quantities into kilocalories; we then divide by the effective household size to get per capita daily caloric intake.[7] The effective number of household members incorporates guests eating meals within the home (and deducts when members are not regularly eating meals at home).[8] The effective number of household members is greater than household size for the relatively richer households, and less than household size for the poorest of households. The value of expenditure on food away from home is included in the calculation of the value of food consumption, but not included in the calculation of caloric intake since quantity data on such food was not collected.[9] As a percent of total food expenditure, food away from home constitutes less than half a percent for the poorest 20 percent of the population and about four percent for the richest 20 percent of the population.

To measure household dietary diversity, we use the food consumption score (FCS) developed by the World Food Programme (WFP). It is a weighted sum of the frequencies with which households consume foods within eight food groups over the previous week.[10] The food groups include staples, pulses, vegetables, fruit, meat/fish, milk/dairy, sugar, and

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[5] The imputation process filled in missing values using the first feasible methodology according to the following order: 1) median of the 20 nearest neighbors (weighted by inverse distance); 2) province median of that month; 3) national median of that month; 4) median price of 20 neighboring districts of the quarter (weighted by inverse distance); 5) province median of that quarter; and 6) national median of that quarter.

[6] We use a Laspeyres price index estimated by quarter for each region using the district price data. Real consumption is relative to the chosen base: urban areas in the Central region in quarter one; the capital, Kabul, is located in the Central region.

[7] Spices, water, and 'other' foods do not contribute to total calories. USDA sources were used for a few items that were not available in the FAO tables.

[8] Some studies use household size to calculate per capita amounts. In Afghanistan the custom of sharing meals with guests makes it important to account for guests eating meals from the household cooking pot. The effective household size also incorporates information on household members eating outside the home. Other studies use equivalency scales to account for differences in consumption of adults and children when calculating measures of wellbeing. We opt to include variables for household composition directly into the regression model in order to control for such differences.

[9] Expenditure on food away from home accounts for approximately two percent of household food expenditure.

[10] Weights for the food groups range from 0.5 to 4 based on nutrient density. Condiments receive zero nutritional weight. Frequencies are truncated at 7 for each food group. The measure ranges from 0 to 112.

oil/fat. Higher scores denote a more varied diet and are suggestive of a higher quality diet with potential for higher micronutrient intake. The FCS has been used in food security assessments throughout the world. In Afghanistan, the national average is 61. The WFP uses a cutoff of 48 for an acceptable diet in countries where most households consume staples and oil every day. Under this categorization approximately 80 percent of the population have acceptable diets; however recent work suggests that the cutoff points for the FCS classifications may be too low (Weismann, Basssett, Benson, & Hoddinott, 2009).

Sample

The effective sample size for our analysis is 20,483 households.[11] Approximately 80 percent of households reside in rural areas. On average, households have 8.6 members living in about 3.6 rooms (or tents for Kuchi populations). The typical household consists of 2.1 men, 2 females, and 4.5 children (under 16). Heads of households are about 45 years old; the majority are married and illiterate.

In the empirical work, we estimate the effects of the wheat flour price increases at the national level, as well as based on a household's access to agricultural land (defined hereafter as agricultural households). This categorization broadly relates to the net seller – net buyer distinction in the literature that is discussed in detail below. The vast majority (95 percent) of agricultural households are situated in rural areas. About 67 percent of households in rural areas and 15 percent of households in urban areas have access to agricultural land.

Table 1 displays population averages for the national sample, for agricultural households and nonagricultural households. Afghan households spend about 60 percent of their budgets on food, with agricultural households spending about 65 percent and nonagricultural households spending about 55 percent. Nonagricultural households are better off in terms of total consumption and caloric intake. These patterns are consistent with the typical rural-urban divide observed in many countries. Most nonagricultural

[11] The household response rate was 99.8%, and the PSU replacement rate was 3%. Thirty-two households were dropped due to missing female questionnaires; all of these households are located in four communities, suggesting systematic errors in field operations. Fifty-nine households were dropped due to missing consumption data. One household is missing data on household size and is dropped because per capita measures of consumption and food security cannot be calculated.

households are situated in urban areas which are, on average, richer than rural areas. Agricultural households have statistically higher levels of dietary diversity, though the differences are small; these differences may be due to access to a larger variety of foods through home production.

Price data

Our analysis focuses on the price of domestic wheat flour, the form of wheat most commonly purchased by households. Most wheat is consumed in the form of naan, local unleavened bread that is prepared by households after purchasing either refined wheat flour or whole grain wheat (Chabot & Dorosh, 2007). Wheat and other grains represent 48 percent of food expenditure and 70 percent of calories consumed for the national sample.

From 2007 to 2008, wheat flour prices in Afghanistan more than doubled. Figure 1 displays the retail prices of wheat flour in four major urban centers. The price increases were due to several key factors: high international prices; a poor harvest brought on by a drought; and export bans in key suppliers such as Pakistan. In the empirical work below, we estimate the marginal effects of the total price increases; we are unable to disentangle the effects of the price increases due to each factor.

Table 2 displays the average prices of wheat flour and other important commodities.[12] We choose these commodities because they represent several key food groups and because milk, lamb, rice, vegetable oil, and wheat flour make up a large percentage of monthly household food expenditure; for example, the relatively poor (20th to 50th quantile of the total consumption distribution) spend eighty percent of their food expenditure on these five food items. We include kerosene because it is commonly used in cooking.

Though the differences in all the commodity prices are statistically significant across the subpopulations, they do not differ by more than four percent. In contrast, prices change dramatically over the survey year, as seen in table 3. Using ANOVA (analysis of variance analysis), we find that 75-85 percent of the total variation in wheat flour prices is explained

[12] Prices are aggregated to the stratum level in order to mitigate potential measurement error in district-level prices. Strata are based on urban and rural designation within provinces.

by variation over the four quarters of the survey year; in contrast, approximately 5 percent of the total variation can be explained by variation across provinces.

Changes in food security over the survey year

The potential impact of the commodity price increases can be seen in the raw data. Table 4 displays population averages for some key indicators of food security by quarter of the survey. While the nominal amounts of total consumption and food consumption are relatively flat, the decline in household food security can be seen in the changes in the real value of food consumption, as well as in the two nutritional measures. Further, during this time period, the percentage of the population consuming less than 2100 calories per day increased from 24 in fall 2007 to 34 in summer 2008. According to the Government of Afghanistan, the official poverty rate increased from 23.1 percent in the fall to 46 percent in the summer (M. o. E. Islamic Republic of Afghanistan, and the World Bank Economic Policy and Poverty Sector, 2010). These statistics indicate potentially serious changes in household wellbeing and in particular, nutritional status. In the empirical work below, we find similar patterns after controlling for a variety of household and environmental factors.

3 Methodology

In this section, we first describe the basic model and then discuss our approach to estimate the effects of the wheat flour price increases on various measures of household food security. The basic specification is as follows:

$$+ \qquad (1)$$

where *h* denotes household, *a* denotes area (urban or rural), *d* denotes district, *p* denotes province, and *q* denotes quarter. *fs* is one of the three measures of household food security described earlier. *Prices* represents a vector of commodity prices, *HH* represents household-level variables, *DIST* represents district-level variables, denotes province dummy variables, and is an idiosyncratic error term.[13]

In order to isolate the effect of changes in wheat flour prices, we control for simultaneous price increases in other important commodities since household purchasing decisions are based on relative prices. The price vector includes the prices of milk, lamb, rice, vegetable oil, and kerosene for reasons described above. We include the following household characteristics: dummy for agricultural households (households who report owning or operating agricultural land); log values of assets, housing and livestock; age of household head; dummy for households in which heads are literate; dummy for households in which heads are married; and, separately, the numbers of men, women and children. We include the household composition variables to control for differences in consumption requirements between children and adults and for economies of scale in consumption.[14]

The asset values are intended to control for wealth effects and are assumed to be quasi-fixed in the short run.[15] The value of durable goods is estimated based on a detailed inventory of household assets; it accounts for depreciation and the opportunity cost of the funds tied up in the good. For housing, we estimate a hedonic model for housing based on characteristics of the structure, as well as the location, and derive an imputed rental value from this.[16] Finally we also include the current value of livestock owned by the household (all values are in Afghani).

[13] For our OLS estimates, we use a standard Huber-White estimator which allows for correlation of the residuals within PSUs and also corrects for stratification. For estimation of the sampling variance for our UQR estimator, we use a PSU-level bootstrap that accounts for correlation of the residuals within the PSUs, but does not account for the stratification.

[14] An alternative approach to account for such differences employs equivalency scales that take into account nutritional requirements based on age and, sometimes, gender when calculating per capita measures. See, for an early example, Buse and Salathe (1978). An advantage of including household composition in the specification, rather than through equivalence scales, is that this method allows the data to specify the parameterization of the scales.

[15] In previous versions of this work, we included quintiles of total per capita consumption in the specification to control for wealth and socio-economic status. A concern with this specification is that food consumption is one component of total consumption, thus inclusion of total consumption in any form would introduce endogeneity bias. We are grateful to a conference discussant for noting that, even more importantly, the inclusion of the consumption quintiles only allows the price effect to pick up variation within consumption quintiles and not across quintiles. In lieu of consumption, we now use multiple measures of assets to control for wealth and socio-economic status, and we treat these as fixed in the short run (i.e., not immediately linked to food consumption in the short run).

[16] The estimated housing value is the log of imputed, monthly rental value based on a hedonic model of the housing structure. The log value of assets is a self-assessed valuation based on a list of 13 assets including items

At the district level, we include dummies for topography—plateau and mountainous areas (plains areas make up the excluded category). To control for observable and unobservable time-invariant province-level factors that could confound the results, we include province dummy variables. While this method does not control for time-varying province characteristics, it does control for factors such as instability and conflict that may present throughout the survey year in certain provinces.

Equation (1) models changes in food security for all types of households; however we may expect these changes to differ based on whether a household is able to produce its own food. Deaton (1989, 2000) draws a theoretical distinction between households that can produce their own food (and sell it on the market) and those that cannot. Net buyers depend on the market to meet their food needs, while net sellers produce enough food to consume and to sell on the market. Increases in food prices hurt net buyers, but benefit net sellers whose revenues increase. The NRVA data do not allow us to distinguish directly between these households, thus we use an indicator for households that report owning or operating agricultural land as a broad proxy for this distinction. While not all households that have access to agricultural land are net sellers of food, most net sellers of food have access to agricultural land. In order to incorporate this distinction into the model, we add in an interaction between the log of wheat flour prices and the dummy for agricultural households.

Model Estimation

We estimate the parameters above with both ordinary least squares (OLS) and unconditional quantile regression (UQR). Each estimator has advantages and disadvantages, which we describe below. We argue that from a policy perspective the UQR estimator has the benefit of allowing one to examine the behavioral changes at a specific location on the distribution (such as the 25th quantile) or at a particular threshold on the distribution (such as the food poverty line) of the dependent variable.

OLS provides an estimate of the partial derivative ($_{1\text{-OLS}}$) of the conditional mean of the food security–related dependent variables with respect to changes in the price of wheat

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such as stove, refrigerator, radio, sewing machine, bicycle, etc. For details of the estimation, see Islamic Republic of Afghanistan, Central Statistics Organization (2011).

flour in equation (1). This is also a consistent estimator of the partial derivative with respect to price evaluated at the (unconditional) mean of the dependent variable because, by construction, OLS imposes the condition that the price response is assumed to be constant over the entire conditional distribution. This constraint stems from the linearity of OLS and the law of iterated expectations.[17] Thus an advantage of OLS is that the distinction between the conditional and unconditional distributions is not a concern. However, for those interested in estimating the marginal effects at the tails of the distribution, OLS techniques are inadequate.

The quantile estimator allows the partial response to vary across the conditional distribution. This flexibility is particularly relevant for policy analysis; for example, stakeholders may be interested in the impact of high food prices on those living close to subsistence levels rather than the response for the average (mean) household.

The quantile estimator estimates the conditional quantile marginal effect (CQME) or the partial derivative, as described by the following expression:

(2)

Following the notation of Koenker (2005), Q_{fs} is the conditional quantile function of our food security-related measures and represents quantiles of the conditional distribution. The estimated CQME can differ at each th quantile of the conditional distribution of the dependent variable.[18] Chamberlain (1994) illustrates the usefulness of this attribute by estimating the wage premium from union participation. LS results indicate that union participation has a positive effect on mean wages, but the quantile estimator results indicate a much larger premium to participation for those who are on the left-hand tail of the conditional distribution. Thus for low-wage earners, OLS appears to underestimate the effect of union participation, a fact that may be of relevance to social policy.

[17] The law of iterated expectations states that if X and Y are random variables, and Y is integrable, then the expected value of Y is equal to the expectation of the expected value of Y conditional on X; that is, $E(Y)=E[E(Y|X)]$.

[18] It is not always the case that the quantile estimator will necessarily provide qualitatively different information from OLS, but Koenker and Bassett (1982) show that in the presence of a heteroscedastic error distribution, the quantile estimator will typically differ from the OLS estimator.

The disadvantage of the quantile estimator is that its nonlinearity means that the CQME is not equal to the unconditional quantile marginal effect (UQME). The parameter estimate from the quantile estimator measures the marginal effect evaluated at the th quantile of the conditional, not unconditional, distribution. Equation (3) formalizes this statement.

(3)

This distinction between the conditional and unconditional distributions is important because policymakers may not be interested in the CQME, but rather may want to know the effect of the explanatory variable on the *unconditional* distribution (UQME). For example, policymakers are likely to be more interested in the price responsiveness of households who are at the food poverty line, and not those who are at the point on the conditional distribution corresponding to the food poverty line (after conditioning on several other household characteristics).

Firpo, Fortin and Lemieux (2009b, hereafter referred to as FFL) recently proposed a new estimator, the UQR estimator, which improves on both the OLS and quantile estimators. The UQR estimator allows marginal effects to be estimated at different points on the distribution, like the quantile estimator; and also respects the law of iterated expectations, like OLS. The implication of these attributes is that the UQR estimator provides an estimate of the UQME, which we argue is the essential information for policymakers.

The UQR estimator is based on influence functions, which were introduced by Hampel (1988) as a tool in robust estimation techniques.[19] Using notation (largely) from FFL, consider some distributional statistic, (F_y), such as the median, inter-quantile range, or any quantile. The influence function, IF(Y; , F_y), represents the influence of an individual observation on the distributional statistic, (F_y). A key innovation of FFL is that the authors add (F_y) to the influence function in order to center it; this new function is called a

[19] Robust statistics are statistics and estimators that are not heavily influenced by deviations from model assumptions, nor alternatively, heavily influenced by single observations. Influence functions provide a formal way of measuring the extent to which a particular estimator is affected by a single observation in the sample.

re-centered influence function (RIF). By design then, the E(RIF(Y; , F_y))= (F_y); that is, the expectation of the RIF at the th quantile is the value at the th quantile (e.g., the median if =50). FFL define (X) = E(RIF(Y; , F_y)|X) as the unconditional quantile regression model. The parameter estimates from the RIF regression provide estimates of UQME, or in our example, the marginal effect of a change in wheat flour prices on food expenditure evaluated at the food poverty line of the unconditional distribution, while controlling for the covariates in our model specification.[20]

With the quantile estimator, marginal effects are typically compared at fixed points on the conditional distribution. For example, Chamberlain (1994), Nguyen *et al.* (2007), Patrinos and Sakellariou (2006), and Stifel and Averett (2009) all examine the CQME at fixed intervals (such as the 10th, 25th, 50th, 75th, or 90th quantiles) on the conditional distribution. For our analysis, we similarly compare the UQME of the food security-related dependent variables at the 25th, 50th, 75th quantiles of their distributions to examine whether the effects differ in informative ways. Table 5 displays the values of the food security measures at various points of the unconditional distributions. The observed variation in these indicators suggests that the UQME may differ for households at the bottom and top of the distributions.

We also take a slightly different approach and examine the UQME for each of the dependent variables at points on the distribution that are assumed to have specific policy or nutritional relevance. For example, when examining per capita food expenditure, we estimate the UQME of a change in wheat flour prices at the point on the distribution that corresponds to the food poverty line. This line is a policy-relevant threshold on the expenditure distribution that is constructed to measure the minimum cost to obtain 2100 calories (following typical consumption patterns of the relatively poor). Similarly, we examine the UQME at points on the distribution corresponding to 2,100 calories (which is also the calorie basis for the food poverty line and the poverty line), and the food consumption score thresholds of 28 (identifying a poor diet) and 42 (identifying a marginal

[20] FFL provide an estimation method based on transforming the dependent variable into the re-centered influence function and then using OLS estimation. FFL show that this approach yields a consistent estimator of the average marginal effect, E[d Pr[Y > | X]/dX], if Pr[Y > | X=x] is linear in x. In order to estimate the standard errors, we follow FFL (2009b) and use a bootstrap estimator of the sampling variance. For the interested reader, FFL (2009a) derive the asymptotic properties of the estimator and provide the analytical standard errors.

diet). Measuring responses at these thresholds helps better inform policymakers how those individuals and households who are on the cusp of poverty and/or poor health are affected by wheat flour price changes.

Results

In this section, we first present and compare the results using the OLS estimator and the unconditional quantile regression estimator for quartiles of the respective dependent variable distributions. We then present and discuss estimates corresponding to the policy-relevant thresholds mentioned above. These are estimated for all households and then repeated with an interaction term to determine if the responses differ based on a household's access to agricultural land. The main results tables display the coefficients of interest. Full sets of results can be found in the appendix, tables A2-A6.

OLS and unconditional quantile regression estimation

An increase in the price of wheat flour is associated with statistically significant declines in our food security-related measures at the national level. The declines are observed at the means of the unconditional distributions of the food security-related measures, as well as across the distributions. Table 6 displays the coefficient of interest (on the log of wheat flour price) for the OLS estimator and UQR estimators (at the 25th, 50th, and 75th quantiles).

The OLS estimates reveal a negative marginal effect of an increase in the price of wheat flour on the real value of monthly per capita food consumption; due to the nature of the OLS estimator, this coefficient represents the estimated response for all households across the distribution. Similar to the results in D'Souza and Jolliffe (2010), this reduction is approximately evenly split between a reduction in caloric intake and dietary diversity. These coefficients are larger in magnitude than those in D'Souza and Jolliffe (2010) due to differences in the specification, but the general finding that calories and diversity decline by approximately equal levels is the same.[21]

We interpret these results as a quality for quantity trade-off that households make in order to maintain energy (calorie) levels in the face of declining purchasing power. The declines in dietary diversity indicate that households changed the composition of their diets, perhaps by cutting back on more expensive, nutrient-rich foods and moving toward cheaper foods and food groups. Such changes in dietary composition can have potentially serious implications for more vulnerable groups who have high nutrient requirements, such as children at developmental stages, pregnant and lactating mothers, and the elderly.

The results across the distributions of households paint a richer picture of the impact of the price shocks. As may have been expected, richer households (75th quantile), in terms of food consumption, experienced a much larger drop in the real value of food consumption; in fact, the percentage reduction for these households is over two and a half times as large as the reduction for households at the bottom quartile (25th quantile).[22] At a very basic level, richer households have more to give, whereas poorer households cannot make large reductions to their food consumption because they live closer to subsistence levels. Further, richer households host more guests, eat away from home more often, and may waste more food, on average, than poorer households; therefore the former may be able to make larger reductions in the value of food consumption without greatly affecting the food intake of individual household members.

The estimates of changes in caloric intake also support this story. Those at the bottom of the caloric intake distribution (25th quantile) experience a very small decline in per capita intake, equivalent to about 175 calories or a third of a standard naan (Afghan bread).

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[21] The coefficients from the regression analysis correspond (approximately) to a one percent increase in the price of wheat flour. Converting the coefficients to percentage changes associated with a 10 percent increase in wheat flour prices suggests that there would be a corresponding 4.3% reduction in the value of food consumption and slightly less than 2% reductions in both caloric intake and dietary diversity.

[22] We note here the standard caution that the regression coefficients represent estimated effects from small, marginal price changes. This caution against using estimated marginal effects as a basis for simulating large, non-marginal price changes is particularly warranted in the case of quantile estimators where different estimated effects at different points on the distribution of the dependent variable imply a changing shape of this distribution due to price changes. Variation in the estimated marginal effects at different points on the distribution can readily imply re-rankings of observations (in terms of the dependent variable) with large enough simulated changes. But this exercise would be nonsensical as one would expect that as the shape of the distribution changes from non-marginal price changes, thus there would be a new set of estimated marginal effects at each of the points on the distribution.

These households are living at the threshold of energy requirements (with an average daily per capita caloric intake of 2,030) and, most likely, are unable to cut back on calories without experiencing serious nutritional consequences. In contrast, the percentage reduction in caloric intake for richer households (75th quantile) is over three times as large as that for poorer households.

These adjustments in caloric intake link directly to concessions in dietary quality. Households at the bottom of the dietary diversity distribution must make larger reductions in the diversity of their diets in order to maintain energy levels, relative to those at the top of the distribution. The richer households (75th quantile) make larger percentage reductions in the quantity (calories) of food consumed than in the quality (dietary diversity) of food consumed.

These findings are consistent with the literature on the impact of high food prices on nutritional outcomes. For example, Klotz et al. (2008) argue that during times of economic crisis and when households cannot increase the amount that they spend on food, they are forced to cut back on expensive, micronutrient-rich foods in order to maintain their consumption of core staples. Therefore economic shocks will lead to micronutrient deficiencies before weight loss.

These findings are also consistent with past studies related to the impact of economics shocks on nutrition. Diagana *et al.* (1999) find decreases in levels of dietary diversity and changes in food consumption patterns after the 1994 devaluation of the CFA franc using data from West Africa. Martin-Prevel *et al.* (2000) find reductions in maternal and nutritional status following the same currency devaluation. And Block *et al.* (2004) find declines in maternal and child nutritional status following the drought and financial crisis of 1997-98 in Indonesia. See Ruel *et al.* (2010) for a more detailed review of the literature on the effects of economic crises on household wellbeing.

Next we turn to the effects of the wheat flour price increases for different types of households – those who have access to agricultural land and those who do not. (Table 7) There is no statistically significant difference in the impact of the price shocks on the real value of food consumption for these two groups, based on either OLS or UQR techniques. But the behavioral responses of these two groups vary with respect to the other measures of food security. The OLS estimates indicate that nonagricultural households make relatively larger reductions in dietary diversity and relatively smaller reductions in caloric intake than agricultural households. These differences may stem from differences in preferences for a more diverse diet or differences in access to a variety of foods during periods of high food prices, e.g., agricultural households may be able to obtain a more diverse basket of foods through home production.

The UQR estimates paint a similar picture for households at the median but slightly different pictures for richer and poorer households. For poorer households (25th quantile), we observe no statistically significant difference in the responses of agricultural and nonagricultural households with respect to caloric intake, but we do observe a difference with respect to dietary diversity. For richer households (75^{th} quantile), the opposite is true; we observe significant differences with respect to caloric intake, but not with respect to dietary diversity.

Policy-relevant thresholds

The next set of results corresponds to the effects of wheat flour prices on measures of food security at pertinent points of the respective distributions. For the real value of food consumption, we use the value of the food poverty line described earlier, 687 Afghani per person per month. For caloric intake we use 2,100 kilocalories and for the food consumption score we use the WFP recommended thresholds of 28 and 42. The results are displayed in Table 8; we include the OLS results for comparison.

In most cases, the marginal effects estimated by OLS are larger than those estimated at the policy-relevant cutoff by UQR, implying that the mean household is more affected by the price shocks than those living near subsistence levels. This finding is consistent with a story of market exposure, as well as the story described above that richer households have more to give in terms of the value of their food consumption and their caloric intake. We might expect households living close to subsistence levels to have a minimum level of market participation and thus be less affected by price shocks.

In the case of dietary diversity, the OLS estimate is smaller than the UQR marginal effect for those households living at the threshold of a borderline diet (food consumption score = 42). The substantial decreases in dietary quality indicated by these results suggest that the micronutrient intake of some or all individuals in these households may have declined in a significant way. These findings may provide useful information for policymakers as they seek to better understand the behavior of the most vulnerable households during times of high food price inflation.

Robustness – to be completed

Conclusion

Increases in the level and volatility of food prices over the past several years have led to a severe erosion of purchasing power in developing countries where the poor often spend the majority of their budgets on food. In particular, increases in the price of staple foods can have deleterious effects for households living at subsistence levels.

In this paper, we use the case of Afghanistan during the 2007-08 global food price crisis to examine the impact of high staple food prices on household food security. We build on work by D'Souza and Jolliffe (2010), who use OLS estimation techniques to identify the effect of increases in wheat flour prices on several measures of food security. Instead of focusing on the marginal price effects associated with mean values, we utilize the unconditional quantile regression estimator, proposed by Firpo, Fortin and Lemieux (2009b), to examine the marginal effects associated with the 25^{th}, 50^{th} and 75^{th} quantiles of the distribution of each food security-related dependent variable, as well as marginal effects associated with key policy-relevant thresholds.

The key findings of our analysis illustrate the value of distribution-sensitive analysis. We find large differences in the behavioral response of a household to wheat flour price increases based on its location on the unconditional distribution of each of our measures of food security – differences that are obscured when using OLS estimation techniques. Households at the 75^{th} quantile of the distribution of real food consumption experience the largest percentage declines in real food consumption for a given increase in wheat flour prices – over two and a half times larger than those at the 25^{th} quantile. Analogously, those at the 75^{th} quantile of the caloric intake distribution experience the largest percentage declines in caloric intake for a given increase in wheat flour prices. As to be expected, households at the bottom of the caloric intake distribution make very small reductions in caloric intake due to the price increases. Such households live near subsistence levels and are forced to make adjustments to the quality of their diets in order to maintain energy levels; households at the 25th quantile of the dietary diversity distribution make the largest changes to the quality of their diets – about one and a half times larger than those at the 75th quantile.

The findings have several implications. First, if policymakers focus exclusively on changes in caloric intake that result from price shocks, they may miss an important component of the big picture. While poorer households do not cut back on calories very much, it is likely that they reduce dietary quality. Such findings underscore the importance of micronutrient interventions, such as fortification of staples and vitamin distributions, during periods of high food prices.

Second, household survey consumption modules often include questions on the quantity of food items consumed or the expenditure on food items, but not on the frequencies with which the food items are consumed. Given the low cost of adding questions on the frequencies of food intake, it may be beneficial to consider augmenting household surveys, particularly for populations that are vulnerable to food insecurity. Measures of dietary diversity are useful tools when detailed food journals or anthropometric data are not available and so micronutrient and macronutrient intake cannot be measured directly. Ruel (2003) discusses some of the benefits and costs of indicators of dietary diversity. In the nutrition literature, Alexander and Thomson (1992) discuss the importance of collecting frequency data in addition to quantity intake data. They demonstrate that both the quantity of food ingested and the intake frequency are important determinants of diet-induced diseases; they argue that looking solely at quantity data could be misleading. Our findings are consistent with this view.

Finally and more broadly, examining household responses using OLS estimation may be misleading since the response for the mean household may be substantially different from the responses of those at the top or the bottom of the distribution. This paper demonstrates the potential benefits of using a quantile regression estimator, particularly one that allows estimation of marginal effects at various quantiles of the unconditional distribution.

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Table 1. Population means

	National	Agricultural Households [a]	Nonagricultural Households [a]
Nominal value of per capita monthly total consumption (Afghani)	1926	1752	2159
	(1158)	(934)	(1371)
Nominal value of per capita monthly food consumption (Afghani)	1158	1134	1189
	(583)	(528)	(648)
Per capita daily caloric intake (kilocalories)	2601	2587	2619
	(974)	(977)	(969)
Food consumption score	60.95	61.59	60.07
	(20.03)	(19.48)	(20.71)
Age of household head	44.87	45.37	44.19
	(13.78)	(13.68)	(13.89)
Number of males	2.09	2.19	1.96
	(1.30)	(1.33)	(1.25)
Number of females	2.01	2.09	1.89
	(1.19)	(1.22)	(1.13)
Number of children under 16	4.51	4.75	4.18
	(2.39)	(2.46)	(2.26)
Dummy for married household heads	0.95	0.95	0.94
Dummy for literate household heads	0.32	0.30	0.34
Dummy for plateau areas	0.22	0.27	0.16
Dummy for mountainous areas	0.39	0.49	0.27
Total observations	20,491	11,633	8,858
Percentage of full sample	100.00	0.57	0.43

Note: Estimates are population weighted means, with standard deviations in parentheses. All prices are in Afghani per kilogram, except the price of kerosene, which is per liter. [a] Statistical tests of differences in means between Agricultural and Nonagricultural Households show significant differences at a 5% level of significance for all estimated means. *Source:* NRVA 2007/08

Table 2. Average prices of key commodities			
	National	**Agricultural Households** [a]	**Nonagricultural Households** [a]
Price of wheat flour	28.45	29.01	28.45
	(8.15)	(8.35)	(8.15)
Price of vegetable oil	81.16	82.39	81.16
	(6.88)	(6.97)	(6.88)
Price of rice	42.77	43.25	42.77
	(14.93)	(15.07)	(14.93)
Price of lamb	184.44	183.01	184.44
	(11.97)	(12.38)	(11.97)
Price of milk	26.94	26.57	26.94
	(23.91)	(24.08)	(23.91)
Price of kerosene	48.12	48.80	48.12
	(6.25)	(6.05)	(6.25)

Note: Estimates are population weighted means, with standard deviations in parentheses. Prices are in Afghani per kilogram, with the exception of the price of kerosene, which is per liter. [a] Statistical tests of differences in means (corrected for complex sample design) between prices faced by Agricultural and Nonagricultural Households (based on location) show significant differences at a 5% level of significance for all estimated means, with the exception of the price of lamb. *Source:* NRVA 2007/08

Table 3: Average prices by quarter

	Quarter 1 (Fall)	Quarter 2 (Winter)	Quarter 3 (Spring)	Quarter 4 (Summer)
	Full Sample			
Price of domestic wheat flour	18.09	23.51	34.19	36.51
Price of vegetable oil	64.81	76.93	88.90	91.70
Price of domestic rice	33.93	33.99	46.16	55.29
Price of lamb	182.34	186.20	189.28	180.27
Price of milk	23.44	25.66	27.23	30.75
Price of kerosene	43.15	45.78	46.83	55.48

Note: Estimates are population weighted means. Prices are in Afghani per kilogram, with the exception of the price of kerosene, which is in Afghani per liter. *Source:* NRVA 2007/08

Table 4. Population statistics by quarter

	Quarter 1 (Fall)	Quarter 2 (Winter)	Quarter 3 (Spring)	Quarter 4 (Summer)
	Full Sample			
Nominal value of monthly total consumption	2017.79	1902.86	1876.92	1914.64
Real value of monthly total consumption	2022.00	1718.27	1519.12	1477.56
Nominal value of monthly food consumption	1196.98	1123.25	1129.01	1182.97
Real value of monthly food consumption	1201.19	961.26	789.41	797.60
Daily caloric intake	2884.92	2725.03	2445.83	2387.33
Food consumption score	67.88	61.28	57.86	57.69

Note: Estimates are population weighted means. All values are in per capita terms, except the food consumption score, which is calculated for the household. Real values reflect adjustments for spatial and temporal price differences, covering 13 months of field work. Values are in Afghani. Caloric intake is in kilocalories. *Source:* NRVA 2007/08

Table 5. Food security measures across the distribution

National sample	Mean	25th	50th	75th
Real value of per capita monthly food consumption	929	612	810	1101
Daily per capita caloric intake	2601	2030	2441	3006
Food consumption score	61	46	61	74
Agricultural households	Mean	25th	50th	75th
Real value of per capita monthly food consumption	911.29	606.95	801.34	1088.28
Daily per capita caloric intake	2586.81	2026.04	2419.25	2964.53
Food consumption score	61.59	48.00	62.00	74.00
Nonagricultural households	Mean	25th	50th	75th
Real value of per capita monthly food consumption	951.86	619.16	821.26	1121.48
Daily per capita caloric intake	2619.47	2033.54	2470.99	3044.94
Food consumption score	60.07	44.00	59.50	75.00

Note: Real values, in Afghani, reflect adjustments for spatial and temporal price differences, covering 13 months of field work. Caloric intake is in kilocalories. *Source:* NRVA 2007/08

Table 6. Effects of wheat flour prices on measures of food security

	OLS		Unconditional Quantile Regression		
	Mean		*25th quantile*	*50th quantile*	*75th quantile*
Log Real Value of Monthly Per Capita Food Consumption	-0.425***		-0.242***	-0.433***	-0.619***
	[0.0364]		[0.0437]	[0.0447]	[0.0571]
Log Daily Per Capita Calorie Intake	-0.184***		-0.0866***	-0.187***	-0.279***
	[0.0244]		[0.0290]	[0.0268]	[0.0340]
Log Food Consumption Score	-0.189***		-0.246***	-0.173***	-0.158***
	[0.0270]		[0.0508]	[0.0305]	[0.0319]

Note: Coefficients and standard errors are from separate, population weighted regression with the dependent variable listed in the first column. Total observations: 20,483. Real values reflect adjustments for spatial and temporal price differences. OLS standard errors are corrected for clustering and stratification, UQR standard errors are clustered bootstrap (with replacement) estimates. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 7. Coefficients of Interest at the Sub-national Level

	OLS		Unconditional Quantile Regression		
	Mean		*25th quantile*	*50th quantile*	*75th quantile*
	Log Real Value of Monthly Per Capita Food Consumption				
Log Price of Wheat Flour	-0.437***		-0.220***	-0.416***	-0.615***
	[0.0401]		[0.0460]	[0.0540]	[0.0608]
Log Price of Wheat Flour X Agricultural Household	0.0196		-0.0355	-0.0275	-0.0072
	[0.0288]		[0.0349]	[0.0336]	[0.0410]
P-value of F-statistic of joint significance	0.00		0.00	0.00	0.00
	Log Daily Calorie Per Capita Intake				
Log Price of Wheat Flour	-0.138***		-0.0641**	-0.136***	-0.237***
	[0.0263]		[0.0298]	[0.0285]	[0.0356]
Log Price of Wheat Flour X Agricultural Household	-0.0750***		-0.037	-0.0837***	-0.0700***
	[0.0203]		[0.0231]	[0.0206]	[0.0267]
P-value of F-statistic of joint significance	0.00		0.01	0.00	0.00
	Log Food Consumption Score				
Log Price of Wheat Flour	-0.229***		-0.317***	-0.201***	-0.156***
	[0.0300]		[0.0551]	[0.0316]	[0.0341]
Log Price of Wheat Flour X Agricultural Household	0.0665***		0.117***	0.0459**	-0.00321
	[0.0195]		[0.0368]	[0.0215]	[0.0240]
P-value of F-statistic of joint significance	0.00		0.00	0.00	0.00

Note: Each set of coefficients and standard errors are from separate, population weighted regression, with the dependent variable listed above the estimates. Total observations: 20,483. Real values reflect adjustments for spatial and temporal price differences. OLS standard errors are corrected for clustering and stratification, UQR standard errors are clustered bootstrap (with replacement) estimates. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 8. Marginal Effects at Policy-relevant Cutoffs

	OLS	UQR
	Mean	*Policy-relevant cutoff*
Log Real Value of Monthly Per Capita Food Consumption	-0.425***	-0.298***
Cutoff: Value = 687.13	[0.0364]	[0.0437]
Log Daily Per Capita Calorie Intake	-0.184***	-0.115***
Cutoff: Intake = 2,100	[0.0244]	[0.0279]
Log Food Consumption Score		
Mean	-0.189***	
	[0.0270]	
Poor Diet Cutoff: Score= 28		-0.163***
		[0.0565]
Borderline Diet Cutoff: Score= 42		-0.256***
		[0.0518]

Note: Coefficients and standard errors are from separate, population weighted regression with the dependent variable listed in the first column. Below the dependent variable, we list the policy-relevant cutoff at which the marginal effect is evaluated using UQR. Total observations: 20,483. Real values reflect adjustments for spatial and temporal price differences. OLS standard errors are corrected for clustering and stratification, UQR standard errors are clustered bootstrap (with replacement) estimates. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 9. Unconditional and Conditional Quantile Regression Estimates for Policy-relevant Cutoffs

	UQR	QR
Log Real Value of Monthly Per Capita Food Consumption	-0.298***	-0.383***
Cutoff: Value = 687.13	[0.0437]	[0.0224]
Log Daily Per Capita Calorie Intake	-0.115***	-0.116***
Cutoff: Intake = 2,100	[0.0279]	[0.0153]
Log Food Consumption Score		
Poor Diet Cutoff: Score= 28	-0.163***	-0.134***
	[0.0565]	[0.0333]
Borderline Diet Cutoff: Score= 42	-0.256***	-0.160***
	[0.0518]	[0.0231]

Note: QR represents unconditional quantile regression estimation. Coefficients and standard errors are from separate regressions with population weighted estimates with the dependent variable and the cutoff value listed in the first column. Total observations: 20,483. Real values reflect adjustments for spatial and temporal price differences. OLS standard errors are corrected for clustering and stratification, UQR standard errors are clustered bootstrap (with replacement) estimates. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table A1. Key indicators across quarters

	Quarter 1 (Fall)	Quarter 2 (Winter)	Quarter 3 (Spring)	Quarter 4 (Summer)	All
Demographic Indicators					
Average household size*	7.4	7.5	7.1	7.2	7.3
Average age (years)	20.6	20.4	20.7	20.5	20.6
Household members %, age <15)	47.9	48.7	48.4	48.7	48.5
Age dependency ratio	131.6	134.2	133.6	134.0	133.4
Education and Health Indictors					
Full Immunization (%, age 12-23 months)*	33.0	41.1	34.8	37.6	36.7
Literate household head (%)*	34.4	28.8	28.4	29.5	30.1
Ever attended school (%, age >18)*	21.7	21.3	18.9	21.6	20.9
Education level of persons (age >18)	2.0	1.9	1.6	1.9	1.9
Access to Services and Infrastructure Indicators					
Safe drinking water (% hh)*	30.4	27.7	24.2	25.3	26.8
Sanitary toilet (% hh)	5.9	5.6	4.5	4.0	4.9
Electricity (% hh)	40.9	42.2	41.5	39.8	41.1

Note: Estimates are population weighted means. * denotes estimates that are statistically different at 10% across quarters. *Source:* NRVA 2007/08

Table A2. National results using the OLS estimator			
	Log Real Value of Monthly Food Consumption	**Log Daily Calorie Intake Per Capita**	**Log Food Consumption Score**
Log Wheat Flour Price	-0.425***	-0.184***	-0.189***
	[0.0364]	[0.0244]	[0.0270]
Agricultural Household	0.0351***	0.0302***	0.0310***
	[0.0100]	[0.00713]	[0.00727]
Log Real Value Monthly	0.0366***	-0.00489	0.0381***
Housing Per Capita	[0.00684]	[0.00444]	[0.00479]
Log Real Value Monthly	0.0996***	0.0375***	0.0571***
Durables Per Capita	[0.00444]	[0.00332]	[0.00303]
Log Real Value Livestock	0.0133***	0.00670***	0.0166***
Per Capita	[0.00128]	[0.000932]	[0.000999]
Log Kerosene Price	0.233***	0.179***	-0.0286
	[0.0644]	[0.0461]	[0.0477]
Log Vegetable Oil Price	-0.140**	0.0136	-0.0329
	[0.0598]	[0.0443]	[0.0442]
Log Local Rice Price	-0.0059	-0.109***	0.0734***
	[0.0398]	[0.0264]	[0.0263]
Log Lamb Price	-0.128	-0.0488	-0.0199
	[0.0903]	[0.0629]	[0.0644]
Log Milk Price	-0.140***	-0.143***	-0.103***
	[0.0376]	[0.0280]	[0.0268]
Head Age	0.00173	0.0284	0.024
	[0.0264]	[0.0213]	[0.0200]
Head Married	0.00754	-0.0323***	0.0621***
	[0.0144]	[0.0106]	[0.0101]
Head Literate	-0.0371***	-0.000189	-0.0453***
	[0.00775]	[0.00610]	[0.00572]
Number Men	0.00194	-0.004	0.0198***
	[0.00382]	[0.00303]	[0.00294]
Number Women	-0.00192	-0.00502*	0.0167***
	[0.00353]	[0.00275]	[0.00256]
Number Children	-0.0208***	-0.0212***	0.0128***
	[0.00177]	[0.00144]	[0.00127]
Plateau	0.00367	5.49E-06	-0.00466
	[0.0210]	[0.0141]	[0.0153]
Mountainous	-0.00373	0.00126	-0.0115
	[0.0196]	[0.0141]	[0.0139]
Observations	20,483	20,483	20,483
R-squared	0.353	0.25	0.392

Note: Each column represents a separate regression with population weighted estimates. Robust standard errors -in brackets- are clustered by stratum and adjusted for survey design. Real values reflect adjustments for spatial and temporal price differences. Plains is excluded category. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table A3. National results using the unconditional quantile regression			
	Log Real Value of Monthly Food Consumption		
	25th	50th	75th
Log Wheat Flour Price	-0.242***	-0.433***	-0.619***
	[0.0437]	[0.0447]	[0.0571]
Agricultural Household	0.0382***	0.0321***	0.0407***
	[0.0126]	[0.0117]	[0.0138]
Log Real Value	0.0210**	0.0396***	0.0410***
Monthly Housing Per	[0.00854]	[0.00774]	[0.00910]
Log Real Value	0.0813***	0.0807***	0.107***
Monthly Durables Per	[0.00568]	[0.00518]	[0.00733]
Log Real Value	0.0117***	0.0135***	0.0115***
Livestock Per Capita	[0.00154]	[0.00147]	[0.00209]
Log Kerosene Price	0.215**	0.141*	0.272***
	[0.0839]	[0.0727]	[0.0930]
Log Vegetable Oil Price	-0.0755	-0.0717	-0.119
	[0.0621]	[0.0689]	[0.0900]
Log Local Rice Price	-0.0615	-0.00552	0.0283
	[0.0562]	[0.0476]	[0.0573]
Log Lamb Price	-0.141	-0.200*	-0.258*
	[0.107]	[0.109]	[0.132]
Log Milk Price	-0.108**	-0.0809*	-0.173***
	[0.0421]	[0.0431]	[0.0553]
Head Age	0.0192	0.00517	-0.00127
	[0.0361]	[0.0342]	[0.0411]
Head Married	0.0461**	0.024	-0.00441
	[0.0189]	[0.0181]	[0.0223]
Head Literate	-0.0245**	-0.0349***	-0.0434***
	[0.00973]	[0.00997]	[0.0128]
Number Men	-0.00244	0.00781*	0.00366
	[0.00467]	[0.00467]	[0.00599]
Number Women	0.00194	-0.00318	0.00264
	[0.00448]	[0.00430]	[0.00539]
Number Children	-0.0150***	-0.0182***	-0.0236***
	[0.00239]	[0.00225]	[0.00287]
Plateau	-0.00518	-0.00539	0.0382
	[0.0244]	[0.0220]	[0.0268]
Mountainous	-0.00952	0.00443	0.000734
	[0.0212]	[0.0220]	[0.0273]
Observations	20,483	20,483	20,483
R-squared	0.183	0.231	0.23
See Notes for Table A2.			

Table A3 continued			
	Log Daily Calorie Intake Per Capita		
	25th	50th	75th
Log Wheat Flour Price	-0.0866***	-0.187***	-0.279***
	[0.0290]	[0.0268]	[0.0340]
Agricultural Household	0.0303***	0.0215***	0.0254***
	[0.00791]	[0.00744]	[0.00917]
Log Real Value Monthly	-0.00970*	-0.00513	0.00438
Housing Per Capita	[0.00510]	[0.00488]	[0.00565]
Log Real Value Monthly	0.0329***	0.0344***	0.0336***
Durables Per Capita	[0.00370]	[0.00341]	[0.00462]
Log Real Value Livestock	0.00578***	0.00541***	0.00509***
Per Capita	[0.00101]	[0.000964]	[0.00130]
Log Kerosene Price	0.176***	0.217***	0.326***
	[0.0522]	[0.0452]	[0.0554]
Log Vegetable Oil Price	0.057	0.0294	-0.00418
	[0.0465]	[0.0448]	[0.0556]
Log Local Rice Price	-0.120***	-0.0990***	-0.111***
	[0.0350]	[0.0301]	[0.0351]
Log Lamb Price	-0.158**	-0.00786	0.0426
	[0.0737]	[0.0647]	[0.0813]
Log Milk Price	-0.128***	-0.123***	-0.161***
	[0.0316]	[0.0285]	[0.0351]
Head Age	0.00601	0.0417**	0.0591**
	[0.0243]	[0.0211]	[0.0277]
Head Married	-0.0146	-0.0198*	-0.0318**
	[0.0120]	[0.0117]	[0.0146]
Head Literate	0.00476	0.00286	0.00699
	[0.00682]	[0.00655]	[0.00823]
Number Men	-0.00124	-0.00111	-0.00453
	[0.00327]	[0.00340]	[0.00440]
Number Women	0.000764	-0.00398	-0.00670*
	[0.00324]	[0.00290]	[0.00382]
Number Children	-0.0155***	-0.0184***	-0.0235***
	[0.00162]	[0.00162]	[0.00222]
Plateau	0.00628	0.00175	0.00868
	[0.0142]	[0.0141]	[0.0165]
Mountainous	-0.000836	0.00897	0.015
	[0.0134]	[0.0140]	[0.0177]
Observations	20,483	20,483	20,483
R-squared	0.163	0.194	0.177
See Notes for Table A2.			

Table A3 continued			
	Log Food Consumption Score		
	25th	**50th**	**75th**
Log Wheat Flour Price	-0.246***	-0.173***	-0.158***
	[0.0508]	[0.0305]	[0.0319]
Agricultural Household	0.0586***	0.0361***	0.0179**
	[0.0148]	[0.00834]	[0.00834]
Log Real Value Monthly	0.0456***	0.0415***	0.0322***
Housing Per Capita	[0.00995]	[0.00581]	[0.00525]
Log Real Value Monthly	0.0627***	0.0490***	0.0553***
Durables Per Capita	[0.00573]	[0.00375]	[0.00424]
Log Real Value Livestock	0.0303***	0.0163***	0.00762***
Per Capita	[0.00232]	[0.00123]	[0.00118]
Log Kerosene Price	-0.180**	-0.0888*	0.0648
	[0.0891]	[0.0458]	[0.0495]
Log Vegetable Oil Price	0.0192	-0.0525	-0.120**
	[0.0793]	[0.0479]	[0.0481]
Log Local Rice Price	0.205***	0.108***	0.00474
	[0.0492]	[0.0316]	[0.0348]
Log Lamb Price	0.244**	-0.108	-0.296***
	[0.118]	[0.0686]	[0.0682]
Log Milk Price	-0.0797*	-0.109***	-0.159***
	[0.0471]	[0.0289]	[0.0331]
Head Age	0.0526	0.00479	0.00531
	[0.0388]	[0.0230]	[0.0233]
Head Married	0.0828***	0.0645***	0.0448***
	[0.0222]	[0.0115]	[0.0128]
Head Literate	-0.0654***	-0.0397***	-0.0353***
	[0.0113]	[0.00710]	[0.00742]
Number Men	0.0211***	0.0153***	0.0231***
	[0.00539]	[0.00347]	[0.00401]
Number Women	0.0178***	0.0149***	0.0126***
	[0.00490]	[0.00306]	[0.00337]
Number Children	0.0162***	0.0118***	0.0128***
	[0.00242]	[0.00154]	[0.00175]
Plateau	-0.0376	0.00798	0.0366**
	[0.0264]	[0.0154]	[0.0154]
Mountainous	-0.034	-0.00204	0.0181
	[0.0246]	[0.0153]	[0.0166]
Observations	20,483	20,483	20,483
R-squared	0.268	0.284	0.237
See Notes for Table A2.			

Table A4. Differential impact of wheat flour price increases using the OLS estimator			
	Log Real Value of Monthly Food Consumption	**Log Daily Calorie Intake Per Capita**	**Log Food Consumption Score**
Log Wheat Flour Price	-0.437***	-0.138***	-0.229***
	[0.0401]	[0.0263]	[0.0300]
Log Wheat Flour Price X Agricultural Household	0.0196	-0.0750***	0.0665***
	[0.0288]	[0.0203]	[0.0195]
Agricultural Household	-0.0296	0.277***	-0.188***
	[0.0971]	[0.0685]	[0.0649]
Log Real Value Monthly Housing Per Capita	0.0367***	-0.00538	0.0385***
	[0.00685]	[0.00440]	[0.00482]
Log Real Value Monthly Durables Per Capita	0.0996***	0.0372***	0.0573***
	[0.00444]	[0.00332]	[0.00303]
Log Real Value Livestock Per Capita	0.0133***	0.00675***	0.0165***
	[0.00128]	[0.000930]	[0.000999]
Log Kerosene Price	0.236***	0.169***	-0.0192
	[0.0644]	[0.0461]	[0.0476]
Log Vegetable Oil Price	-0.141**	0.0147	-0.0338
	[0.0598]	[0.0442]	[0.0440]
Log Local Rice Price	-0.00662	-0.107***	0.0710***
	[0.0399]	[0.0263]	[0.0262]
Log Lamb Price	-0.128	-0.0492	-0.0196
	[0.0902]	[0.0628]	[0.0642]
Log Milk Price	-0.140***	-0.145***	-0.101***
	[0.0377]	[0.0279]	[0.0268]
Head Age	0.0013	0.0301	0.0225
	[0.0263]	[0.0212]	[0.0200]
Head Married	0.00756	-0.0324***	0.0622***
	[0.0144]	[0.0106]	[0.0101]
Head Literate	-0.0370***	-0.000657	-0.0448***
	[0.00776]	[0.00608]	[0.00573]
Number Men	0.00196	-0.00405	0.0199***
	[0.00382]	[0.00302]	[0.00294]
Number Women	-0.00194	-0.00495*	0.0166***
	[0.00353]	[0.00274]	[0.00255]
Number Children	-0.0208***	-0.0213***	0.0129***
	[0.00177]	[0.00144]	[0.00127]
Plateau	0.00375	-0.000291	-0.0044
	[0.0210]	[0.0141]	[0.0153]
Mountainous	-0.00372	0.00119	-0.0115
	[0.0196]	[0.0141]	[0.0139]
Observations	20,483	20,483	20,483
R-squared	0.353	0.251	0.393
See Notes for Table A2.			

Table A5. Differential impact of wheat flour price increase using the unconditional quantile regression estimator			
	Log Real Value of Monthly Food Consumption		
	25th	**50th**	**75th**
Log Wheat Flour Price	-0.220***	-0.416***	-0.615***
	[0.0460]	[0.0540]	[0.0608]
Log Wheat Flour Price X	-0.0355	-0.0275	-0.0072
Agricultural Household	[0.0349]	[0.0336]	[0.0410]
Agricultural Household	0.155	0.123	0.0644
	[0.116]	[0.113]	[0.140]
Log Real Value Monthly Housing	0.0208**	0.0394***	0.0410***
Per Capita	[0.00866]	[0.00768]	[0.00915]
Log Real Value Monthly Durables	0.0812***	0.0806***	0.107***
Per Capita	[0.00548]	[0.00538]	[0.00732]
Log Real Value Livestock Per	0.0118***	0.0135***	0.0115***
Capita	[0.00158]	[0.00155]	[0.00196]
Log Kerosene Price	0.210**	0.137**	0.271***
	[0.0831]	[0.0697]	[0.0899]
Log Vegetable Oil Price	-0.075	-0.0713	-0.119
	[0.0623]	[0.0720]	[0.0940]
Log Local Rice Price	-0.0602	-0.00452	0.0286
	[0.0543]	[0.0484]	[0.0589]
Log Lamb Price	-0.141	-0.200**	-0.258*
	[0.106]	[0.0961]	[0.134]
Log Milk Price	-0.109**	-0.0817**	-0.173***
	[0.0434]	[0.0416]	[0.0578]
Head Age	0.02	0.00578	-0.00111
	[0.0358]	[0.0321]	[0.0413]
Head Married	0.0461**	0.024	-0.00441
	[0.0189]	[0.0170]	[0.0223]
Head Literate	-0.0247**	-0.0350***	-0.0435***
	[0.0104]	[0.00945]	[0.0127]
Number Men	-0.00246	0.00779*	0.00366
	[0.00474]	[0.00461]	[0.00589]
Number Women	0.00197	-0.00315	0.00264
	[0.00437]	[0.00415]	[0.00523]
Number Children	-0.0150***	-0.0183***	-0.0236***
	[0.00223]	[0.00221]	[0.00269]
Plateau	-0.00532	-0.0055	0.0382
	[0.0234]	[0.0220]	[0.0280]
Mountainous	-0.00955	0.00441	0.000728
	[0.0218]	[0.0212]	[0.0277]
Observations	20,483	20,483	20,483
R-squared	0.183	0.231	0.23
See Notes for Table A2.			

Table A5 continued			
	Log Daily Calorie Intake Per Capita		
	25th	**50th**	**75th**
Log Wheat Flour Price	-0.0641**	-0.136***	-0.237***
	[0.0298]	[0.0285]	[0.0356]
Log Wheat Flour Price X Agricultural Household	-0.037	-0.0837***	-0.0700***
	[0.0231]	[0.0206]	[0.0267]
Agricultural Household	0.152**	0.297***	0.256***
	[0.0771]	[0.0697]	[0.0911]
Log Real Value Monthly Housing Per Capita	-0.00994**	-0.00568	0.00393
	[0.00497]	[0.00457]	[0.00557]
Log Real Value Monthly Durables Per Capita	0.0327***	0.0342***	0.0333***
	[0.00366]	[0.00351]	[0.00466]
Log Real Value Livestock Per Capita	0.00581***	0.00547***	0.00514***
	[0.00100]	[0.000978]	[0.00132]
Log Kerosene Price	0.171***	0.205***	0.316***
	[0.0500]	[0.0449]	[0.0556]
Log Vegetable Oil Price	0.0576	0.0306	-0.00319
	[0.0463]	[0.0444]	[0.0555]
Log Local Rice Price	-0.119***	-0.0960***	-0.109***
	[0.0341]	[0.0284]	[0.0347]
Log Lamb Price	-0.158**	-0.00828	0.0423
	[0.0745]	[0.0640]	[0.0806]
Log Milk Price	-0.129***	-0.125***	-0.163***
	[0.0310]	[0.0289]	[0.0340]
Head Age	0.00683	0.0435**	0.0607**
	[0.0234]	[0.0222]	[0.0282]
Head Married	-0.0146	-0.0198*	-0.0319**
	[0.0125]	[0.0110]	[0.0146]
Head Literate	0.00453	0.00233	0.00655
	[0.00679]	[0.00657]	[0.00839]
Number Men	-0.00127	-0.00117	-0.00458
	[0.00326]	[0.00343]	[0.00417]
Number Women	0.000798	-0.0039	-0.00663*
	[0.00322]	[0.00295]	[0.00357]
Number Children	-0.0155***	-0.0185***	-0.0236***
	[0.00170]	[0.00163]	[0.00220]
Plateau	0.00614	0.00141	0.0084
	[0.0140]	[0.0138]	[0.0179]
Mountainous	-0.000867	0.0089	0.015
	[0.0130]	[0.0144]	[0.0188]
Observations	20,483	20,483	20,483
R-squared	0.163	0.195	0.177
See Notes for Table A2.			

Table A5 continued			
	Log Food Consumption Score		
	25th	**50th**	**75th**
Log Wheat Flour Price	-0.317***	-0.201***	-0.156***
	[0.0551]	[0.0316]	[0.0341]
Log Wheat Flour Price X	0.117***	0.0459**	-0.00321
Agricultural Household	[0.0368]	[0.0215]	[0.0240]
Agricultural Household	-0.328***	-0.115	0.0284
	[0.123]	[0.0715]	[0.0812]
Log Real Value Monthly Housing	0.0464***	0.0418***	0.0322***
Per Capita	[0.00965]	[0.00593]	[0.00536]
Log Real Value Monthly Durables	0.0630***	0.0491***	0.0553***
Per Capita	[0.00585]	[0.00371]	[0.00415]
Log Real Value Livestock Per	0.0302***	0.0163***	0.00762***
Capita	[0.00230]	[0.00123]	[0.00113]
Log Kerosene Price	-0.163*	-0.0823*	0.0643
	[0.0900]	[0.0483]	[0.0473]
Log Vegetable Oil Price	0.0175	-0.0532	-0.120**
	[0.0803]	[0.0437]	[0.0496]
Log Local Rice Price	0.201***	0.107***	0.00486
	[0.0501]	[0.0303]	[0.0376]
Log Lamb Price	0.244**	-0.108	-0.296***
	[0.115]	[0.0685]	[0.0696]
Log Milk Price	-0.0763*	-0.108***	-0.160***
	[0.0454]	[0.0286]	[0.0336]
Head Age	0.05	0.00378	0.00538
	[0.0374]	[0.0240]	[0.0233]
Head Married	0.0829***	0.0645***	0.0448***
	[0.0213]	[0.0116]	[0.0122]
Head Literate	-0.0646***	-0.0394***	-0.0354***
	[0.0108]	[0.00694]	[0.00771]
Number Men	0.0212***	0.0154***	0.0231***
	[0.00551]	[0.00338]	[0.00378]
Number Women	0.0177***	0.0149***	0.0126***
	[0.00495]	[0.00309]	[0.00339]
Number Children	0.0163***	0.0118***	0.0128***
	[0.00236]	[0.00153]	[0.00176]
Plateau	-0.0372	0.00816	0.0366**
	[0.0260]	[0.0153]	[0.0159]
Mountainous	-0.0339	-0.002	0.0181
	[0.0246]	[0.0151]	[0.0162]
Observations	20,483	20,483	20,483
R-squared	0.269	0.284	0.237
See Notes for Table A2.			

Table A6. Unconditional quantile regression estimates at policy-relevant cutoffs				
	Real Value of Monthly Food Consumption = 687.13	**Daily Calorie Intake Per Capita = 2,100**	**Food Consumption Score = 28**	**Food Consumption Score = 42**
Log Wheat Flour Price	-0.298***	-0.115***	-0.163***	-0.256***
	[0.0437]	[0.0279]	[0.0565]	[0.0518]
Agricultural Household	0.0300**	0.0292***	0.0103	0.0426***
	[0.0119]	[0.00803]	[0.0192]	[0.0154]
Log Real Value Monthly Housing Per Capita	0.0339***	-0.0101**	0.0345***	0.0378***
	[0.00790]	[0.00476]	[0.0101]	[0.0101]
Log Real Value Monthly Durables Per Capita	0.0771***	0.0353***	0.0613***	0.0581***
	[0.00552]	[0.00345]	[0.00855]	[0.00592]
Log Real Value Livestock Per Capita	0.0140***	0.00604***	0.0199***	0.0281***
	[0.00152]	[0.00103]	[0.00290]	[0.00221]
Log Kerosene Price	0.129*	0.174***	-0.209	-0.237**
	[0.0780]	[0.0498]	[0.146]	[0.101]
Log Vegetable Oil Price	-0.0851	0.0603	0.0795	0.0491
	[0.0636]	[0.0426]	[0.103]	[0.0831]
Log Local Rice Price	-0.0378	-0.133***	0.0709	0.198***
	[0.0527]	[0.0347]	[0.0561]	[0.0497]
Log Lamb Price	-0.167	-0.0955	0.425**	0.283**
	[0.107]	[0.0680]	[0.166]	[0.125]
Log Milk Price	-0.0932**	-0.115***	0.0404	-0.0143
	[0.0419]	[0.0288]	[0.0686]	[0.0524]
Head Age	-0.00678	0.03	0.0296	0.107***
	[0.0350]	[0.0228]	[0.0514]	[0.0401]
Head Married	0.0428**	-0.0183	0.0728**	0.0631***
	[0.0175]	[0.0121]	[0.0298]	[0.0237]
Head Literate	-0.0208**	-0.0018	-0.0231*	-0.0584***
	[0.00977]	[0.00680]	[0.0139]	[0.0119]
Number Men	0.00286	-0.000983	0.0190***	0.0159***
	[0.00475]	[0.00335]	[0.00634]	[0.00567]
Number Women	0.00133	-0.00378	0.0171***	0.0209***
	[0.00443]	[0.00305]	[0.00607]	[0.00522]
Number Children	-0.0153***	-0.0159***	0.00585*	0.0147***
	[0.00222]	[0.00168]	[0.00316]	[0.00256]
Plateau	0.00114	0.0019	-0.0577	-0.0107
	[0.0247]	[0.0140]	[0.0397]	[0.0281]
Mountainous	0.00193	-0.00515	-0.0779**	-0.0127
	[0.0220]	[0.0129]	[0.0318]	[0.0260]
Observations	20,483	20,483	20,483	20,483
R-squared	0.207	0.174	0.101	0.254
See Notes for Table A2.				