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Food prices, their determinants and connections to child nutrition in Nepal

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Introduction

A majority of Nepalese households are net buyers of food and depend on markets for their food purchases (CBS 2011). As a result, market performance and food prices directly influence levels of household consumption. These, in turn, can influence nutrition outcomes. Given the potentially deleterious effects of high food prices on child nutrition outcomes in food-purchasing households, one of the important pathways to reducing child malnutrition rates over time is likely to be by increasing market efficiency and reducing food prices. A number of studies have documented a negative association between food prices and child nutrition outcomes. Higher sugar and dairy prices were associated with lowered child height in Brazil (Thomas and Strauss 1992); higher food prices were found to be detrimental to short-term child nutrition outcomes (weight-for-height) in Cote d'Ivoire (Thomas et al. 1992); increases in prices of plantain and sugar were found to negatively affect short-term child nutrition outcomes in rural areas of Ghana (Lavy et al. 1996); and food price increases had negative impacts on child health in Kenya (Grace et al. 2014). According to WFP/NDRI (2008), recent price increases in Nepal have forced people to buy cheaper and lower-quality food items, suggesting potentially deleterious nutritional impacts as a result.

Given the important role of markets and food prices on child nutrition outcomes, it is somewhat surprising that little formal attention has been focused on understanding the connections between price and nutrition outcomes in Nepal. As figures 1 and 2 illustrate, there is a high degree of spatial variation in food prices and food price variability in Nepal.

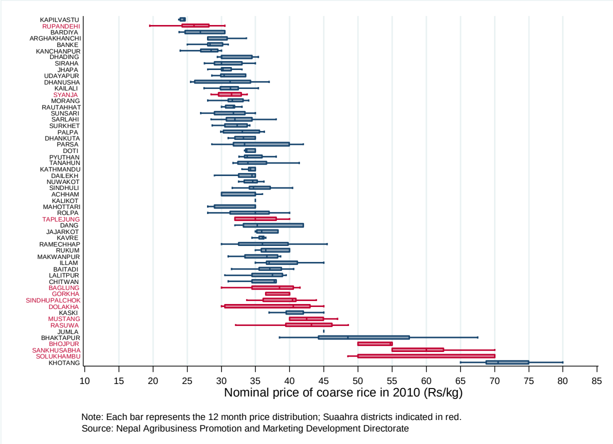

Figure 1: Nominal price of coarse rice, by district (2010)

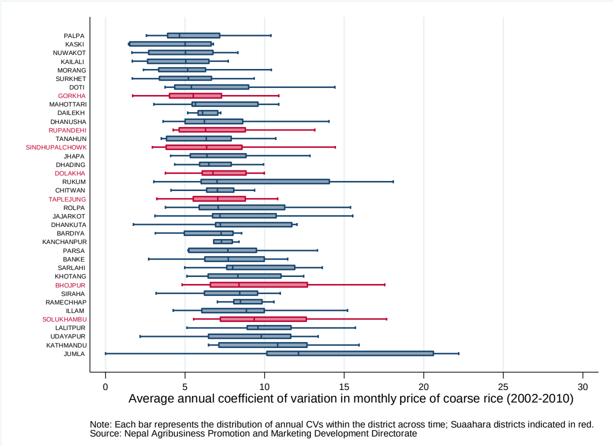

Figure 2: Variation in real price of coarse rice, by district (2002-2010)

High transportation costs and poorly functioning markets widely blamed for these patterns. Linkages between agricultural markets in Nepal are imperfect, but have been improving over time in conjunction with improvements in market infrastructure. To date, however, no empirical studies have been conducted to explore the determinants of food prices in Nepal.

Several studies, among them WFP/FAO (2007), WFP/NDRI (2008), and FAO (2010) provide descriptive analyses of food prices. Additionally, Sanogo (2008) and Sanogo and Amadou (2010) assess market integration, but only in a limited number of markets. To the address the research gap that remains, the main objectives of this study are to (1) examine patterns of association between food prices and short-term nutrition outcomes of children under age five in Nepal and (2) to carefully analyze the market and infrastructure characteristics associated with district-level food prices in Nepal.

For this analysis we combine data from a number of sources, including the 2006 and 2011 Nepal Demographic and Health Surveys (DHS) and district-level food price data observed monthly between 2002 and 2010. We first examine the broad patterns of association between food prices and short-term nutrition outcomes, and then study spatial and temporal price transmission using regression models. Findings suggest multiple points of entry that might be effective for policies aimed at influencing food prices and, thereby, child nutrition outcomes.

Child nutrition indicators and food prices

Weight-for-height and height-for-age are widely accepted as indicators of short-term and long-term nutrition outcomes in children. Accordingly, to examine the relationship between food prices and nutrition outcomes we use data from the 2006 and 2011 Nepal Demographic and Health Surveys. The DHS surveys are comprehensive and nationally representative household surveys carried out in more than 70 countries. In Nepal, the survey was administered by the Ministry of Health and Population (MOHP) using a two-stage stratified sample of households. The questionnaires provide detailed and comparable statistics on various aspects of human health, health behavior and nutrition across all ecological zones and development regions of Nepal. The nutrition indicators used here cover 5,103 children under age 5. Since coarse rice is one of the main foods consumed by poor households in

Nepal, we concentrate on examining patterns of association between coarse rice and child growth.

[1] We focus attention on weight-for-height Z-scores (WHZ) as our nutrition indicator of choice because it is more likely to be affected by price movements than height-for-age Z-scores (HAZ) (Brown et al. 1982; Panter-Brick 1997). This choice of focus is supported by the data presented in Figure 3, which reveal no strong correlation between district-average HAZ and the coefficient of variation in rice prices (left panel) but a negative correlation between district-average WHZ and the coefficient of variation in rice prices (right panel).

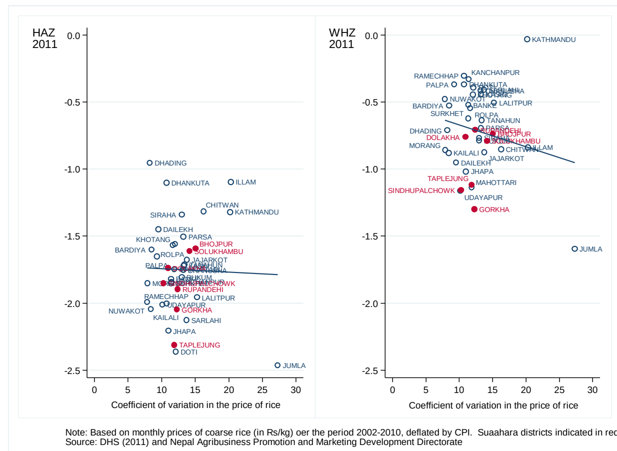

Figure 3: District prices and average WHZ and HAZ in 2011

Consistent with a pattern in which many households in Nepal are net-buyers of food, these data reveal a modest negative correlation between the rice price and WHZ. Regressions suggest that a one-unit increase in the average annual price of coarse rice is associated with a 0.025 standard deviation decrease in WHZ in food deficit districts, on average, and a 0.026 in standard deviation decrease in WHZ, on average, in districts with roads.

The negative association between food prices and WHZ is especially clear in districts linked by roads

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[1] A complete series of food price data is available in 2005 and 2010 only for 46 of the 75 districts of Nepal. As a result, only the subset of children found in these districts with price data are used for this analysis. The sample and findings are indicative, but should not be construed as nationally representative.

(Figure 4) and food deficit districts (Figure 5). Road networks reduce transport costs, which in turn moderate food prices. Generally speaking, higher food prices compromise food consumption by households that are net-buyers (i.e. those who consume more than they produce, and must therefore rely on purchases). At the same time, higher food prices may benefit households that are net-sellers (i.e. those who produce more than they consume, and therefore generate income through sales).

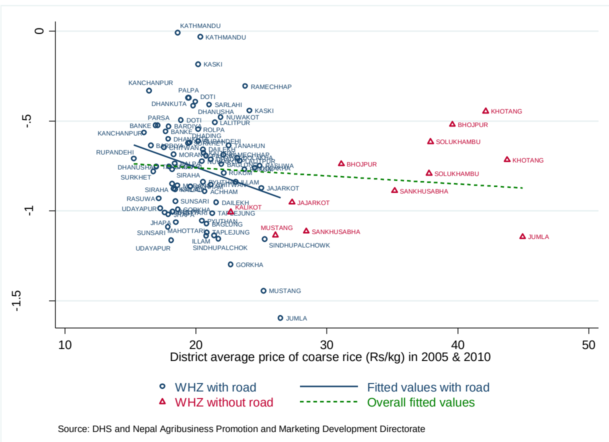

Figure 4: District average WHZ and price of coarse rice in districts linked by roads

As the data in Figure 5 show, price increases may be nutritionally beneficial in food surplus-districts, perhaps because higher food prices lift incomes, which then allow consumption of higher quality and/or more nutritious foods. An additional perspective on this relationship is provided by Figure 6, which plots WHZ against rice prices for children in the bottom quintile of the wealth distribution and those in the top quintile of the wealth distribution. The poorest households tend to be net-buyers of food, and are therefore harmed by higher food prices, and the richest households tend to be net-sellers of food, and are therefore helped by higher food prices.

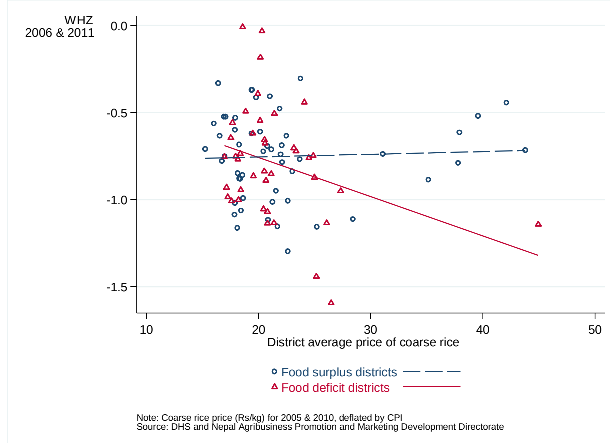

Figure 5: District average WHZ and price of coarse rice in food surplus and deficit districts

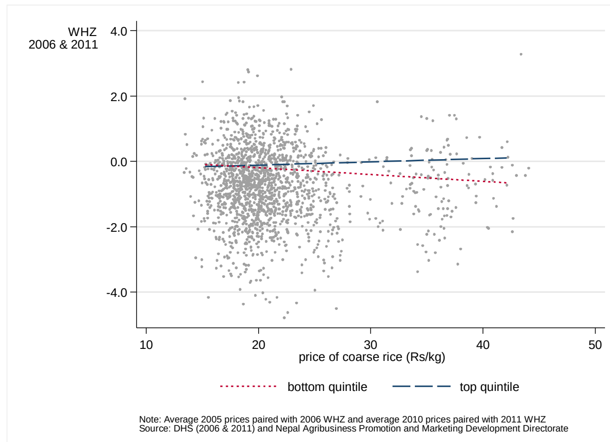

Figure 6: Rice prices and WHZ for children in top and bottom wealth quintiles in 2011

Determinants of food prices in Nepal

To study the determinants of food prices we work with monthly retail prices for coarse rice, medium rice, fine rice and wheat flour. These data were obtained from the Nepal Agribusiness Promotion and Marketing Development Directorate and cover 37 Nepalese districts and 7 Indian border markets. We categorized the average district prices from Nepal into three groups: (1) *local market* prices (prices from 28 district markets, most of them located in food deficit districts); (2) *regional market* prices (prices from 8 adjacent markets, located in districts that are highly suitable for agricultural production); and (3) *central market* prices (the price from the capital city, Kathmandu). Nominal prices were deflated using the country-wide consumer price index (CPI). We add to these prices data from a number of sources including monthly rainfall data obtained from Nepal's Department of Hydrology and Meteorology, the remotely sensed Normalized Difference Vegetation Index (NDVI) from NASA, district-level data on population, agricultural production, and planted area from Nepal's Ministry of Agriculture Development (MOAD), district-level monthly fuel price data from the Nepal Oil Corporation Limited (NOCL) and Nepal Petroleum Dealers' Association (NPDA), district-level data on roads and bridges from the Department of Road (DOR), Ministry of Physical Planning, Works and Transport Management, and exchange rates obtained from the Nepal Rastriya Bank.

We estimated a series of ordinary least squares (OLS) regressions and hierarchical (multi-level) regressions to study price determination and spatial and temporal price transmission. We pool retail food price data at the district level for four important food commodities (coarse rice, medium rice, fine rice and wheat flour) from 2002 to 2010. We first implement a parsimonious regression incorporating the food prices, incorporating zone, month, and commodity fixed effects. We then add a series of explanatory and control variables to account for agricultural production, population, district infrastructure (including length of roads and number of bridges), fuel prices, and exchange rates. As we are working with monthly time series data for prices, we employ an autoregressive approach. Diagnostic testing suggested an AR(1) model was a reasonable fit to the data.

We also employ a series of hierarchical (multi-level) regressions models to study the composition of price variance at spatial and temporal levels. This approach is often appropriate when outcomes observed at one level (here, for example, a market) also depend on variables determined at a higher level (e.g. a district). As a result of this nested structure, observations within levels are likely to be correlated, which may violate the independence assumptions of OLS. Our unit of analysis is the district-level price. These prices are nested within zones and years, which suggests three levels of nesting: year, zones within year, and districts within zones. To improve the statistical efficiency of our results, therefore, we properly account for variance components at zone and year levels. The overall variance of observed local prices can be partitioned into year, zones, and district levels. The shares of each are reported below as the intraclass correlation coefficients (ICCs).[2]

Table 1 presents the regression results from four models. Models 1 and 2 are OLS regressions. Models 3 and 4 are multi-level regressions. Patterns are similar across these four specifications, although there is a slight change in the magnitude of the coefficients across regressions. Models 1 and 2 treat zones as fixed effects. Models 3 and 4 treat zones and years as random effects. All models include month as a fixed effect. Comparing these four models, both the AIC and BIC tests suggest that Model 4 provides the best fit of the data. Accordingly, we focus our discussion on Model 4.

Model 4 accounts for spatial and temporal variation in local food prices. We account for variance across zones (level two) and across years (level three). As indicated by the intra-class correlation coefficients (ICCs) for a model without covariates (reported in the bottom panel of the table), about 31% of the observed variation in real food prices is explained at the zone level and about 5% is explained at the year level. High spatial variation in food prices in Nepal emanate from variations in topography, soil and climatic conditions, and market infrastructure. Temporal variation in food prices results mainly from differences in market infrastructure and growing conditions at different points in time.

Even after accounting for spatial and temporal

[2] We do not present the model in mathematical form here. Interested readers can contact the lead author at for a technical version of the paper.

price variation, we observe a slight, statistically significant upward trend in real prices over time. We include one-month lags for local, regional, central, and border markets. All coefficients on these lagged price variables, the border market excepted, are statistically different from zero at a 1% test level. This indicates multiple mechanisms of price transmission and a high degree of market connectedness. Current period local food prices are correlated, though not perfectly so, with previous period local prices. High prices tend to follow high prices, and low prices tend to follow low prices, but increases and decreases are damped between periods. Current period prices in central, regional and border markets are positively correlated with contemporaneous prices, suggesting that an instantaneous price change in one of these markets is transmitted quickly to the local market. However the rate of price transmission is quite weak. Although the regional market appear to have high price transmission rates, all markets (regional, border, central) have price transmission rates that are less than 5% of the local market influence. This suggests relatively weak market integration, overall, in Nepal. Lagged prices in these connected markets move inversely with local prices; this again suggests some price dampening across markets through time. Our regressions use fine rice as the base commodity category. Based on the commodity fixed effects, we see that prices of coarse rice, medium rice, and wheat flour are 12%, 7%, and 10% lower, on average, than that of fine rice. These differences are statistically significant at the 1% test level.

Among variables potentially amenable to policy intervention, we see that annual district population and fuel prices are positively correlated with local food prices whilst district-level agricultural production, total road length in a district and the number of bridges in a district are all negatively correlated with food prices at statistically significant levels. A 1% increase in the price of fuel is associated with a 0.03% increase in the local rice price. Although the fuel price is an

important and statically significant correlate with food prices, we find the overall magnitude of this relationship to be surprisingly small. Roads and bridges connect local markets (especially rural markets) with regional and border markets and facilitate faster transportation of foods at lower cost. Districts from hilly and mountainous regions that are less well connected by roads and suffer from a lack of bridges witness higher food prices. Local agricultural production/harvest matters to local agricultural prices. Districts with higher agricultural production have lower rice prices, on average.

Conclusions and policy implications

Child malnutrition rates in Nepal are among the highest in the world. In this paper we have studied patterns of association between food prices and child nutrition outcomes, as indicated by weight-for-height and height-for-age Z-scores. Having observed an overall correlation between district-level child growth and district-level prices, we further concentrated our effort on understanding food prices and their determinants. We conclude that short-term child growth is especially sensitive to higher food prices in food-deficit districts and among the poorest households. Spatial and temporal variation in food prices can be explained by market connections, infrastructure, fuel prices and levels of agricultural production. Not surprisingly, the correlation between prices and child nutrition is somewhat stronger in districts connected by roads. Approximately 31% of the observed variation in food prices occurs within zones and 5% occurs across time. The remaining 64% occurs at the district level, suggesting multiple effective points of entry for polices aimed at influencing food prices and, indirectly, nutrition outcomes. The points of entry suggested by our results include fuel prices, agricultural production, population policy, and infrastructure development, especially construction of roads and bridges.

Table 1: Regression results for models of monthly food prices in Nepal, 2002-2010

VARIABLES	Model 1	Model 2	Model 3	Model 4
Time trend	0.00179***	0.00489***	0.00166***	0.00338*
	(0.00055)	(0.00146)	(0.00060)	(0.00174)
Local(t-1)	0.83406***	0.78943***	0.83003***	0.77893***
	(0.02400)	(0.02938)	(0.00484)	(0.00545)
Regional market (current)	0.04065***	0.03400***	0.04131***	0.03558***
	(0.01137)	(0.01091)	(0.00985)	(0.00980)
Regional market (t-1)	-0.02930**	-0.03402***	-0.02960***	-0.03340***
	(0.01145)	(0.01151)	(0.00993)	(0.00983)
Central market (current)	0.03125***	0.03148***	0.02812***	0.02779***
	(0.01090)	(0.01076)	(0.01032)	(0.01023)
Central market (t-1)	-0.01917*	-0.01762	-0.02209**	-0.02188**
	(0.01089)	(0.01086)	(0.01012)	(0.01003)
Border market (current)	0.01673	0.01875	0.01861*	0.02037*
	(0.01215)	(0.01187)	(0.01106)	(0.01102)
Border market (t-1)	-0.01025	-0.00834	-0.00993	-0.00757
	(0.01225)	(0.01214)	(0.01094)	(0.01080)
Coarse Rice[a]	-0.07795***	-0.10776***	-0.08199***	-0.11547***
	(0.01437)	(0.01749)	(0.00943)	(0.00987)
Medium Rice[a]	-0.04839***	-0.06735***	-0.05039***	-0.07147***
	(0.00941)	(0.01128)	(0.00669)	(0.00696)
Wheat Flour[a]	-0.06494***	-0.09621***	-0.06946***	-0.10392***
	(0.01292)	(0.01613)	(0.00953)	(0.01002)
Annual district population		0.00003**		0.00003*
		(0.00001)		(0.00001)
Road length (kms)		-0.00033***		-0.00036***
		(0.00005)		(0.00003)
Bridges (#)		-0.00048***		-0.00050***
		(0.00011)		(0.00010)
Monthly fuel price (Rs/liter)		0.01708*		0.03002**
		(0.00980)		(0.01419)
Monthly exchange rate		0.01321		-0.00225
		(0.01811)		(0.02280)
Cereal production (1000 MT)[b]		-0.00635***		-0.00596***
		(0.00204)		(0.00179)
Constant	0.42871***	0.53654***	0.45857***	0.61887***
	(0.08601)	(0.12659)	(0.04899)	(0.12107)
Random Effects				
Zones:Variance (Intercept)			.0012704	.0010054
			(.000538)	(.0004369)
Year: Variance (Intercept)			.0000848	.0001859
			(.0000364)	(.0000566)
Variance (Residual)			.0129507	.0125422
			(.000168)	(.0001634)
Intraclass correlation coefficient (ICC) for null model (with intercept only)				
Level two (Zone)			31%	
Level three (Year)			5%	
Zones FE	Yes	Yes	No	No
Zones RE	No	No	Yes	Yes
Monthly FE	Yes	Yes	Yes	Yes
Number of Zones	12	12	12	12
Number of Years	9	9	9	9
AIC	-17907.87	-18218.14	-17870.86	-18205.99
BIC	-17656.67	-17922.6	-17678.76	-17969.56
R^2	0.90	0.90	—	—
Number of observations	11,948	11,948	11,948	11,948

Note: [a] indicates dummy variable. [b]Instrumented value – see complete paper for details. Standard errors in appear in parentheses, *** indicates p<0.01, ** p<0.05, * p<0.1. Agricultural prices, fuel prices, exchange rate, and harvest variables have been converted to natural logarithm form.

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