Asymmetric Response of Nutrient Intakes to Cereal Price Changes among the Poor in China: Implications for the Effect of Cereal Price Subsidies on the Poor's Nutrient Intakes

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Abstract

Previous studies commonly assume that the effects of introducing and ending cereal price subsidies on the poor's nutrient intakes are symmetric. We question the assumption of symmetry and show that the poor's nutrient intakes respond asymmetrically to declines and increases in the price of cereal in China. Our results imply that introducing cereal price subsidies can increase the poor's total energy intake by increasing their calorie intakes from fat and protein, and that ending such subsidies would insignificantly affect the poor's total energy intake; however, it may further increase their calorie intakes from fat and protein. (JEL I38; O12; Q18)

Key words: Food price subsidy, Nutrition, Poverty, Asia, China

1. INTRODUCTION

Price subsidies on staple cereals such as rice and wheat have been used to ensure or improve the food security of people in a number of low-income countries such as Egypt, India, and Tunisia (see, for example, FAO 2001). In response to recent rapid increases in world cereal prices, policy makers have paid increasingly more attention to such price subsidies.

While a key justification of using such subsidies is to protect or improve the nutrition of the poor, previous studies have often found that such subsidies have little effect on this issue (Kochar 2005). This lack of effect may be because the poor respond to the subsidies by switching away from nutritious but inferior cereals and toward luxury foods (e.g., meat), which are more expensive sources of nutrients (Jensen and Miller 2008). Thus, removing such ineffective subsidies can be an attractive option for policy makers to reduce their budgetary burden. Despite this possibility, the existing literature has rarely examined how removing cereal price subsidies influences the nutrition of the poor. This is because most previous studies assume that the poor respond symmetrically to declines and increases in cereal prices, and that the poor's nutrient intakes return to their ex-ante intakes when cereal prices return to the ex-ante prices (the so-called symmetric framework).

This paper questions the symmetric framework and shows that the poor's nutrient intakes can respond asymmetrically to declines and increases in cereal price. Clarifying such asymmetric responses provides different implications from the symmetric framework in terms of the nutritional effects of introducing and ending cereal price subsidies. Although cereal price subsidies are an effective welfare tool regardless of their nutritional consequences, clarifying such asymmetry in the nutritional effects is important because nutritional effects are a key criterion for comparing the subsidies with alternative welfare policies. Additionally, nutritional effects are often a primary justification for introducing and designing the subsidies.

This paper first employs a habit formation framework and shows conceptually that if a luxury food is subject to habit formation, the poor's nutrient intakes can respond asymmetrically to the introduction and termination of cereal price subsidies. Further, the nutritional status of the poor can be worse than the ex-ante status due to the conclusion of such subsidies. Second, we empirically argue the possibility of such asymmetric effects of cereal price subsidies by estimating the elasticity of nutrient intakes (intake of energy, carbohydrate, protein, and fat) with respect to declines and increases in a cereal price. We use data from the China Health and Nutrition Survey for the period 1989-2004. Our analysis focuses on poor households, as defined by either the Chinese national poverty line or the World Bank $1.08 PPP per day per person.

Key advantages of this paper over previous studies are two-hold. First, based on the habit formation framework, we incorporate asymmetric consumption behavior into the estimation of the cereal price elasticity of nutrient intakes. This allows us to discuss whether the poor's nutrient intakes respond asymmetrically to the introduction and termination of cereal price subsidies. Second, we examine the effect of cereal price changes on the intakes of energy and three macronutrients, while most previous studies have examined only the effect on energy intake. Examining the effect on macronutrient intakes allows us to examine the effect on the quality of the poor's nutrient intakes.

The paper continues describing a conceptual framework in Section 2. Sections 3, 4 and 5 present the empirical strategy, the data, and the empirical results, respectively. Lastly, Section 6 discusses and concludes.

2. CONCEPTUAL FRAMEWORK

Suppose there are at least two time periods and two food types (a staple cereal, F^S, and a luxury and less nutritious food, F^L). We explicitly include nutrient intake as a function of food consumption, i.e., $N(F^S, F^L)$ such that $\frac{\partial N}{\partial F^S} > \frac{\partial N}{\partial F^L} > 0$. We also assume that the luxury food (F^L) is subject to habit formation. The stock characterizing the habit formation, L_t, evolves according to the law of motion $L_{t+1} = \delta L_t + F_t^L$, where $\delta \in (0,1)$ is the rate of depreciation of the stock. In the context of our model, δ can be interpreted as a habit persistence of the luxury food.

The utility function for a representative individual is

$$U = u(N(F_1^S,\ F_1^L), F_1^S,\ F_1^L, C_1, L_1) + \rho \cdot u(N(F_2^S,\ F_2^L), F_2^S,\ F_2^L, C_2, L_2), \qquad (1)$$

where C_t is consumption of all other goods at period t; $\rho \in (0,1)$ represents a subjective discount factor; and u(.) is the period utility function that is strictly increasing in F_t^S, F_t^L, and C_t, twice continuously differentiable, strictly concave, and satisfies complementarity of F_t^L and L_t and substitute of F_t^S and L_t. The Individual maximizes the utility subject to the budget constraint, $p_1^S \cdot F_1^S + p_1^L \cdot F_1^L + p_1^C \cdot C_1 + p_2^S \cdot F_2^S + p_2^L \cdot F_2^L + p_2^C \cdot C_2 = Y_1 + Y_2$, where Y_t is an income at period t; p_t^S, p_t^L, and p_t^C are the prices of F_t^S, F_t^L, and C_t at period t, respectively; and $p_t^S < p_t^L$ for t = 1, 2. To describe the effect of habits on consumption behavior as simple as possible, we assume that prices and income are certain. Solving the first order conditions yields the optimal levels of all three goods at each time period. The optimal consumption levels at period t depend on the prices of all goods and incomes at all time periods and the stock at period t, $F_t^{j*} = F^{j*}(P_1, P_2,\ Y_1, Y_2, L_t)$ for t = 1, 2 and j = S, L, where P_t is a vector of prices at period t, $\frac{\partial F^{j*}}{\partial p^j} < 0$, $\frac{\partial F^{j*}}{\partial Y} > 0$, $\frac{\partial F^{L*}}{\partial L} > 0$, $\frac{\partial F^{S*}}{\partial L} < 0$, $\frac{\partial^2 F^{L*}}{\partial L^2} < 0$, and $\frac{\partial^2 F^{S*}}{\partial L^2} < 0$. Thus, the optimal nutrient intake at period t is

$$N_t^* = N^*(F^{S*}(P_1, P_2,\ Y_1, Y_2, L_t),\ F^{L*}(P_1, P_2,\ Y_1, Y_2, L_t)) \text{ for t = 1, 2.} \qquad (2)$$

Note that the optimal nutrient intake needs not optimize individual's nutritional status.

First, we employ this framework to examine how introducing price subsidies on a staple cereal affects the nutrition of the poor. Assume that poor individuals are informed at the beginning of period 1 that the government will start subsidizing the price of a staple cereal from period 2. For now, we focus on the case that other prices (p_t^L and p_t^C) and income (Y_t) are constant over time. Then, a change in nutrient intake due to the introduction of such subsidies can be expressed as

$$\Delta N_{12}^* = \frac{\partial N^*}{\partial F^S}\left(\frac{\partial F^{S*}}{\partial p^S} + \frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\middle| L_1\right)\Delta p_{12}^S + \frac{\partial N^*}{\partial F^L}\left(\frac{\partial F^{L*}}{\partial p^S} + \frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\middle| L_1\right)\Delta p_{12}^S \quad (3)$$

where ΔX_{12} indicates a change in X from period 1 to period 2, and $\Delta p_{12}^S < 0$. On the right hand side of equation (3), the first and the second terms represent changes in nutrient intake due to changes in the consumption of a cereal and a luxury food, respectively. According to previous studies, luxury food consumption F^L tends to increase after the introduction of such subsidies (see, for example, Jensen and Miller 2008). To capture the tendency, we consider the case that $\frac{\partial F^{L*}}{\partial p^S} < 0$ and $L_1 \leq \delta L_1 + F_1^L = L_2$. Then, equation (3) indicates that the habit formation weakens the positive effect of such subsidies on cereal consumption ($\frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S} > 0$) and strengthens the positive effect of such subsidies on luxury food consumption ($\frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S} < 0$).

Next, we employ the same framework to examine how ending price subsidies on a staple cereal affects the nutrition of the poor. Suppose that poor individuals are informed at the beginning of period 3 that the government will stop subsidizing the price of a staple cereal from the next period (period 4). Then, a change in nutrient intake due to the end of such subsidies can be expressed as

$$\Delta N_{34}^* = \frac{\partial N^*}{\partial F^S}\left(\frac{\partial F^{S*}}{\partial p^S} + \frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\middle| L_3\right)\Delta p_{34}^S + \frac{\partial N^*}{\partial F^L}\left(\frac{\partial F^{L*}}{\partial p^S} + \frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\middle| L_3\right)\Delta p_{34}^S \quad (4)$$

where ΔX_{34} indicates a change in X from period 3 to period 4, and $\Delta p_{34}^S > 0$. Besides the sign of a cereal price change, the initial stock level, L_t, is a key difference between equations (3) and (4). The difference in the initial stock can result in a difference in the magnitude of

$\frac{\partial F^{j*}}{\partial L}$ for j = S, L because F^{j*} is strictly concave in L_t for j = S, L. Thus, even when $|\Delta p_{12}^S| = |\Delta p_{34}^S|$, it is possible to observe that $|\Delta N_{12}^*| \neq |\Delta N_{34}^*|$.

Now, our key question is under what conditions poor individuals return to their ex-ante diets when price subsidies on a staple cereal end. For simplification, assume that $\Delta p_{12}^S = -\Delta p_{34}^S$ and $\frac{\partial F^{L*}}{\partial p^S}$ and $\frac{\partial F^{S*}}{\partial p^S}$ are independent of L_t. Then, the condition is, $\frac{\partial F^{j*}}{\partial L}\Big|_{L_1} = \frac{\partial F^{j*}}{\partial L}\Big|_{L_3}$ for j = S, L. The equation is hold only when $L_1 = L_3$, and L_3 can be equal to L_1 if $(1-\delta^2)L_1 = \delta F_1^L + F_2^L$ (so-called a symmetry condition). However, under the framework of habit formation, the symmetry condition is rarely satisfied (prove is available from the authors upon request).

Moreover, when L_3 is greater than L_1, cereal consumption responds less elastically to the introduction of price subsidies on a staple cereal than to the end of those, while luxury food consumption responds more elastically to the introduction of such subsidies than to the end of those. Thus, ending such subsidies can lead the poor to consume less cereal and more luxury food than the ex-ante diet (i.e., $F_4^{S*} < F_1^{S*}$ and $F_4^{L*} > F_1^{L*}$), which can make the nutritional status of the poor worse than the ex-ante status.

3. ESTIMATION STRATEGY

We directly estimate the elasticity of nutrient intake with respect to a cereal price. The advantage of this method is that it includes all substitution and complement effects among food and non-food items in estimating the effect of a cereal price change on nutrient intake. The basic estimating equation for individual *i* in household *h* in community *v* between periods t–1 and t is

$$\Delta\ln(N_{ihvt}) = \alpha + \lambda\,\Delta\ln\left(p_{vt}^S\right) + \alpha_X \Delta X_{ihvt} + \Delta\mu_{it} + \Delta\mu_{ht} + \Delta\mu_{vt} + +\Delta\nu_{ihvt} \qquad (5)$$

where $\Delta\ln(N_{ihvt})$ is a change in log nutrient intake for individual *i* between t–1 and t; $\Delta\ln\left(p_{vt}^S\right)$ is a change in the log price of the most commonly eaten cereal among the poor in community *v* between t–1 and t; ΔX_{ihvt} is a vector of changes in other time-variant individual-, household- and community-level characteristics between t–1 and t; $\Delta\mu_{it}$, $\Delta\mu_{ht}$ and $\Delta\mu_{vt}$ reflect changes in the average time-variant nutrient requirements specific for individual, household and community, respectively; and $\Delta\nu_{ihvt}$ is the remaining error.

In equation (5), time-invariant unobserved factors are eliminated by differencing across years within the same individual. To control the effects of remaining unobserved time-variant factors, we use several proxies: gender and age dummies at t-1 (A_{it-1}) for the individual-specific nutrient requirement $\Delta\mu_{it}$; household head characteristics and household demography at t-1 (S_{ht-1}) for the household-specific nutrient requirement $\Delta\mu_{ht}$; and location dummies of residence at t-1 (R_{vt-1}) for the community-specific nutrient requirement $\Delta\mu_{vt}$. Because gender and age are controlled, calorie intake N_{ihvt} needs not be normalized using the age- and gender-specific calorie requirements. Then, equation (5) can be rewritten as

$$\Delta\ln(N_{ihvt}) = \alpha + \lambda\,\Delta\ln(p^S_{vt}) + \alpha_X\Delta X_{ihvt} + \alpha_A A_{it-1} + \alpha_S S_{ht-1} + \alpha_R R_{vt-1} + \Delta\nu_{ihvt} \qquad (6)$$

To introduce asymmetric consumption behavior into equation (6), we employ a framework similar to that in Bowman et al. (1999) as follows

$$\Delta\ln(N_{ihvt}) = \alpha + \lambda^+(POS_{vt})\Delta\ln(p^S_{vt}) + \lambda^-(NEG_{vt})\Delta\ln(p^S_{vt}) + \alpha_X\Delta X_{ihvt} \qquad (7)$$

$$+\alpha_A A_{it-1} + \alpha_S S_{ht-1} + \alpha_R R_{vt-1} + \Delta\nu_{ihvt}$$

where POS_{vt} is a dummy variable for a community *v* in where a cereal price increases between t–1 and t; and NEG_{vt} is a dummy variable for a community *v* in where a cereal price declines between t–1 and t. Thus, $\lambda^+$and λ^- measure the responsiveness of individual nutrient intake to increases and declines in a cereal price, respectively. We call equations (6) and (7) first-differenced (FD) models.

A key identification issue in specifying equations (6) and (7) is the potential correlation between per capita income in X and unobserved factors in the remaining error $\Delta\nu_{ihvt}$, while community-level prices may be reasonably assumed exogenous. There are at least two reasons to suspect such a correlation: reverse causality through unobserved labor productivity, and a common unobserved factor such as one's self-discipline. To address such problems, I incorporate instrumental variables (IV) estimation into the specification of equations (6) and (7) using two-stage least squares (2SLS). As excluded instruments for per capita income, we employ a dummy of farming-related households and a government crop price that contributes most to crop income in the community. These factors are expected to influence nutrient intake through their effects on household income. The validity of the instruments will be subjected to empirical examinations in the following sections.

4. DATA

Our estimation samples consist of the poor in the China Health and Nutrition Survey (CHNS) during 1989-2004. Detailed information on the survey is available at the CHNS website (http://www.cpc.unc.edu/projects/china). Table 1 presents selected characteristics of our samples. To define the poor, we employed the Chinese national poverty line (NBSC 2004) and the World Bank poverty line of $1.08 per day per person in 1993 PPP prices.

As a dependent variable, we employed the intake of energy in kilocalories (kcal) and three macronutrients in grams (g): carbohydrate, protein, and fat. Table 1 presents average nutrient intakes in our samples by gender and age. By comparing their nutrient intakes with nutrient requirements proposed by FAO/WHO/UNU (1985), it is apparent that energy deficiency is a key nutrition problem for the poor adults in China. For example, males aged 18-30 years old in the CNPL sample are deficient in energy by about 660 kcal/day (FAO standards recommend 2,749 kcal/day). On the other hand, the shares of calories from fat and protein are sufficiently high among the poor by the WHO standard, i.e., protein 10-15% of total energy; fat 15-30% of total energy (WHO 2003).

For cereal price, we employed the community-level price of a staple cereal that is most commonly eaten among the poor in the community (the so-called commonly eaten cereal price). We also include the prices of pork, soybeans, vegetables, eggs, and edible oil. These prices are deflated by the consumer price index. These food groups are main sources of calories for poor adults aged 18-60 years old in the CHNS 1989-2004, regardless of whether the poor are defined by the CNPL or by the WBPL.

Our models additionally controlled for the following variables: log (deflated) income per household member, log household size, a female dummy, age dummies (under 5y, 6-11y, 12-17y, 18-30y, 31-40y, 41-50y, 51-60y, over 60y), proportions of demographic groups within households (children aged 5 years or under, children aged 6-17 years, adults aged 18-60 years, and over 60 years, for each gender), characteristics of household heads (gender, age, and an indicator of secondary or higher education), an urban dummy, province dummies, and year dummies.

Lastly, valid instruments for IVFD models were available only for poor households that included at least one farmer during 1991-1997 because the CHNS reports government crop prices only in 1991-1997. Thus, samples for IVFD estimations (the so-called IV samples) included only 295 observations for the CNPL sample and 827 observations for the WBPL sample.

5. ESTIMATION RESULTS

We start with presenting the results of basic models that apply FD models to the CNPL and the WBPL samples (columns (1) and (4) in table 2). The results show that the poor's nutrient intakes respond asymmetrically to increases and declines in commonly eaten cereal price. The estimates of λ_N^+ and λ_N^- were significantly different at the 10 percent level for the intake of energy, protein and fat in the CNPL sample and for the intake of energy, carbohydrate and protein in the WBPL sample.

Some may wonder at the insignificant or positive responses of nutrient intakes to increases in cereal price in table 2. Such responses may be explained by a substitution of foods with lower-quality foods and non-food items. Additionally, the insignificant responses of energy and carbohydrate intake to cereal price increases may be because the poor cannot decrease their already insufficient levels of energy and carbohydrate intakes following cereal price increases. Insufficient intakes of energy and carbohydrate also explain why the poor significantly increase their energy and carbohydrate intakes following cereal price declines. This logic, however, does not explain the positive and significant changes in the fat and protein intake of the poor in response to cereal price increases; however, such responses may be better explained by the habit formation of luxury foods such as pork. This possibility can be further examined by checking the sensitivity of the elasticity of fat and protein intakes to their own initial intakes.

If a habit formation underlies the observed asymmetric responses of fat intake in table 2, fat intakes should be less elastic to cereal price changes if the poor initially have a higher fat stock. A similar logic can also be applied to the case of protein intake. As a measure of the level of fat stock, we used the share of fat and protein calories in the total calorie intake. We divided each of the CNPL and the WBPL sample into halves at the median share of fat for the case of fat intake and at the median share of protein for the case of protein intake. We found strong support for the habit formation of fat intake only in the CNPL sample. In contrast, we could not find any evidence for the habit formation of protein intake.

Next, we investigate how the findings based on basic results can be influenced by the potential endogeneity of income per household member. We control for the endogeneity of income per household member by applying IVFD models to our IV samples. In the first-stage regressions, the hypotheses that the coefficients on the excluded instruments are jointly equal to zero are rejected at the one percent level in both samples. In addition, the overidentification tests fail to reject the null hypotheses that instruments are uncorrelated to the residual at the 10 percent level in all models.

In table 2, the second-stage results are presented in columns (2) and (5) and are compared with the basic results in columns (1) and (4). To clarify whether the observed changes are due to IV estimations or sample reductions, we applied FD models to the IV samples (columns (3) and (6) in table 2). After the reduction in sample sizes, only the estimate of λ_{energy} continued to be significant at the 10 percent level, and all other significant estimates in basic results became insignificant. Also, the magnitudes of all estimates except for the estimate of λ_{fat}^{+} became smaller compared to the basic results. Thus, the sample reduction is a main factor that reduces the magnitude of FD estimates and makes the estimates statistically insignificant.

The magnitudes of FD estimates for the IV samples are increased by controlling for the endogeneity problem. The IVFD estimates are also statistically more significant in comparison to the corresponding FD estimates. From these findings, we can reasonably expect that both asymmetric and symmetric estimates in FD models would be biased downward if there is any bias due to the endogeneity of income per household member. Also, such bias results in understating the differences between the estimates of λ_{N}^{+} and λ_{N}^{-}.

Lastly, a Hausman test indicates that the hypothesis that FD and IVFD coefficients are equal cannot be rejected at the 10 percent level for all nutrient intakes. Moreover, our IVFD results imply that the significance of estimates of λ_{N}^{+} and λ_{N}^{-} and their differences would be preserved after controlling for the endogeneity problem. Taking these findings into account, the preferred estimates from this paper may be the basic estimates, whose sample size is the largest and whose standard errors are tighter than the IVFD results. Thus, this paper hereafter focuses on examining basic estimates.

6. CONCLUSIONS

Overall, we find significant asymmetry in the elasticity of nutrient intakes with respect to declines and increases in the price of a commonly eaten cereal among the poor in China. In our sample, a key nutrition problem for the poor is energy deficiency. At the same time, the share of fat calories is relatively high by the international standard, which has been considered a newly emerging problem among the poor in China (see, for example, Ng et al. 2008). Thus, our asymmetric results imply that introducing cereal price subsidies can mitigate energy deficiencies among the poor, while it can also increase the share of fat calories in the poor's total calorie intake. And, ending such subsidies can further increase the share of fat calories, while it may not worsen the existing calorie deficiencies. At the same time, it should be noted that not all types of fats are harmful to health. While this paper could not distinguish between different types of fats, identifying the types of fats that respond more elastically to cereal price changes would be an important aim for future research.

From a policy perspective, there are three important differences between asymmetric and symmetric estimates in terms of implications about the effects of cereal price subsidies on the poor's nutrient intakes. First, symmetric estimates may overlook a potential difference in the effects of introducing and ending such subsidies on the poor's nutrient intakes, which can lead to unexpected and undesirable policy outcomes in terms of nutrition. Second, symmetric estimates may underestimate the responsiveness of nutrient intakes to cereal price changes, which results in understating the effects of cereal price subsidies on the poor's nutrient intakes. Lastly, symmetric estimates may overlook a difference between the poorest and the poor in the effects of cereal price subsidies on their nutrient intakes, which can affect the design of targeting.

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Table 1: Selected Characteristics for the Poor in the CHNS 1989-2004

			The Poor below the Chinese National Poverty Line		The Poor below the World Bank $1.08 PPP Poverty Line	
Structure of Panel Data						
Number of Observations			1,024		2,278	
Number of Waves			6		6	
Summary statistics of Key Variables			Mean	(SD)	Mean	(SD)
Nutrient Intakes						
Energy intake	Males	18-30y	2086.7	(1021.0)	2185.0	(1001.9)
(kcal/day)		31-60y	2615.1	(881.6)	2742.5	(948.0)
	Females	18-30y	1955.4	(857.5)	2015.4	(851.0)
		31-60y	2344.2	(861.5)	2460.4	(1927.6)
Carbohydrate	Males	18-30y	69.3	(10.7)	69.5	(10.9)
(% of total energy)		31-60y	66.7	(12.2)	67.6	(11.9)
	Females	18-30y	68.4	(11.0)	69.3	(10.3)
		31-60y	67.4	(11.3)	67.9	(11.2)
Protein	Males	18-30y	11.1	(2.2)	11.0	(2.1)
(% of total energy)		31-60y	10.9	(2.2)	10.8	(2.1)
	Females	18-30y	11.1	(2.1)	11.1	(2.0)
		31-60y	11.0	(2.2)	10.8	(2.1)
Fat	Males	18-30y	19.6	(10.4)	19.3	(10.6)
(% of total energy)		31-60y	21.4	(11.2)	20.5	(11.0)
	Females	18-30y	20.5	(10.8)	19.7	(10.2)
		31-60y	21.6	(11.0)	21.3	(11.2)
Cereal Price Changes (1988 yuan)			2.0	(5.8)	1.7	(4.0)
proportion of positive changes (%)			19.6	(39.7)	20.9	(40.7)
average positive % change (%)			22.1	(48.9)	24.8	(66.1)
average negative % change (%)			-31.6	(19.1)	-29.4	(18.4)
Per capita income (1988 yuan)			174.8	(74.9)	274.9	(109.3)

Source: China Health and Nutrition Survey (CHNS) 1989, 1991, 1993, 1997, 2000, and 2004.

Notes: Standard deviations are presented in parentheses.

Table 2: Elasticity Estimates of Nutrient Intakes with respect to the Price of Most-commonly-Eaten Cereal in a Community

Dependent variable = Nutrient Intake		The Chinese National Poverty Lines						World Bank $1.08 PPP per day per person					
		BASIC[a] (1)	(SE)	IVFD[a] (2)	(SE)	FD[a] (3)	(SE)	BASIC[a] (4)	(SE)	IVFD[a] (5)	(SE)	FD[a] (6)	(SE)
Ln(Energy Intake [kcal])													
Symm[b]	λ_{energy}	-0.059*	(0.03)	-0.187**	(0.09)	-0.025	(0.06)	-0.055**	(0.02)	-0.089**	(0.04)	-0.050*	(0.03)
	F-statistic	*4.31*		*2.80*		*3.95*		*6.73*		*4.16*		*4.52*	
Asymm[b]	λ^{+}_{energy} [c]	0.222	(0.14)	0.154	(0.26)	-0.020	(0.26)	0.091	(0.06)	-0.111	(0.07)	-0.093	(0.08)
	λ^{-}_{energy} [c]	-0.089***	(0.03)	-0.281**	(0.12)	-0.026	(0.08)	-0.081***	(0.03)	-0.083	(0.05)	-0.036	(0.04)
	Difference[c]	0.311**	(0.16)	0.434	(0.31)	0.006	(0.30)	0.172**	(0.07)	-0.027	(0.10)	-0.057	(0.10)
	F-statistic	*4.27*		*2.69*		*3.88*		*6.65*		*4.01*		*4.40*	
Ln(Carbohydrate Intake [g])													
Symm[b]	λ_{carbo}	-0.055	(0.04)	-0.173*	(0.09)	-0.029	(0.07)	-0.058**	(0.03)	-0.074	(0.05)	-0.034	(0.03)
	F-statistic	*3.73*		*4.12*		*4.18*		*6.89*		*4.08*		*5.28*	
Asymm[b]	λ^{+}_{carbo} [c]	0.174	(0.17)	0.085	(0.30)	-0.072	(0.30)	0.104	(0.07)	-0.058	(0.09)	-0.039	(0.09)
	λ^{-}_{carbo} [c]	-0.079*	(0.04)	-0.246**	(0.12)	-0.018	(0.09)	-0.086***	(0.03)	-0.081	(0.06)	-0.032	(0.05)
	Difference[c]	0.253	(0.19)	0.331	(0.35)	-0.054	(0.35)	0.189**	(0.08)	0.023	(0.12)	-0.007	(0.12)
	F-statistic	*3.66*		*4.08*		*4.11*		*6.85*		*3.95*		*5.13*	
Ln(Protein Intake [g])													
Symm[b]	$\lambda_{protein}$	-0.021	(0.03)	-0.073	(0.08)	0.013	(0.07)	-0.024	(0.02)	-0.114**	(0.05)	-0.024	(0.04)
	F-statistic	*4.49*		*3.63*		*3.81*		*7.40*		*3.31*		*4.50*	
Asymm[b]	$\lambda^{+}_{protein}$ [c]	0.252*	(0.14)	0.238	(0.26)	0.143	(0.26)	0.146**	(0.06)	-0.029	(0.11)	0.012	(0.09)
	$\lambda^{-}_{protein}$ [c]	-0.050*	(0.03)	-0.160	(0.12)	-0.021	(0.09)	-0.053**	(0.02)	-0.141**	(0.07)	-0.036	(0.05)
	Difference[c]	0.303**	(0.15)	0.398	(0.31)	0.164	(0.31)	0.199***	(0.07)	0.113	(0.14)	0.047	(0.12)
	F-statistic	*4.45*		*3.48*		*3.67*		*7.36*		*3.25*		*4.38*	
Ln(Fat Intake [g])													
Symm[b]	λ_{fat}	-0.095*	(0.05)	-0.317*	(0.19)	0.001	(0.10)	-0.085**	(0.04)	-0.081	(0.10)	-0.081	(0.05)

	F-statistic	*2.45*		*2.93*		*4.21*		*3.06*		*2.28*		*2.27*	
Asymm[b]	λ^{+}_{fat} [c]	0.421***	(0.14)	0.862**	(0.41)	0.525	(0.33)	-0.023	(0.13)	-0.152	(0.17)	-0.151	(0.17)
	λ^{-}_{fat} [c]	-0.150***	(0.06)	-0.631**	(0.27)	-0.139	(0.15)	-0.096**	(0.05)	-0.060	(0.12)	-0.058	(0.08)
	Difference[c]	0.571***	(0.17)	1.493**	(0.59)	0.664	(0.43)	0.072	(0.14)	-0.092	(0.21)	-0.093	(0.21)
	F-statistic	*2.90*		*3.38*		*4.35*		*2.98*		*2.22*		*2.20*	
Number of observations		1,024		295		295		2,278		827		827	

Source: Authors' analysis based on data from CHNS 1989-2004.
Notes: One of four measures of nutrient intakes (log intake of energy, carbohydrate, protein, or fat) is used as a dependent variable in each regression. The presented elasticity estimates are the coefficient estimates on log cereal price. Other explanatory variables are as discussed in the text. Robust standard errors are presented in parentheses. F-statistics are for all variables.
* significant at 10%.
** significant at 5%.
*** significant at 1% (two-tailed).
[a] BASIC = first difference models using all available data; IVFD = instrumental variables first difference models using a sub-sample in which instruments are available (the so-called IV sample); FD = first difference model using the IV sample.
[b] 'Symm' and 'Asymm' denote symmetric and asymmetric models, respectively.
[c] λ^{+}_{N} and λ^{-}_{N} denote the elasticity of nutrient N with respect to increases and declines in a cereal price, respectively, where N = energy, carbohydrate, protein, and fat. And, 'Difference' denotes the difference between λ^{+}_{N} and λ^{-}_{N}.