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# Nutrient Intake of the Poor and its Implications for the Nutritional Effect of Cereal Price Subsidies: Evidence from China

SATORU SHIMOKAWA *
*Hong Kong University of Science and Technology, Kowloon, Hong Kong*

**Summary.** — We incorporate habit formation into an analysis of the effect of cereal price changes on the nutrient intake of the poor in China. We find that the poor's nutrient intake responds asymmetrically to declines and increases in cereal prices, and that the asymmetric response of their fat intake may be due to habit formation. Our results also imply that introducing cereal price subsidies can increase their total energy intake by increasing their calorie intake from fat and protein, while ending such subsidies would insignificantly affect their total energy intake, but further increase their calorie intake from fat and protein.


*Key words* — food price, nutrition, poverty, habit formation, 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, including China, [1] Egypt, India, and Tunisia (see, e.g., Farrar, 2000; FAO, 2001). In response to rapid increases in world cereal prices occurring from 2006 until early 2008, policy makers have paid increasingly more attention to such price subsidies. Although world cereal prices started declining substantially after late 2008, cereal price subsidies are still a major cause for concern among policy makers due to the large fluctuations in world cereal prices.

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; Tarozzi, 2005). Regardless of whether subsidies are universal or targeted at the poor, this lack of effect may be because the poor respond to the subsidies by switching away from nutritious, but inferior, cereals toward luxury foods (e.g., meat), which are more expensive sources of nutrients (Jensen & 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 affects the nutrition of the poor. Aside from ethical and political reasons, this is because most previous studies assume that the poor respond symmetrically to declines and increases in cereal prices, and that their nutrient intakes return to their *ex ante* intakes when cereal prices return to the *ex ante* prices under *ceteris paribus* conditions (the so-called symmetric framework).

This paper questions the symmetric framework and explores potential asymmetry in the response of poor's nutrient intakes to cereal price changes by employing a habit formation framework. Our framework with habit formation may provide different implications on the nutritional effects of introducing and ending cereal price subsidies from those of the symmetric framework. That is, the nutritional effect of ending cereal price subsidies may not be the reverse of the effect obtained from introducing the subsidies, even under *ceteris paribus* conditions. Although cereal price subsidies are an effective welfare tool regardless of their nutritional consequences, it is important to clarify any asymmetry in their nutritional effects because nutritional effects are a key criterion for comparing subsidies with alternative welfare policies. Moreover, nutritional effects are often a primary justification for introducing and designing the subsidies.

This paper first conceptually shows that if a luxury food is subject to habit formation, the nutrient intake of the poor may respond asymmetrically to the introduction and termination of cereal price subsidies. Further, the nutritional status of the poor can be worse than their *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 cereal price. We use data from the China Health and Nutrition Survey (CHNS) for the period 1989–2004. Our analysis focuses on poor households, as defined by either the Chinese national poverty line or the World Bank poverty line of $1.08 per day per person in 1993 PPP (Purchasing Power Parity) prices. These samples provide useful implications for cereal price subsidies, because such subsidies typically target the poor as a means of improving their nutritional status.

This paper offers two key advantages over previous studies. 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 nutrient intake of poor people responds asymmetrically to the introduction and termination of cereal price subsidies. Second, we examine the effect of cereal price changes on their intakes of energy and three

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macronutrients, while most previous studies have examined only the effect on energy intake (e.g., Bouis, 1990; Dawson & Tiffin, 1998). Examining the effect on macronutrient intakes allows us to examine how a cereal price change affects the quality as well as the quantity of the nutrient intake.

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

## 2. CONCEPTUAL FRAMEWORK

We construct the simplest possible consumption model with habits, in order to show that the nutrient intake of the poor can respond asymmetrically to the introduction and the ending of price subsidies on a staple cereal. This requires that the model includes at least two time periods and two food types (a staple cereal $F^S$, and a luxury food $F^L$). We assume that the poor care about the nutritional content of food by including nutrient intake as a function of food consumption (i.e., $N(F^S, F^L)$), and we examine the most problematic case, in which the poor prefer a less nutritious luxury food to a staple cereal (i.e., $\frac{\partial N}{\partial F^S} > \frac{\partial N}{\partial F^L} > 0$). For example, fried foods and sweets are luxuries and tend to be preferred to staple cereals among the poor in low-income countries, but they are not necessarily more nutritious than staple cereals. Moreover, we assume that luxury food ($F^L$) is subject to habit formation. The stock variable $L_t$ characterizing the habit formation evolves according to the law of motion $L_{t+1} = \delta L_t + F^L_t$, where $\delta \in (0,1)$ is the rate of depreciation of the stock. For example, $L_t$ may represent the share of fat calories in total calorie intake, and $\delta$ may be a habit persistence of the share of fat calories.

The utility function for a representative individual is

$$U = u(N(F^S_1, F^L_1), F^S_1, F^L_1, C_1, L_1) + \rho u(N(F^S_2, F^L_2), F^S_2, F^L_2, C_2, L_2), \quad (1)$$

where $C_t$ is the consumption of all other goods at period $t$; $\rho \in (0,1)$ represents a subjective discount factor; and $u(.)$ is the period utility function, which is strictly increasing in $F^S_t$, $F^L_t$, and $C_t$, twice continuously differentiable, and strictly concave, and satisfies the complementarity of $F^L_t$ and $L_t$ and the substitutability of $F^S_t$ and $L_t$. The individual maximizes the utility function subject to the budget constraint, $p^S_1 F^S_1 + p^L_1 F^L_1 + p^C_1 C_1 + \gamma(p^S_2 F^S_2 + p^L_2 F^L_2 + p^C_2 C_2) = Y_1 + \gamma Y_2$, where $Y_t$ represents an income at period $t$; $p^S_t, p^L_t$, and $p^C_t$ are the prices of $F^S_t$, $F^L_t$, and $C_t$ at period $t$, respectively; and $\gamma \in (0,1)$ is the discount rate. We assume $p^S_t < p^L_t$ for $t = 1, 2$. For simplification, we assume that prices and income are certain.

Solving the first-order conditions yields the optimal levels of all three goods for each time period. The optimal consumption levels at period $t$ depend on the prices of all goods and incomes at all time periods and on the stock at period $t$, $F^{j*}_t = F^{j*}(P_1, P_2, Y_1, Y_2, L_t)$ for $t = 1, 2$ and $j = S, L$, where $P_t$ is the 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 $\frac{\partial^2 F^{S*}}{\partial L^2} < 0$ for $j = S, L$. Thus, the optimal nutrient intake at period $t$ is

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

Note that the optimal nutrient intake does not necessarily optimize the 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. We 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. The poor are assumed to believe that the price subsidy is permanent. For simplification, we assume that other prices ($p^L_t$ and $p^C_t$) and income ($Y_t$) are constant over time. Note that the stock $L$ may change over time, depending on $\delta, F^L_1$, and the initial stock $L_1$. Under these conditions, a change in nutrient intake due to the introduction of such subsidies can be expressed as

$$\Delta N^*_{12} = \frac{\partial N^*}{\partial F^{S*}}\left(\frac{\partial F^{S*}}{\partial p^S} + \frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\bigg|L_1\right)\Delta p^S_{12} + \frac{\partial N^*}{\partial F^{L*}}\left(\frac{\partial F^{L*}}{\partial p^S} + \frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\bigg|L_1\right)\Delta p^S_{12}, \quad (3)$$

where $\Delta N_{12}$ and $\Delta p^S_{12}$ indicate changes in $N$ and $p^S$ from period 1 to period 2, respectively, and $\Delta p^S_{12} < 0$. On the right-hand side of Eqn. (3), the first and the second terms represent changes in the intake of nutrient $N$ due to changes in the consumption of a cereal and a luxury food, respectively. Here, we consider the case of $\frac{\partial F^{L*}}{\partial p^S} < 0$ to capture the widely observed tendency that luxury food consumption $F^L$ increases after the introduction of such subsidies (e.g., Jensen & Miller, 2008).

Note that, without habit formation, the nutritional effects of introducing the price subsidies are $\Delta N^*_{12} = \frac{\partial N^*}{\partial F^{S*}}\frac{\partial F^{S*}}{\partial p^S}\Delta p^S_{12} + \frac{\partial N^*}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\Delta p^S_{12}$. Thus, the effects of habits are represented by $\left(\frac{\partial F^{S*}}{\partial p^S} + \frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\Big|L_1\right)$ and $\left(\frac{\partial F^{L*}}{\partial p^S} + \frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\Big|L_1\right)$ in Eqn. (3). Compared to the framework without habits, the habit formation framework indicates a smaller positive effect on cereal consumption and a larger positive effect on luxury food consumption because $\frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S} > 0$ and $\frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S} < 0$. As a result, when the luxury food is less nutritious than the cereal, such habits weaken the effect of the subsidies on improving the nutrition of the poor.

Next, we employ the same framework to examine how ending cereal price subsidies 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 the staple cereal, starting in the next period (period 4). The poor are again assumed to believe that this is a permanent event. Under these conditions, a change in nutrient intake due to the end of such subsidies can be expressed as

$$\Delta N^*_{34} = \frac{\partial N^*}{\partial F^{S*}}\left(\frac{\partial F^{S*}}{\partial p^S} + \frac{\partial F^{S*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\bigg|L_3\right)\Delta p^S_{34} + \frac{\partial N^*}{\partial F^{L*}}\left(\frac{\partial F^{L*}}{\partial p^S} + \frac{\partial F^{L*}}{\partial L}\frac{\partial L}{\partial F^{L*}}\frac{\partial F^{L*}}{\partial p^S}\bigg|L_3\right)\Delta p^S_{34}, \quad (4)$$

where $\Delta N_{34}$ and $\Delta p^S_{34}$ indicate changes in $N$ and $p^S$ from period 3 to period 4, respectively; and $\Delta p^S_{34} > 0$. Besides the sign of the change in the price of cereal, the initial stock level $L_t$, is a key difference between Eqns. (3) and (4). The difference in the initial stock ($L_1$ and $L_3$) 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 $|\Delta p^S_{12}| = |\Delta p^S_{34}|$, 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* nutrient intakes after the end of the cereal price subsidies. For simplification, assume that $\Delta p^S_{12} = -\Delta p^S_{34}$. Then, from Eqns. (3) and (4), the necessary