DO CONSUMER PRICE SUBSIDIES REALLY IMPROVE NUTRITION?*

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Abstract: Many developing countries use food price subsidies or price controls to improve the nutrition of the poor. However, subsidizing goods that households spend a high proportion of their budget on can create large wealth effects. Consumers may then substitute towards foods with higher non-nutritional attributes like taste, but lower nutritional content per unit currency, weakening or perhaps even reversing the intended impact of the subsidy. We present data from a randomized program of large price subsidies for poor households in two provinces of China. We are unable to reject that the subsidy had no nutritional impact overall, and in fact may have had a negative impact for some households. (JEL I38; O12; Q18)

KEYWORDS: Price subsidies; Consumption; Poverty; Economic Development.

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I. INTRODUCTION

A number of low-income countries use consumer price subsidies or price controls to improve or protect the nutrition of the poor. For example, both India and Egypt spend about 1 percent of GDP subsidizing basic foods such as rice and wheat, making them among the largest forms of social assistance in both countries. And the use of such programs is expanding worldwide in response to recent increases in world food prices (The Economist, 2007a, b, c).[1,2] Critics often attack such policies on the grounds that they distort market signals; lead to shortages, smuggling and black market activity; or in practice are poorly targeted and disproportionately benefit the least poor. However, the more fundamental question remains: do food subsidies actually improve the nutrition of the poor?

While the proposition that subsidizing the prices of staple foods will improve nutrition seems straightforward, the prediction from theory is ambiguous. Consumers value the non-nutritional attributes of food in addition to the nutritional attributes, and the net nutritional consequences of a price subsidy will depend on how consumers substitute among foods. The poorest households in many low income countries often spend a large share of their budget on, and receive most of their nutrition from, staple foods such as rice, wheat, maize, sorghum or cassava. These staples are frequently the cheapest source of nutrition, in terms of calories per unit currency as well as other nutrients. Since subsidies are typically applied to these very same foods, and at high rates, they can create large wealth effects. Thus, there is the possibility that consumers may respond to the price subsidy by switching away from these nutritious staples, which are typically strongly inferior goods, and toward "luxury" foods (such as meat) that offer more taste or that add variety to the diet but are more costly sources of nutrients. This substitution is the motivation behind the large literature estimating the income elasticity of demand for calories (see Strauss and Thomas 1995 and Deaton 1997 for summaries). If this substitution is substantial enough, consumers may weaken or potentially even reverse the intended nutritional impact of the subsidies.

[1] These increases have largely been attributed to increased demand from large, rapidly growing economies such as India and China, increased world oil prices that in turn drive up the cost of agricultural inputs such as fuel and fertilizer, and the increasing production of biofuels from grains such as corn.

[2] For example, the government of Mexico in January of 2007 imposed price ceilings on the price of corn, a staple of the Mexican diet, due to sharp increases in world corn prices driven by expanded ethanol production.

While it may be argued that price subsidies are an effective welfare tool independent of their nutritional consequences, assessing this impact is important since nutritional objectives are often a primary justification for introducing such programs, or for choosing them over other welfare policies. In addition, food-based welfare programs like subsidies often enjoy greater public and political support than, for example, untied cash transfers, specifically because of the perception and general presumption that they improve nutrition, whereas there is no "control" over how cash would be spent by recipients. Finally, given the widespread incidence of under-nutrition in the developing world,[3] the health and economic consequences of under-nutrition, and the commitment to addressing hunger stated in the first UN Millennium Development Goal, it is important to understand which programs most effectively address the problem.

Consumer price subsidies have been studied on a variety of fronts, particularly the incidence and targeting of such programs in practice (see Behrman and Deolalikar 1988 for a summary). However, surprisingly few studies have focused on their nutritional impact. Two notable exceptions are Kochar (2005) who finds that India's subsidy program has only a limited effect on caloric intake, and Tarozzi (2005) who finds similarly limited effects on children's weight in one state of India. However, as Kochar (2005) notes, the limited impact of India's program is primarily due to low take-up rates and low purchases of subsidized goods conditional on take-up. The reasons for low take-up and use are unclear, though they may result from unique incentives under the program for shopkeepers to undersupply subsidized goods (Kochar 2005).[4]

[3] The FAO estimates that 850 million people worldwide are under-nourished (FAO 2006).

[4] And although these studies improve dramatically upon earlier evaluations, some empirical problems may bias both estimates of the program effect towards zero. For example, Kochar's study relies in part on variation across households in the value of the subsidy and the quantity of the subsidized good for which a household is eligible, which is largely determined by whether they are below the poverty line (BPL). However, BPL status is not measured in the data and must be estimated from observable characteristics. Any mistakes in classification, "assigning" the program to the non-poor and "non-assigning" it to the poor will bias towards finding no effect of the subsidy. Complicating factors further is that in practice BPL "cards" are poorly targeted, with only 57% of eligible poor receiving benefits and 21% of all benefits accruing to non-eligible households (Planning Commission 2005). And while variation over time and space in the value of the benefits is also used, such variation may not be exogenous with respect to consumption. Additionally, BPL status is an eligibility requirement for a variety of other government welfare programs which also affect consumption (including food-for-work, which would reduce food purchases). Thus, it is difficult to attribute differences in consumption to the subsidy program alone (especially since these other benefits may vary over space and time along with the subsidy program). Finally, prices are not directly measured in the data, but derived as unit values (expenditure divided by quantity). Such variation could reflect differences in the variety or quality of the grain households choose or measurement error, which would again bias towards finding no effect. Tarozzi (2005) exploits an increase in the value of the subsidy coupled with variation in survey interview dates across households to estimate the impact of the program via duration of exposure. However, actual receipt of benefits is not observed, and again low take-up would lead towards finding no effect. Additionally, due to data limitations the study focuses only on children under the age of 4, whose nutritional status it may be

It therefore remains important to determine whether a subsidy that more effectively reaches the poor does improve nutrition.

Related, there is a large literature on the nutritional impact of price changes in developing countries, much of which is summarized by Behrman and Deolalikar (1988). The literature, which includes Williamson-Gray (1982), Pitt (1983), Strauss (1984), Pitt and Rosenzweig (1985, 1986), Behrman and Deolalikar (1987), Behrman, Deolalikar and Wolfe (1988), Guo et al. (1999) as well as others has generally found mixed results. While some have found the more intuitive result that calories decrease when food prices increase, several others have found the opposite. While the latter results may be attributable in some studies to the impact of food prices on incomes of farm households, rather than pure consumer price effects, in several studies this effect holds even when accounting for any possible income effects. One lingering concern much of this literature however is whether price variation can be treated as exogenous.[5]

In this paper we present results from a field experiment exploring the response of poor households in China to food price subsidies. For five months, randomly selected households in two provinces, Hunan and Gansu, were given vouchers that subsidized purchases of their province-specific dietary staple. Our analysis focused on households officially designated as the "urban poor," a population that includes approximately 90 million individuals throughout China (Ravallion 2007). This sample provides a useful test case, since consumer price subsidies are typically intended to improve the nutrition of the poorest. In a previous study (Jensen and Miller 2008), we used this experiment as a source of exogenous price variation to test for the existence of Giffen behavior, i.e., an increase in demand for a good in response to an increase in the price of that good. In the present paper, our interest is in the broader household consumption response to a price subsidy, and in particular the impact the subsidy has on nutrition.

Our study offers several important advantages over previous studies of subsides. First, take-up of the subsidy was universal among eligible households, unlike the case for India's program. Second, we have clean, exogenous price variation with which to identify the effects of

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easier to buffer due to their lower needs. Finally, variation in survey interview date only provides differences in program exposure of 1 to 3 months, which may be insufficient time for the nutritional impacts to be felt.

[5] For example, higher demand for food overall, and thus greater caloric intake, could increase prices, rather than the reverse. An additional concern is that spatial or time series price variation may be correlated with factors affecting nutrient demand, such as geography. This could even plague studies examining anthropometric outcomes instead of nutrient intakes; locations with different prices, such as driven by degree of urbanization, may have different levels of access to medical goods and services or different levels of air or water pollution, all of which could independently affect anthropometric status.

the subsidy. Finally, we measure consumption from dietary diaries rather than expenditure data, which may not as accurately measure consumption or nutrition due to food given (or fed) to others or wasted, or meals eaten elsewhere, such as food provided at work or purchased at food stalls or restaurants.

Using consumption surveys gathered before, during and after the subsidy was introduced, we find that poor households in Hunan actually *reduce* their intake of calories and several other important nutrients in response to the price subsidy. In Gansu, calories and other nutrients do not decline; the estimated effects are in most cases actually positive, but they are extremely small and not statistically significantly different from zero. Thus, we find no evidence that subsidies improve nutrition for the poor, and may in fact even harm it. Finally, in both provinces there is evidence that in response to the subsidy, households alter their consumption patterns in ways intended to improve the non-nutritional qualities of their diets.

The paper continues in Section II, where we discuss the field experiment, data, and estimation strategy. Section III presents the results and Section IV discusses and concludes.

II. EMPIRICAL STRATEGY

II.A. The Experiment

Our field experiment provided randomly selected poor households in two Chinese provinces with subsidies for their locally-relevant staple good; rice in Hunan, and wheat (consumed primarily as buns, a simple bread called *mo* or noodles) in Gansu. Households were randomly assigned to either a control group or one of three treatment groups. Households in the treatment groups were given printed vouchers entitling them to a price reduction of 0.10, 0.20 or 0.30 yuan (Rmb; 1 Rmb ≈$0.13) off the price of each *jin* (1 *jin* = 500g) of the staple good (the subsidy level stayed fixed for each household over the course of the study). These subsidies represented substantial price changes, since the average pre-intervention price of rice in Hunan was 1.2 yuan/*jin*, and the average for wheat flour in Gansu was 1.04 yuan/*jin*. The vouchers were printed in quantities of 1, 5 and 10 *jin*, and the month's supply of vouchers was distributed at the start of each month, with each household receiving vouchers for 750g per person per day (about twice the average per capita consumption). All vouchers remained valid until the end of the intervention. Households were told in advance they would receive vouchers for five months and that any un-redeemed vouchers would not be honored afterwards.

The vouchers were redeemable at local grain shops. Households could only use the vouchers to purchase the province-specific staple good, and were not permitted to resell the vouchers or the goods purchased with the vouchers (they were told there would be auditing and accounting to make sure they were in compliance with the rules, and that any violations would result in them being removed from the study without any additional compensation). Jensen and Miller (2008) discuss additional safeguards put in place to prevent cheating or "cashing out," and provide evidence from voucher use that suggests that if any such cheating took place at all, it was extremely limited. We also provide evidence to suggest it is unlikely that the vouchers affected consumption through a behavioral or "salience" effect as opposed to a pure price effect, or to the extent that those effects occurred, they would actually work counter to our predictions and results, and thus do not weaken our conclusions.

II.B. Data

The survey and intervention were conducted by employees of the provincial level agencies of the Chinese National Bureau of Statistics. The sample consisted of 100-150 households in each of 11 county seats in the two provinces (Anren, Baoqing, Longshan, Pingjiang, Shimen and Taojiang in Hunan, and Anding, Ganzhou, Kongdong, Qingzhou and Yuzhong in Gansu), for a total of 1,300 households (650 in each province), with 3,661 individuals. Within each county, households were chosen at random from lists of the "urban poor" maintained by the local offices of the Ministry of Civil Affairs. Households on this list fall below a locally-defined poverty threshold (the *Di Bao* line), typically between 100 and 200 yuan per person per month or $0.41 − $0.82 per person per day, which is below even the World Bank's "extreme" poverty line of one dollar per person per day. These are the type of households price subsidies are typically designed to provide with nutritional protection; they are China's poorest, and they are also extremely poor by international standards. This sample therefore provides a useful case for studying the impacts of a price subsidy.

The questionnaire consisted of a standard income and expenditure survey, gathering information on the demographic characteristics of household members as well as data on employment, income, asset ownership and expenditures. A key component of the survey was a

24-hour food recall diary completed by each household member.[6] Respondents were asked to report everything they ate and drank the previous day, whether inside or outside the home, by specifically listing the components of all foods eaten.[7] These foods were recorded in detail in order to match with the 636 detailed food items listed in the 1991 Food Composition Tables constructed by the Institute of Nutrition and Food Hygiene at the Chinese Academy of Preventative Medicine. Though because the households in our sample are very poor, most diets are very simple and consist of a small number of basic (non -processed, -prepared or -packaged) foods like rice, bean curd or stir-fried cabbage, so concerns about coding the specific quantities of the various ingredients in a complex dish or meal are not significant.[8] We convert food consumption into calories and protein using the nutritional information contained in the Food Composition Tables.

Data were gathered in three rounds, conducted in April, September and December of 2006. After completing the first survey, treatment households were told they would receive the subsidies for five months, from June through October. Thus, the initial interviews occurred before treatment households knew of or received the subsidies, the second occurred after the subsidy had been in place for slightly more than 3 months, and the final interviews were conducted 1 to 2 months after the subsidy had ended, by which time treatment households would likely have exhausted any stocks of rice or wheat flour they may have purchased with the subsidy, and will therefore again be purchasing at the full market price. Sample attrition was extremely low, since the three rounds occurred in a relatively short span. Only 11 of 1,300 households (<1%) in the first round did not appear in the second round. All households in the second round were interviewed in the third round.

Table 1 shows the basic consumption patterns in the two provinces in the pre-intervention survey round. The dominance of, and difference in, staple goods in the two regions is evident. In

[6] There are several alternative methods for assessing food and nutrient intake, discussed in detail in Strauss and Thomas (1995, 1998). Some common alternatives to food diaries commonly used today include a household inventory approach, where foods to be eaten are physically weighed by enumerators, and "food frequency questionnaires." The China Health and Nutrition Survey gathered both a food diary like that used here, as well as a household inventory approach. A validation study by Zhai et. al (1996) finds that, especially for calories, the two methods yield results differing by only about 1 percent.

[7] While it may seem difficult to recall or estimate how many grams of, say, rice was eaten with a meal, for the extreme poor who are on a very limited budget, food is often apportioned and accounted for much more carefully. Further, diets for these extremely poor households often vary little or not at all from day-to-day, except on special occasions, so recalling the quantity of specific food items is not as difficult.

Hunan, households receive on average 64 percent of their calories from rice, while in Gansu wheat-based foods comprise 69 percent of calories.[9] The reliance on these basic foods for nutrition is underscored even more by the fact that the average total calorie share from all cereals or grains is 72 percent in Hunan and 77 percent in Gansu. Further, in both provinces, on average 13 percent of calories come from edible oils (mostly vegetable oil), which is primarily used in cooking, and is generally not a substitute for other forms of consumption or nutrition. Thus, the consumption of all other foods combined on average contributes only 10 percent of calories in Gansu, and 15 percent in Hunan. In Hunan, the greatest remaining share comes from meat, comprising 7 percent of average caloric intake. In Gansu meat consumption is much lower, with pulses (primarily bean curd or tofu) providing a larger share of calories than meat. This difference is likely due to the lower income levels in Gansu; pulses are often referred to as "poor man's meat" because they are a cheaper source of protein (when combined with other foods typically eaten as staples).

It is also worth noting that daily caloric intake in the sample is low by international standards.[10] The median intake among working-aged men (18 − 60) is 1,982 kcal in Hunan and 1,866 kcal in Gansu. For women, the medians are 1,719 and 1,604, respectively. While we can't rule out some undercounting of calories, these values are far below international standards.[11]

II.C. Estimation Strategy

Given the random assignment of the price change and the panel nature of our survey, our basic strategy is to simply compare the household-level changes in nutrient intake for treatment and control groups. Since assignment to these groups was randomized within sample counties, we add county*time fixed effects, so that we are in effect comparing the changes for households with different subsidy levels within the same community. This strategy controls for any county-

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[8] Similarly, because households were so poor, almost all food (98 percent) was at-home consumption, so respondents were aware of the exact ingredients and quantities used.

[9] These goods are also the cheapest source of calories in each province: rice in Hunan yields 1399 calories/yuan, while wheat in Gansu yields 1655 calories/yuan. By contrast, the calories per yuan for other common foods are: wheat (1221), millet (537), pork (331), bean curd (239), and cabbage (141) in in Hunan, and millet (1105), rice (980), pork (340), bean curd (224), and cabbage (173) for Gansu.

[10] The FAO estimates that about 150 million people in China are undernourished (FAO 2006).

[11] The FAO/WHO/UNU Expert Consultation on Energy and Protein Requirements suggests approximate daily energy requirements ranging from 2,335 − 3,164 kcal (depending on level of physical activity) for men and 1,846 − 2,154 kcal for women. In both cases, these requirements are for the "lowest acceptable" body weight (54kg or 119 pounds for men, and 47 kg or 103 pounds for women).

level factors that change over time, such as the prices of foods, labor market conditions or the value of government transfer programs.

We regress the percent change in nutrient intake for household *i* in period *t* on the change in the subsidy (in percent). The percent change formulation normalizes for factors such as household size, composition, and activity level and allows us to interpret the coefficients as elasticities. For each household, we observe two changes: the change between periods 2 and 1 ($t = 2$), capturing the effect of imposing the subsidy, and the change between periods 3 and 2 ($t = 3$), capturing the effect of removing the subsidy.[12] Thus we estimate:

$$\%\Delta Nutrient_{i,t} = \alpha + \beta \%Subsidy_{i,t} + \sum \gamma \%\Delta Z_{i,t} + \sum \delta County * Time_{i,t} + \Delta \varepsilon_{i,t} \qquad (1)$$

where $\%\Delta Nutrient_{i,t}$ is the percent change in household *i*'s total consumption of a given nutrient, $\%Subsidy_{i,t}$ is the percent value of the subsidy (positive for $t = 2$ and negative for $t = 3$), $\%\Delta Z$ is a vector of percent changes in other control variables including income (split into earned and unearned (government payments, pensions, remittances, rent and interest from assets) sources) and household size, and *County*Time* denotes a set of county*time dummy variables. We compute all changes as arc-percent-changes (i.e., $100*(x_t - x_{t-1}) / ((x_t+x_{t-1}) /2)$).[13] The percent value of the subsidy is computed as 100 times the change in the subsidy divided by the average (net of subsidy) price of the staple good in the two corresponding rounds. The results are robust to a range of alternative specifications, including log-log or specifying the dependent variable in levels or per capita terms.

III. RESULTS

III.A. Calories

The results for calories are presented in table 2 (standard errors clustered at the household level). For Hunan, the elasticity of calories with respect to the subsidy is negative and statistically significantly different from zero. While the elasticity is relatively small at 0.21, the price subsidy actually caused a *decline* in caloric intake.[14] Although we are already focusing on

[12] The results do not differ appreciably if we use just the introduction of the subsidy.

[13] We prefer the arc-percent-change specification over the simple percent change because the subsidies represent large changes and because the arc formulation has the desirable property of being symmetric over time. However, the results are largely unchanged if we use the simple percent change instead.

[14] Similar results hold if we omit the changes in income (earned and unearned) and household composition. Controlling for these other variables absorbs any residual variation, and isolates the "pure" price effect of the intervention, as opposed to any behavioral effects the intervention may have on household size or either source of

households officially designated as poor, it is worth exploring whether the subsidies might have at least improved nutrition among the poorest of the poor. In columns 2 and 3, we split the Hunan sample based on whether the household's first period (pre-intervention) expenditure per capita is above or below the province median.[15] For the poorest households, the elasticity is negative, but the point estimate is extremely small, i.e., essentially zero. The decline in calories for the full sample associated with the subsidy was therefore largely driven by the large effect for households at the upper range of the urban poor sample. However, again, the program did not improve caloric intake among the poorest of the poor. This is further evident in column 4, where we focus on the bottom quartile (unfortunately, our samples become too small to split the sample even further). The coefficient is again zero, indicating no nutritional improvement even for even this much poorer group.

Turning to Gansu, the effect of the subsidy on calories for the full sample is positive, but not statistically significantly different from zero. Further, the coefficient is small, suggesting little adjustment of calories at all. Unlike Hunan, the effect is larger in absolute value for households below the median expenditure per capita, though it is again fairly small and not statistically significant. And while it might be expected then that focusing on the even poorer sample might yield a larger effect, we in fact see the opposite; the response of calories for those in the lowest quartile remains positive, but it is smaller and not statistically significant. This again suggests essentially no improvement in caloric intake from the subsidy.

Thus, for our sample of the urban poor in these two provinces, the price subsidy had at best no effect on caloric intake, even for the poorest households, and at worst actually reduced caloric intake among the least-poor-of-the-poor in Hunan.

There are a few potential explanations for the differing results in the two provinces. The first is that households in Gansu are poorer. As shown in table 1, mean income in our Gansu sample is approximately 30 percent lower than in our Hunan sample. Thus, the urban poor in Gansu may exclude those wealthier households that, like their counterparts in Hunan, would

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income (though in regressions for both provinces and for all population subgroups, the effect of the subsidy on these other variables is small and not statistically significant, suggesting the treatment had no such behavioral effects).

[15] It might seem more meaningful to estimate the effects based on initial caloric intake levels, to see whether the subsidy improved caloric intake for those who need it most. However, categorizing individuals in this way is difficult. Not only is there no consensus on what constitutes a subsistence level of calories, but any such threshold would vary widely by age, sex, height, weight, body fat and muscle composition, level of physical activity, health status and a range of other factors. Thus, although we can compute caloric intake for each individual, identifying whether specific individuals are below, near or above their subsistence level of caloric requirements is not possible.

have had a negative elasticity. Related, men and women in Gansu consume fewer calories on average than those in Hunan, which might limit their willingness to substitute towards foods with higher non-nutritional attributes. The difference may also arise from an unanticipated weakness in our experimental design. Our subsidy applied only to the purchase of raw grains, rice in Hunan and wheat flour in Gansu. However, prior to the intervention, about 10 percent of staple (wheat) consumption in Gansu was in the form of prepared foods such as noodles and bread purchased from shops or food stalls rather than made at home from flour. This could limit the impact of the subsidy in two ways. In some cases, households that consume mostly wheat-based foods produced outside the home would effectively gain little from the subsidy.[16] In other cases, households that consume wheat in many forms may substitute away from those produced outside the home and towards those produced within the home, with little net change in nutrition. Finally, due at least in part to geography, the cost of meat in Gansu is higher than in Hunan.[17] Thus, even with the savings from the subsidy, the price of the usual "luxury" good households would typically substitute towards may be too high for households in Gansu to afford.

III.B. Other Nutrients

While energy content (calories) is a particularly important nutrient, it is important to examine changes in other nutrients as well. We focus first on protein. It should be noted however that computing actual protein intake is more difficult than computing caloric intake, since a "complete" protein consists of 12 essential amino acids. While meat contains all of these amino acids and is therefore considered to provide a complete protein, grains and pulses individually lack some of the essential amino acids; it is only in combination with each other that the required levels of all amino acids is attained. Thus, while nutrition tables such as that used here report an aggregated protein value, the actual protein availability to an individual will depend on the combination of foods they eat and their amino acid contents. Unfortunately, we do not have detailed data on amino acid content, nor is there an agreed-upon empirical model for converting food consumption into protein consumption. We therefore simply use the reported protein content of each individual food, without attempting to adjust for protein completeness. This will likely lead us to overestimate protein consumption. And under our hypothesis that households

[16] And these households may be unable or unwilling to substitute towards producing wheat-based foods at home (either due to time constraints or a lack of knowledge on how to prepare such foods).

may substitute away from basic foods like grains and towards luxuries like meat, we will underestimate the protein gains from the subsidy.

With these caveats in mind, the results in columns 5 and 10 show that the effect of the subsidy on protein is negative for Hunan and positive for Gansu. However, in both provinces the effect is very small in absolute value, and not statistically significant. But again, it must be kept in mind that our results may underestimate the effect; if households switched from the protein in grains and pulses (which only together form a complete protein) towards meat (which in itself provides all essential amino acids for protein creation), we would underestimate the effect of the subsidy on protein consumption. However, as a crude approximation, even if we assign all foods except meat half their reported protein content, the conclusions are unchanged; the subsidy had only a small, and not statistically significant, impact on protein in both provinces.

Since the Chinese Food Composition tables do not report data on other nutrients, we supplement our data with the 2007 release of the United States Department of Agriculture (USDA) National Nutrient Database for Standard Reference. This database provides information on 10 minerals and 13 vitamins for approximately 7,500 foods. However, there are some important limitations to matching this information with our data. First, the food item descriptions in the USDA tables differ from those in the Chinese tables used for coding our data. We therefore had to hand-match foods based on their descriptions, which may have lead to coding errors. Further, there were cases where one of the two databases contained more detailed varieties or components of foods than the other, so the matches are imprecise.[18] Finally, for some of the foods recorded in our data there were no corresponding matches in the USDA database, and thus we do not have augmented nutrition data for these foods. Overall, we are unable to match 5.5 percent of the foods entries reported in our consumption diaries. However, many of these items are plants and roots used for tea or in traditional Chinese medicine, and therefore have very little nutritional content, especially in the quantities typically consumed. For example, based on the Chinese Food Composition tables, these foods account for only 0.8 percent of average caloric intake. We therefore will assume these foods similarly contain little in the way of minerals or vitamins and thus would not appreciably influence our results.

[17] The cheapest meat in both provinces is fish, with a mean price of 5.7 yuan/kg in Gansu and 4.0 yuan/kg in Hunan.
[18] For example, the Chinese tables contains separate entries for the leaves, stems and roots of raw mustard greens, whereas the USDA data contain only one entry for the whole plant in its raw form.

The coefficients from regressions using the vitamin and mineral intake as derived from the USDA database as the dependent variables are presented in table 3. For Hunan, the elasticities of nutrient intake with respect to the subsidy-induced price change are almost uniformly negative. However, they are only statistically significant (at the 5 to 10 percent level) for calcium, magnesium, manganese, folate and vitamin A. The effects are large for two particularly important nutrients: calcium, where the point estimates suggest a 1 percent price subsidy leads to a nearly 0.5 percent reduction, and vitamin A, where a 1 percent subsidy leads to a 0.7 percent reduction. Among other things, these two nutrients are important for the growth and maintenance of bones, and deficiencies in them can lead to a variety of significant, long-term health problems.[19] In Gansu, the point estimates for the various vitamins and minerals are more mixed between positive and negative effects, though in no cases are they statistically significant. And the estimates are also extremely small in most cases, with more than half of the nutrients featuring point estimates of the elasticities of less than 0.10 in absolute value. Thus again, overall we conclude that the subsidy had little effect on the nutrition of the poor in Gansu, and may have actually worsened it in Hunan.

III.C. Patterns of Substitution

The motivating hypothesis for this study, as well as the literature on the income elasticity of demand for calories, is that when able, consumers may substitute towards foods with higher non-nutritional attributes (or seek to add variety to their diet). In table 4, we consider the impact of the subsidy on dietary patterns using the percentage change in consumption of various food categories as the dependent variables in regressions like (1) above.

The results overall provide some explanation for the nutrition results. In Hunan, the rice price subsidy causes consumers to cut back on their consumption of rice, i.e., the Giffen behavior documented in Jensen and Miller (2008). In addition, they cut back on their consumption of vegetables (this category is dominated primarily by cabbage), pulses (primarily bean curd or tofu) and fats (primarily cooking oils). Offsetting these cutbacks is an increase in seafood consumption (primarily fish). While we only know the foods eaten, not how they were prepared or combined as eaten, our field work revealed that the primary diet for most households in

[19] In our data, the baseline levels of these two nutrients show deficiency is widespread. The median daily intake of calcium for adults aged 21-60 in Hunan is 386mg, which is far below the US Recommended Adequate Intake (RAI)

Hunan was rice, eaten with cabbage and bean curd stir-fried in oil. The results in table 4 therefore suggest that households in Hunan substituted away from this primary meal in favor of adding fish when the price subsidy was introduced. Thus, a great deal of calories and nutrients are lost from the consumption of rice and pulses (cabbage has very few calories), only part of which is made up for by the increased consumption of seafood, leading to a net decline in calories (and other nutrients).

In Gansu, the patterns are less clear. There are few statistically significant coefficients and thus little evidence of systematic substitution (it is possible that substitution did take place, but was very heterogeneous and spread across a number of different categories). The primary impact of the wheat price subsidy seems to have been an increase in the consumption of fats (edible oil). In Gansu, this oil is sometimes brushed on top of or eaten with the simple home-made bread *mo* in order to add flavor. Therefore, one interpretation is that, as in Hunan, subsidized households again sought to add taste to their diet; but since they could still not afford meat or seafood, they instead opted for the lower cost option of increasing edible oils. However, since consumption of other foods such as the staple did not decline, overall average caloric intake did not decline. In fact, per unit currency, oil adds more calories than wheat (but little in the way of other nutrients), which may explain why the coefficient on calories was positive in Gansu (and that on other nutrients was largely unchanged).[20]

IV. DISCUSSION AND CONCLUSION

Overall, we conclude that the consumer price subsidy did not improve nutritional status, and may in fact have worsened it. This is despite the fact that the sample households are extremely poor, both by Chinese and international standards, and appear to be undernourished by international standards, and are thus the group whose nutrition food prices subsidies are typically intended to improve. And the subsidies were substantial, ranging from 10 to 30 percent. Of course, we can't rule out that larger subsidies might have a greater impact on nutrition; however, under our hypothesis, larger subsidies would lead to even greater wealth effects, and thus might lead to even worse nutritional outcomes, as more substitution away from basic goods takes place.

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of 1,000mg. For vitamin A, the median intake for adults is 201μg, which is below the US RAI of 800μg.

[20] The only other nutrient that is even close to being marginally statistically significant in table 3 is choline, a nutrient found in relatively high amounts in fats and oils.

Of course, the subsidy still leads to a utility gain for recipient households. And there may be other advantages to price subsidies or controls over other social welfare policy instruments such as cash transfers that overcome their disadvantages (such as distorting prices). For example, they may be easier to target or administer or may enjoy greater political support. However, what is often a primary justification for choosing subsidies over other policy instruments, i.e., improving the nutrition of the poor, does not appear to hold.

It is not the case, however, that the subsidies simply had no effect. Especially in Hunan, they resulted in a substitution away from the subsidized good, in part towards a taste-preferred good, and in doing so reduced nutrition. There are two potential interpretations for these results, which we are unfortunately unable to distinguish. The first is that consumers are maximizing utility, and gain more from the increased taste or variety than they lose in calories or long-term health status. This may be especially likely if consumers heavily discount the future, so they are willing to sacrifice long-term health in favor of short-term utility gains. The second interpretation is that consumers are unaware that they are losing nutrients in substituting among foods. For example, consumers may not fully know the exact caloric content of rice and seafood, and may believe that seafood is so calorie-rich and rice so calorie-poor that they are not losing calories (or other nutrients) when they substitute between those foods in the quantities observed. In this second case, additional nutritional information may lead consumers to make different choices, and thereby cause subsidies to improve nutrition. In the first case, policymakers are confronted with the reality of utility maximizing consumers, and can either abandon their concerns over nutrition (possibly even still favoring price subsidies as a form of welfare policy for other reasons), or take a more paternalistic approach towards nutrition, perhaps as motivated by a public good aspect of good nutrition. However, if policy makers do remain focused on improving nutrition, there are no clear alternative policies that will necessarily be more effective. Similar effects to those observed here may occur with any other type of program aimed at improving nutrition that increases real wealth, including in-kind transfers of food.[21] In fact, the present results are perhaps ironic in light of the policy implications sometimes drawn from the large literature concerned with the income elasticity of demand for calories. Those policy makers who wish to improve nutrition but believe the income elasticity is small might be inclined to suggest,

[21] Providing the good in a quantity in excess of what the household would otherwise consume is unlikely to be a viable alternative, given the challenges of assessing baseline consumption and preventing resale.

as alternatives to cash transfers, subsidies or price controls that directly encourage increased consumption of nutritious foods. Similar policy prescriptions may arise if there is a concern, often stated, that simply giving cash is not desirable because households may spend it on other luxuries (food or non-food). Our results indicate that even these price-based policies will face similar difficulties by virtue of the wealth effects they create.

However, this is of course not to say that recent spikes in world food prices should be ignored, or that consumer price subsidies have no value. Rising food prices will have adverse consequences on the poor, and public policy must find ways to address this concern. However, again, policymakers may have to be satisfied with assessing the gains of any efforts in terms of wealth transferred, not in terms of nutrition.

Finally, it is worth noting that the results can be interpreted as providing somewhat more positive news regarding household vulnerability to price shocks. Policymakers are often concerned that household nutrition may decline when the prices of staple foods increase, and many programs worldwide are designed to protect against this very possibility. While there is a large literature examining the ability of households in developing countries to smooth consumption in the face of volatile income, much less studied is the vulnerability of households to fluctuations in the prices of food (which can lead to large losses in wealth and purchasing power). If we view the subsidies in our study as simply exogenous price changes, the results suggest that households are able to buffer nutrition against such shocks quite well (though we have only explored price changes averaging 20 percent; much higher shocks may have more significant effects on nutrition).

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Table 1. Calorie Shares for Food Categories and Sample Means

	HUNAN	GANSU
% of Calories From:		
Rice	0.640	0.068
	[.171]	[.131]
Wheat	0.080	0.685
	[.117]	[.173]
Other Cereals	0.002	0.009
	[.022]	[.050]
Vegetables and fruit	0.046	0.065
	[.044]	[.045]
Meat	0.074	0.014
	[.115]	[.037]
Pulses	0.022	0.022
	[.043]	[.056]
Dairy	0.00	0.009
	[.003]	[.039]
Fats	0.131	0.126
	[.095]	[.090]
Total Daily Calories, Male 18-60	1,982	1,866
	[778]	[607]
Total Daily Calories, Female 18-60	1,719	1,604
	[614]	[522]
Total Daily Protein (g), Male 18-60	48.6	52.1
	[22.3]	[20.0]
Total Daily Protein (g), Female 18-60	42.5	44.2
	[19.0]	[16.8]
Expenditure Per Capita	220	157
	[174]	[110]
Family Size	2.85	2.78
	[1.29]	[1.06]
Observations	644	649

Notes: Standard deviations in brackets. Expenditure in 2007 *yuan* (Rmb).

Table 2. Calorie Response to the Price Subsidy

	HUNAN					GANSU				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Full Sample (Calories)	Below Median (Calories)	Above Median (Calories)	Bottom Quartile (Calories)	Full Sample (Protein)	Full Sample (Calories)	Below Median (Calories)	Above Median (Calories)	Bottom Quartile (Calories)	Full Sample (Protein)
%Subsidy(rice/wheat)	-0.206*	-0.042	-0.339**	0.004	-0.096	0.154	0.169	0.132	0.070	0.091
	(0.108)	(0.144)	(0.164)	(0.207)	(0.133)	(0.100)	(0.143)	(0.138)	(0.261)	(0.112)
%ΔEarned	0.031***	0.026*	0.036**	0.037*	0.040***	0.028**	0.027	0.029	0.053	0.017
	(0.011)	(0.014)	(0.018)	(0.021)	(0.013)	(0.014)	(0.021)	(0.019)	(0.034)	(0.016)
%ΔUnearned	-0.022	-0.025	-0.023	-0.037	-0.010	0.046	0.020	0.071*	0.101	0.069
	(0.020)	(0.027)	(0.028)	(0.034)	(0.023)	(0.035)	(0.056)	(0.043)	(0.119)	(0.033)
%ΔPeople	0.94***	1.07***	0.80	1.04***	0.93***	0.91***	1.01***	0.81***	1.08***	0.88***
	(0.07)	(0.08)	(0.11)	(0.10)	(0.07)	(0.08)	(0.10)	(0.12)	(0.13)	(0.09)
Constant	0.9	1.6	0.5***	2.8*	0.8	-1.9	0.1	-3.9	0.6	-4.0
	(0.8)	(1.1)	(1.1)	(1.5)	(0.9)	(0.8)	(1.1)	(1.1)	(1.7)	(0.9)
Observations	1258	633	625	317	1258	1269	634	635	320	1269
R^2	0.26	0.34	0.21	0.39	0.20	0.18	0.23	0.15	0.29	0.16

Notes: Regressions include county*time fixed-effects. The dependent variable in columns 1-4 and 6-9 is the arc percent change in household caloric intake and in columns 5 and 10 it is the arc percent change in household protein consumption. Standard errors clustered at the household level. %Subsidy (rice/wheat) is the rice or wheat price subsidy, measured as a percentage of the average price. %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); %ΔPeople is the arc percent change in the number of people living in the household. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.

Table 3. Effect of the Subsidy on Minerals and Vitamins

	MINERALS			VITAMINS	
	HUNAN	GANSU		HUNAN	GANSU
Calcium	-0.467*	-0.133	Vitamin C	-0.394	0.167
	(0.242)	(0.187)		(0.315)	(0.231)
Iron	-0.153	0.077	Thiamin	-0.040	0.110
	(0.134)	(0.118)		(0.115)	(0.117)
Magnesium	-0.240*	-0.072	Riboflavin	-0.100	0.153
	(0.145)	(0.150)		(0.179)	(0.147)
Phosphorus	0.081	0.038	Niacin	-0.063	0.092
	(0.172)	(0.152)		(0.113)	(0.117)
Potassium	-0.206	0.044	Pantotheonic Acid	-0.131	-0.040
	(0.163)	(0.142)		(0.110)	(0.124)
Sodium	-0.275	-0.066	Vitamin B-6	-0.155	0.011
	(0.340)	(0.334)		(0.138)	(0.149)
Zinc	-0.095	-0.068	Folate	-0.208*	0.133
	(0.122)	(0.121)		(0.125)	(0.134)
Copper	-0.117	0.032	Choline	-0.346	0.332
	(0.128)	(0.124)		(0.243)	(0.219)
Manganese	-0.206*	-0.039	Vitamin B-12	0.524	0.049
	(0.111)	(0.116)		(0.439)	(0.330)
Selenium	-0.083	0.329	Vitamin A	-0.710*	-0.168
	(0.149)	(0.226)		(0.433)	(0.360)
			Retinol	0.298	0.104
				(0.446)	(0.334)
			Vitamin E	-0.144	0.280
				(0.248)	(0.216)
			Vitamin K	-0.389	0.171
				(0.431)	(0.343)

Notes: Regressions include county*time fixed-effects. The dependent variables are the arc percent change in household consumption of the good listed at the top of the column. Standard errors clustered at the household level. Coefficients in the table are on the variable %Subsidy(rice/wheat) is the rice or wheat price subsidy, measured as a percentage of the average price. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.

Table 4. Consumption Response to the Price Subsidy

HUNAN

	Rice	Other Cereal	Fruit & Veg	Meat	Seafood	Pulses	Dairy	Fats	Food Out	Non-Food
%Subsidy(rice)	-0.235*	0.397	-0.623***	0.377	0.482**	-0.791*	-0.054	-0.567*	0.117	0.200
	(0.140)	(0.355)	(0.227)	(0.415)	(0.230)	(0.476)	(0.069)	(0.313)	(0.347)	(0.200)
%ΔEarned	0.043***	-0.001	0.058***	0.002	0.036	-0.052	-0.006	0.022	0.059	0.014
	(0.014)	(0.040)	(0.021)	(0.043)	(0.022)	(0.050)	(0.004)	(0.031)	(0.044)	(0.025)
%ΔUnearned	-0.044*	-0.087	-0.018	0.076	-0.004	-0.037	-0.021	-0.007	0.020	0.089**
	(0.025)	(0.065)	(0.040)	(0.071)	(0.042)	(0.075)	(0.019)	(0.055)	(0.057)	(0.038)
%ΔPeople	0.89***	0.46**	0.63***	0.05	-0.07	0.48**	0.09	0.88***	-0.18	0.15
	(0.08)	(0.19)	(0.11)	(0.24)	(0.10)	(0.23)	(0.05)	(0.16)	(0.18)	(0.13)
Constant	4.1***	7.5***	-0.3	-5.7**	-0.2	8.8***	0.2	-8.3***	-3.5	-52.6***
	(1.0)	(2.5)	(1.4)	(2.8)	(1.4)	(3.0)	(0.6)	(2.1)	(2.5)	(1.5)
Observations	1258	1258	1258	1258	1258	1258	1258	1258	1258	1258
R^2	0.19	0.06	0.11	0.07	0.02	0.03	0.02	0.09	0.02	0.20

GANSU

	Wheat	Other Cereal	Fruit & Veg	Meat	Seafood	Pulses	Dairy	Fats	Food Out	Non-Food
%Subsidy(wheat)	0.353	-0.283	0.049	0.130	-0.017	0.240	0.282	0.507**	0.109	-0.021
	(0.258)	(0.335)	(0.190)	(0.299)	(0.017)	(0.320)	(0.207)	(0.251)	(0.276)	(0.180)
%ΔEarned	0.079**	-0.067	0.061**	0.085*	0.000	-0.047	-0.025	0.091***	0.070	0.040
	(0.036)	(0.049)	(0.027)	(0.044)	(0.000)	(0.043)	(0.029)	(0.033)	(0.043)	(0.025)
%ΔUnearned	-0.017	0.130	0.046	0.314***	0.025	0.012	0.108	-0.110	-0.077	0.229***
	(0.092)	(0.106)	(0.077)	(0.091)	(0.025)	(0.104)	(0.073)	(0.091)	(0.097)	(0.070)
%ΔPeople	0.58***	0.52*	1.01***	-0.10	-0.01	0.44**	0.10	0.66	0.00	-0.04
	(0.22)	(0.29)	(0.15)	(0.28)	(0.01)	(0.18)	(0.12)	(0.15)	(0.19)	(0.19)
Constant	-26.1***	23.8***	11.0***	2.4	-0.2	6.0**	-3.4*	7.2	7.5***	-38.2***
	(2.3)	(2.8)	(1.6)	(2.5)	(0.2)	(2.6)	(1.9)	(2.1)	(2.4)	(1.4)
Observations	1269	1269	1269	1269	1269	1269	1269	1269	1269	1269
R^2	0.08	0.06	0.07	0.05	0.03	0.06	0.03	0.07	0.05	0.17

Notes: Regressions include county*time fixed-effects. The dependent variables are the arc percent change in household consumption of the good listed at the top of the column. Standard errors clustered at the household level. %Subsidy(rice/wheat) is the rice or wheat price subsidy, measured as a percentage of the average price. %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); %ΔPeople is the arc percent change in the number of people living in the household. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.