NIH Public Access

Author Manuscript

Soc Sci Med. Author manuscript; available in PMC 2009 January 1.

Published in final edited form as:

Soc Sci Med. 2008 January ; 66(2): 414–426.

Impacts of China's Edible Oil Pricing Policy on Nutrition

Shu Wen Ng[a] and **Barry M. Popkin**[b]

[a]*Department of Health Policy and Administration, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC*

[b]*Department of Nutrition, School of Public Health, Department of Economics, and Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC*

Abstract

China's health profile has shifted to one dominated by obesity and nutrition-related noncommunicable diseases (NR-NCDs) necessitating an examination of how economic policies can improve this situation. Edible oil consumption is responsible for much of the increase in energy density of the Chinese diet and particularly linked with the shifting burden of NR-NCDs toward the poor. Longitudinal analysis among adults in the China Health and Nutrition Survey (CHNS) covering the period 1991 to 2000 revealed that price policy effects on edible oil can influence dietary composition (particularly of the poor) and the results identify a key preventive policy need.

Keywords

China; edible oils; pricing policy; nutrition transition; overweight

Introduction

During the past 20 years, there have been remarkable transformations in global economies and a major shift in the health area—where undernutrition is rapidly being replaced by overweight and obesity (Mendez et al., 2005; Monteiro et al., 2004). One of the major components of this shift has been a rapid increase in the energy density of the diet (Bell & Rolls, 2001; Kral & Rolls, 2004; Prentice & Poppitt, 1996; Rolls & Drewnowski, 2005). Large increases in edible oil consumption are an issue in many countries, representing a major element in this shift toward more energy-dense food intake (Drewnowski & Popkin, 1997; Du et al., 2002; Du et al., 2004).

These newly emerging problems are particularly relevant for China. China, with its rapid economic and social change combined with the nutrition transition (i.e., a series of changes in diet, physical activity, health and nutrition), has seen a similar shift (Popkin et al., 2006; Wang et al., 2006). With some of the fastest rates of increase in overweight and obesity accompanied by large increases in health costs and other related economic costs, China faces a situation

Corresponding Author: Barry M. Popkin Carolina Population Center, University of North Carolina - Chapel Hill, 123 W. Franklin St. Chapel Hill, NC 27516, Phone: (919) 966-1732, Fax: (919) 966-9159, Email: popkin@unc.edu.
Author Comments: Financial assistance for this research comes from the US National Institutes of Health (NIH) (R01-HD30880 and R01-HD38700). The authors thank David Guilkey for methodological assistance, Tom Swasey for his graphics assistance, and Frances L. Dancy for her administrative assistance.
shuwen@unc.edu

where conservative estimates predict 8.7% of its 2025 Gross National Product (GNP) will be allocated to nutrition related noncommunicable diseases (NR-NCDs), linked with energy imbalance and obesity (Popkin et al., 2006). These changes represent serious health and economic threats to China's adults and suggest that the future of their children will not be a healthy one. Prices and other economic incentives, used to foster rapid growth of the economy, can be used to provide a positive effect on the dietary decisions of Chinese adults.

Price policies are basic to China's development, and are also very important in affecting global food consumption decisions (Guo et al., 2000; Guo et al., 1999; Timmer et al., 1984). The basic idea is that the price of food, set by the market, reflects the cost of producing the food rather than true costs (which should include the external costs of treating NR-NCDs such as coronary heart disease or Type II diabetes). If this is indeed true, then a price increase should, in theory, provide an economically efficient solution to the mismatch between true and market costs. However, the effectiveness of such a measure depends on how responsive consumers are to price changes. Since there are convenient substitutes between foods, it is not sufficient to simply look at price changes of targeted food groups to observe dietary impacts. It is also necessary to consider how price changes for one food might impact the demand for other foods and resultant nutritional intakes.

An added consideration is the impact on rich and poor Chinese. Recent research has shown a marked shift in NR-NCDs toward the poor in China (Monteiro et al., 2004). The most rapid shifts in energy dense-foods, higher fat diets, and greater obesity are found among lower-income and rural Chinese (Du et al., 2004; Wang et al., 2006). Similar changes are occurring in other developing countries with increases in GNP per capita greater than $2,500 (in real terms) (Monteiro et al., 2004).

China's edible oil pricing policies

In China, food pricing policies have changed notably over the last half-century. At the time of the founding of the People's Republic of China in 1949, China's grain production was very low, resulting in a limited supply in the face of increasing demand. To address the shortage, a state monopoly for purchasing and marketing grain was implemented nationally in 1953, replacing free trade of grain and edible oils (Ge et al., 1991).

In 1955, a rationing system that gave the government control over the price system for major foods was instituted in urban areas (Today'sChina, 1988) with quotas determined by age, occupation, and intensity of labor. The government purchased farm and farm-related products at a fixed purchasing price and they were subsequently sold to urban residents at lower prices. Due to escalating production costs, the government purchasing price of farm and farm-related products was raised systematically, but the selling price to residents remained unchanged. Government subsidies compensated for the differences between the purchasing and selling prices (Duncan & Jiang, 2001).

China began reforms in 1978 through 1980 that focused on increasing agriculture production, investment, and employment generation. These reforms were followed by many shifts in economic policies at the national, provincial, city, and county levels. Price policy shifts were central to these reforms as the government worked to remove the heavy financial burden of its price subsidy system. Consequently, subsidies for food were gradually reduced to meet the needs of the market economy.

Edible oil price policies were a critical element in this transformation. In 1983, the government removed its unified purchasing policy on edible oils and opened the market for negotiated prices (ChinaGate, 2004). In May 1991, the price of rationed grain and edible oil was re-adjusted, with the price of grain increasing 70% and the price of edible oil almost doubling

(Ge et al., 1991). The government also released food supplies previously unseen in China, resulting in demand and consumption increasing significantly during this period (Du et al., 2002; Popkin et al., 1993). By 1992, governmental control over the price of edible oil was eliminated. To lessen the impact of increased costs, the government provided subsidies on certain non-staple foods to urban residents. In 1996, state own enterprises (SOEs) were also exempted from the value-added tax (VAT) when selling edible oil (Qian & Wu, 2000).

The most recent development was China's accession into the World Trade Organization (WTO) in 2001. As part of WTO trade negotiations, China agreed to phase our tariff quotas for soy oil, and to eliminate the quota on sunflower, peanut, and corn oil, with a 10% tariff put in its place (Agri-Canada, 2002). The supply of domestic oil production also increased, especially for rapeseed and soy oils, with technology improvements in seed crushing and processing. There had been enormous rationalization of the Chinese production sector—employment was dropping significantly and larger, more capital-intensive, and modern production facilities were emerging. All of these signaled general declines in oil prices towards international market prices and had implications on consumer demand.

Demand for edible oils

There are only a few studies that explicitly model the Chinese demand for edible oils, but they all indicate an undeniable increase in demand. One study of the urban population found that demand rose 440% between 1979 and 1999 (Fang & Beghin, 2002). Foreign trade data show that China was one of the world's largest importers of soybean, rapeseed, and palm oils in 1999 (DailyTimes, 2005). Past studies have been careful to point out differences in the dominance of various types of edible oils by region. In particular, the people in the South use mainly peanut oil, those in Central and Western China prefer rapeseed oil, and soy oil is the dominant preference in the North and Northeast (Agri-Canada, 2002). Hence, people's responses to edible oil prices vary, depending on which oil had a price change. For example, a cross-sectional study based in urban areas of China by Fang and Beghin (2002) found that demand for "staple" edible oil was price elastic for each region's major edible oil; however, demand for "non-staple" edible oil was much more price elastic.

Income effects are important considerations, given China's rapid economic growth. Previous studies (Guo et al., 2000) have shown that increases in dietary fat consumption is positively related to improved household income. As stated earlier, Fang and Beghin (2002) found that in urban areas, there were large income elasticities for non-staple edible oils by region, meaning that people will diversify their oil consumption as their income increases. Another related factor is the rural-urban differences. Although growth in demand might be greater in rural areas since rural residents currently consume less oil, rural consumption is likely to be less sensitive to price changes than urban consumption due to income effects.

Guo and colleagues (1999), using 1989-1993 data from the China Health and Nutrition Surveys (CHNS), found that changing prices reduced fat intake of the rich without adversely affecting protein intake for the poor. Guo's study focused only on macronutrients during this early period of the edible oil price shifts in China. Our analysis is larger in scope by (a) encompassing the more recent period with very rapid shifts in edible oil importation and prices and (b) examining the impact of price changes on a set of food groups and edible oil consumption.

Data and Methods

This analysis used four waves of data collected in 1991, 1993, 1997 and 2000 from the China Health and Nutrition Survey (CHNS)—designed to study how the socio-economic transformation of Chinese communities affects the health and nutritional behaviors and status of their populations. The CHNS was initiated in 1989, involving nine provinces that varied in demography, geography, economic development, public resources, and health indicators. A multistage, random cluster process was used to draw the sample surveyed in each of the provinces. Counties in the nine provinces were stratified by income and a weighted sampling scheme was used to randomly select four counties in each province. Villages and townships within counties, and urban and suburban neighborhoods within cities, were selected randomly. The same households were surveyed during each wave as best possible to allow for a longitudinal study.

CHNS 1991 only surveyed individuals belonging to the original 1989 sample households; this resulted in 14,778 surveyed individuals (92.8% of the original 1989 CHNS sample). In CHNS 1993, all new households formed from sample households who resided in sample areas were added to the CHNS 1991 sample, but there was also some attrition, resulting in 13,893 surveyed individuals. In CHNS 1997, all newly-formed households (within the sample areas), additional households (to replace those no longer participating), new communities (to replace communities no longer participating), and Heilongjiang province (to replace Liaoning province) were added, resulting in a sample of 14,426 individuals. In CHNS 2000, newly-formed households, replacement households, and replacement communities were added and Liaoning province was returned to the study, resulting in a sample of 15,648 individuals. Consequently, there were a total of 58,745 person-wave observations available across the four survey waves.

To test if there was attrition bias, we regressed baseline characteristics (i.e., income, education, urbanicity, household size age, and gender) on the probability of being in the CHNS 1991, but missing in the subsequent surveys. We found that younger, male individuals and those residing in urban areas were significantly more likely to attrite in each of the subsequent three surveys. This is not a surprising finding, since these are characteristics of individuals who are more mobile. However, this was a small proportion of the sample as noted by the high response rates for the sample population as a whole.

We limited the analysis to adults, 20 years of age and older, during each survey wave for whom complete variables were available. This resulted in the deletion of 14,818 person-wave observations with age reported as being younger than 20 years old. An additional 12,749 person-wave observations were lost due to incomplete data of the analysis variables. The final case analysis included 31,178 person wave observations from a sample of 12,269 individuals over the nine-year period (1991-2000).

Dependent variables

We used intake measurements of three macronutrients and four food groups as dependent variables. The macronutrients were (a) percent energy from protein, (b) percent energy from fat, and (c) percent energy from carbohydrates. Each gram of protein and carbohydrates provided four calories of energy, while each gram of fat provided nine calories of energy. The food groups included (a) edible plant oils, (b) animal fats, (c) all rice products, and (d) all flour products.

These detailed food consumption data were collected for households and individuals on three consecutive days with the start day randomly allocated from Monday to Sunday. Household food consumption was determined by measuring the change in the weight of the household food inventory at the beginning and the end of each day for all three days. All processed foods, purchases, home production, and processed snack foods at the initiation of the survey were weighed and recorded. Preparation waste was estimated when weighing was not possible. The number of household members and visitors at each meal was recorded. Individual dietary intake was surveyed for all adults based on daily, self-reported, 24 hour recalls on all food consumed away-from-home and at-home. More than 99% of the sample was available for all three days of data collection. Foods cooked with edible oils were used to determine each individual's allocation of the household's total edible oil consumption by taking the individual's edible oil-linked foods, divided by the total household intake of these foods, and multiplied by the amount of edible oil consumed by the household.

The collection of both household and individual dietary intake allowed for quality checks. Where significant discrepancies were found, the household or the individual in question were revisited, and again asked about their food consumption in order to resolve these discrepancies (Wang et al., 2000). Nutrient intakes were calculated by matching the consumption data with the 1991 China Food Composition Tables (FCTs). The FCTs provided a comprehensive list of the macronutrient content of food items available in the Chinese market. The rigor used in obtaining the data is believed to have minimized food consumption reporting errors for households and individuals (Chen, 2004; Paeratakul et al., 1998; Popkin et al., 2002).

Independent Variables

Community price surveys conducted on a set of sample stores and markets were used to provide price data. Variations in food prices across communities are due to both supply and demand side factors. On the supply side, agricultural production, transportation, marketing and distribution costs, imports of specific foods, and availability of substitutes and complements can affect prices across communities. On the demand side, preferences or food fads may vary by communities. In addition, there are also variations in inflation, measured by the Consumer Price Indices (CPI) across communities, depending on the province and urbanicity. Region and urban-rural residence were used to control for major food preference differences. It is felt that most price changes in China are driven by supply factors and exogenous economic decisions made at the provincial level by price commissions and other macroeconomic government decisions; hence, they can be considered exogenous variables.

Community prices for a representative basket of goods were from three sources: (a) state stores (SSs), (b) free markets (FMs)—collected from visits to stores in the communities surveyed, and (c) authority price records published by the State Statistical Bureau (SSB) of China that provided the provincial averages. The SS prices have been decreasingly reflective of market prices since the 1991-1992 price reform in China. Therefore, in most situations, the FM prices were used as the basis (except when the studied goods were not sold in the free market, in which case SS prices were used; SSB prices were used if the other two sources did not contain the information).

Prices were collected in a systematic manner for each surveyed community. The key independent variable of interest was the price of edible oil. Because there were a number of different types of edible oils (e.g., soy, peanut, rapeseed, corn, sesame, etc.), we used two approaches to create an edible oil price. First, we used the price of the cheapest edible oil sold in each community. The second approach was to create a weighted price, based on regional edible oil consumption patterns from the 1992 China Nationwide Nutrition Survey (CMPH, 1994), to create a weighted edible oil price for each community. Other prices included in the modelling were for key common food groupings (e.g., rice, flour, eggs, fatty pork) and the cheapest retail coarse grain (e.g., corn, millet, or sorghum) for each community.

In the surveys, household income was reported as a continuous variable (in yuan). The total household income came from a very detailed income protocol that collected income for each activity. This included all cash and non-cash income components (e.g., state-subsidized housing) and excluded food subsidies that existed before 2001. In addition, we adjusted household income for deflation (explained below) before we categorized it into tertiles to allow for non-linearity in the effect of income.

We deflated price and income variables by year- and province-specific consumer price indices (CPI) developed for urban and rural areas by the China SSB (SSB, 1990,1992,1994,1998, 2001, and 2005), using the 1980 CPI as the baseline. The use of real deflated values in the analyses removed the effect of inflation and allowed the analysis to focus on the effect of an increase in real prices and real incomes.

Other household level variables included were household size, whether the household resided in a community with an urban designation, and region of residence. The regional measurement criteria were developed by the World Bank in collaboration with the China SSB (WorldBank, 1995), reflecting contiguous groupings with comparable income levels. With respect to agricultural economics and food behavior, samples were grouped into three regions: (a) the South Hinterland (Guizhou, Guangxi, & Hunan), (b) the Central Core (Henan, Hubei, & Jiangsu), and (c) the North (Liaoning, Heilongjiang, & Shangdong).

Individual level data controlled in the models were age, gender, and education. Age and the number of years of education were continuous variables and gender was a dichotomous variable. We also included year dummies to account for the possibly of time trends[1].

Estimation

Since we were interested in own price and cross-price elasticities, we used Log-Log models to allow for ease in coefficient interpretations. Own price elasticity of demand is defined as the percentage change in quantity demanded that occurs in response to a percentage change in price. This should be negative. If the *absolute* value of the estimated own-price elasticity is > 1, demand is elastic and if it is < 1, demand is inelastic. Cross-price elasticity of demand is the percentage change in quantity demanded for the first good that occurs in response to a percentage change in the price of a second good. Goods with positive cross-price elasticities are considered substitutes and those with negative cross-price elasticities are considered complements. Examples of substitutes are coffee and tea, while coffee and sugar can be complements.

We used longitudinal random effects models with clustering at the household level for the food groups and the macronutrient estimations. While fixed-effects models allowed us to control for unobserved heterogeneity across the same individuals, it was not ideal since potential time-invariant factors such as gender, education, urbanicity, and region would drop out. Fixed effects models are also inefficient and ‘use up’ many degrees of freedom. Even though the longitudinal random effects model does not exploit the panel aspect of the data fully, it does allow for greater power in the analysis. However, the longitudinal random effects model assumes that the unobserved factors (captured in the error terms) and the explanatory variables are independent of each other.

In our specifications, all models included time, region, household income, food prices, age, gender, education, urban residency, household size, and interactions between edible oil prices with time dummies as control variables. All estimations were clustered at the household level because of the possibility of having multiple adults within each household. Stata version 9.0 was used in all analyses (StataCorp, 2005).

Food groups estimations—Consumption distribution can be skewed because some people do not consume certain food groups. Thus, researchers recommend using two-part models to analyze consumption behaviors (Haines et al., 1988). Two-part models are also useful in predicting actual outcomes based on observed data, such that a zero does not represent missing

[1]The descriptive statistics of the analytic sample are available upon request.

data but is interpreted as a corner solution in consumer optimization. Since prior literature has suggested taste differences by region, we also included interactions between edible oil prices by region. We used longitudinal random effects probit models for the first part of the food group estimations and longitudinal random effects generalized least squares (GLS) models for the second part. The two parts have the same specifications and are:

$$\begin{aligned}\Pr\left(\mathrm{AteFG}_{ihct}\right) = {} & \gamma_0 + \gamma_1 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) + \gamma_2 \mathrm{Time}_t + \gamma_3 \mathrm{Region}_{hc} + \gamma_4 \mathrm{Urban}_{hc} \\ & + \gamma_5 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) * \mathrm{Time}_t + \gamma_6 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) * \mathrm{Region}_{hc} + \\ & \gamma_7 \mathrm{Log}\left(\mathrm{FoodPrices}_{ct}\right) + \gamma_8 \mathrm{IncTertile}_{ht} + \gamma_9 \mathrm{HHsize}_{ht} + \\ & \gamma_{10} \mathrm{Age}_{it} + \gamma_{11} \mathrm{Male}_i + \gamma_{12} \mathrm{Education}_{it} + u_{ih} + v_{ihct}, \text{ and}\end{aligned} \quad (1)$$

$$\begin{aligned}\mathrm{Log}\left(\mathrm{FGamt}_{ihct} \mid \mathrm{AteFG}\right) = {} & \theta_0 + \theta_1 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) + \theta_2 \mathrm{Time}_t + \theta_3 \mathrm{Region}_{hc} + \\ & \theta_4 \mathrm{Urban}_{hc} + \theta_5 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) * \mathrm{Time}_t + \\ & \theta_6 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) * \mathrm{Region}_{hc} + \\ & \theta_7 \mathrm{Log}\left(\mathrm{FoodPrices}_{ct}\right) + \theta_8 \mathrm{IncTertile}_{ht} + \\ & \theta_9 \mathrm{HHsize}_{ht} + \theta_{10} \mathrm{Age}_{it} + \theta_{11} \mathrm{Male}_i + \\ & \theta_{12} \mathrm{Education}_{it} + u_{ih} + v_{ihct}\end{aligned} \quad (2)$$

where the subscripts *i* denote an individual, *h* denotes a household, *c* denotes a community, and *t* denotes time. In order to derive non-conditional elasticities, both parts of the model were combined and corrected standard errors were derived by bootstrapping (Davison & Hinkley, 1997).

Macronutrient estimations—For macronutrient estimations, we used longitudinal random effects GLS models clustered at the household level and included interactions between edible oil price with income tertiles. For example, in the case of logged percent energy from protein, the model specification is:

$$\begin{aligned}\mathrm{Log}\left(\mathrm{eprotein}_{ihct}\right) = {} & \beta_0 + \beta_1 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) + \beta_2 \mathrm{Time}_t + \beta_3 \mathrm{Urban}_{hc} + \\ & \beta_4 \mathrm{Region}_{hc} + \beta_5 \mathrm{Log}\left(\mathrm{OilPrice}_{ct}\right) * \mathrm{Time}_t + \\ & \beta_6 \mathrm{Log}\left(\mathrm{FoodPrices}_{ct}\right) + \beta_7 \mathrm{IncTertile}_{ht} + \beta_8 \mathrm{HHsize}_{ht} + \\ & \beta_9 \mathrm{Age}_{it} + \beta_{10} \mathrm{Male}_i + \beta_{11} \mathrm{Education}_{it} + u_{ih} + v_{ihct}\end{aligned} \quad (3)$$

where, the subscripts *i* denote an individual, *h* denotes a household, and *t* denotes time. The coefficient β_1 tells us the average percentage change in consumption of the macronutrient in response to a 1% increase in the price of the cheapest oil in the community, holding all else constant. The vector of coefficients represented by β_6 provides insight into the cross-price elasticities of the percentage change in consumption of the macronutrient in response to a 1% increase in the price of various types of foods, holding all else constant. We ran the models for energy from protein, fats, and carbohydrates under the constraint that they should sum to 100%.

Sensitivity tests and simulations—We conducted sensitivity tests using a variety of model specifications for each of the outcomes. For consistency, we used the specification that provided robust results that were similar across the food groups and the macronutrient outcomes. Alternative specifications that included income as a continuous variable, the square of household income; different interaction terms between income, regions, prices, and time were also explored[2].

[2]Results from alternative specifications are available upon request.

For ease of interpretation, we derived simulations on food group and macronutrient consumption to estimate the effect of a 10% increase in the price of the cheapest edible oil in the community on the average consumption decisions of Chinese over 20 years old. In addition, we derived predictions by income tertiles and region to see what differences might exist in consumption decisions due to changing edible oil prices.

Results

Edible oil intake trends among those individuals 20 years old and older between 1991 and 2000 are shown in Table 1. The average daily intake increased from 23 to 33 gm over nine years, representing about a 5% increase in the diet composition. While this increase occurred across all income groups and rural-urban areas, it was most noticeable among the poor.

In addition, Figure 1 shows the pre-WTO real prices of some common food items controlled for in the analyses. There is a general downward trend, particularly after 1993, since governmental price controls were lifted around 1992 and market prices began to dominate. Edible oil prices fell from 4.4 to 2.5 yuan/L from 1993 to 2000.

Food groups

Table 2 shows the results for the four food groups (Equations 1 and 2) using the cheapest edible oil price. Results using the two oil prices were generally similar, except for the change in the direction of the relationship between many of the dependent variables and non-plant oil consumption[3]. This is of interest because an increase in oil prices is expected when substituting non-plant oils (positive elasticity). It is also possible that non-plant oil consumption was lowered (negative elasticity) in order to divert resources into consuming plant oils (albeit, still less plant oils). The latter explanation is likely to be the case because across most of China, lard (the prominent source of non-plant oil), is more expensive than some vegetable oils (e.g., rapeseed and cotton seed oils) but cheaper than sesame, peanut, and other high quality plant oils. We can look at the results for fatty pork as a proxy for lard since the Chinese heat fatty meat to extract lard. Our explanation is supported by our finding that in both specifications, the elasticity between the real price of fatty pork and non-plant oil consumption was strongly and significantly negative.

When using a two-part model, it is not readily possible to determine the marginal effects of an increase in the price of edible oil on the consumption of the food groups. Hence, we ran simulations to illustrate the effect of a 10% increase in the prices of the cheapest oil on the consumption of the four food groups. As expected, increased edible oil prices resulted in a decrease in the consumption of edible oils, and as explained earlier, an even more drastic decline in the consumption of non-plant oils. It is clear from the combined estimates that rice and edible plant oils are complements, while rice and flour are substitutes (see Figure 2A).

The simulated effects also show that the poor are generally more price responsive than the rich, especially in rice and flour consumption. Moreover, there are clear regional differences in the cross-price elasticities between edible oil price and other food groups as seen in Figures 2B and 2C. Those in the Southern region are the least price sensitive to rice, plant oils, and non-plant oils; those in the Northern region are the most price sensitive to rice; and those in the Central region are the most price sensitive to edible plant oils. These sensitivities may be related to the cultural diets of the various regions.

[3]Results from weighted oil prices are not reported but are available upon request.

Macronutrients

For the three macronutrients, results from using the two oil prices were generally similar, except for some slight differences in significance for the effects of other food prices on energy from fat and carbohydrates. Only Equation 3 estimation results from using the cheapest edible oil price are presented (Table 3) because the results were more robust and stable across all specifications and the general patterns of results were comparable. We can see that there is a relationship between the real price of the cheapest edible oil, the percentage of energy from fat (strongly negative), and the percentage of energy from protein (significantly positive). This suggests that people have been substituting protein for fats, as the price of edible oil increases. The percentage of energy from carbohydrates also increases as edible oil prices increase, but the results were not statistically significant.

The results are consistent across the two sets of estimations (log-log and percent-log), showing strong negative elasticities between the demand for energy from protein and the real price of flour, while there are positive elasticities between this outcome and the real prices of rice, fatty pork, and the cheapest grain. There is also consistency across the various macronutrients for which flour and rice are substitutes. Moreover, household income appears to have a strong affect on macronutrient composition, similar to the effects of region, education, age, adjusted household income, urban residency, and gender.

To understand the full effect of increasing the price of edible oil on macronutrient intake, we ran simulations and the results are shown in Figures 3A and 3B. Figure 3A shows the predicted change in the composition of energy due to a 10% increase in the real price of the cheapest edible oils for all observations and also for those in the rich and poor tertiles. The poor are more price responsive in reducing their consumption of fats, and possibly substituting, by increasing their consumption of carbohydrates and protein as a proportion of total energy. These three macronutrients sum to total energy and illustrate how shifts in edible oil prices would affect overall energy composition. For example, for someone who is poor, a 10% increase in the real price of edible oil will result in a change in energy composition from an average of 11% protein, 21% fat, and 68% carbohydrates to 11.2% protein, 20.5% fat, and 68.3% carbohydrates.

Figure 3B illustrates the percentage change in demand energy from protein, fats, and carbohydrates due to a 10% increase in the real prices of edible oil. Again, the poor are more price responsive than the rich; elasticity is large and negative for fats, and small and positive for carbohydrates and proteins.

Discussion

Limited work has been conducted in examining price policy options as they relate to the remarkable shifts in diet, activity, and body composition toward an unhealthy pattern of the nutrition transition linked with overweight, obesity, and NCDs. The issue of pricing policy options is complex. Few studies have empirically explored how price policies might shift demand and supply toward healthier diets. This paper looks at China and shows that a situation where the intake of one element in the diet—which contributes adversely to health—can be reduced by the use of price changes for that element. We gain insights into this option, for China, by examining total direct and cross elasticities for a few food groups and looking at the overall effect on energy from fat, protein, and carbohydrates.

Currently, it is likely that edible oil prices will continue declining due to international trade, resulting in an increase in the consumption of edible oils and in fat as a percentage of dietary composition. The impact will likely be larger for the poor, which may result in greater disparities in health by income groups in the near future. The Chinese government should consider using food pricing policies as one method to impact dietary decisions and limit the growth of overweight and obesity in China. If China used taxation or other policies to increase the price of edible oils, one would expect to see a shift away from fat towards proteins and carbohydrates.

However, there are a number of limitations to this analysis. Firstly, the estimates of demand elasticity from this analysis are point estimates. Given the available data, we are unable to derive the actual demand curves. Therefore, these estimates do not account for the actual shape of the relationships between prices and demand.

Secondly, the choice of a random-effects model in this analysis is not without consequences. The assumption that the unobserved factors and the explanatory variables are independent of each other is a strong one. If the assumption is true, the resulting estimates are more efficient than would be the case from a simple ordinary least squares (OLS) regression that ignored the fact that the sample was composed of many of the same individuals over time. However, if the assumption is not true, the resulting estimates may be severely biased due to the correlation between observed and unobserved covariates, such as accurate measures of metabolic rate, or food fads. Mixed (or multi-level) models that combined fixed- and random-effects were also considered, but there were insufficient observations within each level for the analysis to work.

In addition, it is important to distinguish across different types of fats. Trans (hydrogenated) fats and saturated fats, for example, have been identified as dietary culprits in rising cardio-vascular disease and high blood pressure risks. Historically, most of the cooking oils used in China were either monounsaturated (e.g., peanut oil and rapeseed oil) or polyunsaturated (e.g., soybean oil and corn oil). While these oils do not contain significant amounts of trans fats, there are potentially pathogenic elements in the rapeseed oil (Wallingford et al., 2004). In addition, hydrogenated versions of these fats (e.g., margarine spreads or blocks) are gaining popularity due to their longer shelf life. As China gains increased access to these types of fats and processed foods that use them, edible oil consumption will become a growing problem. Unfortunately, this analysis was not able to distinguish between unsaturated, saturated, and trans fats. Ideally, a pricing policy would specifically target the less healthy saturated and trans fats. This also highlights the fact that the effects of price policies and many other regulations need more careful exploration prior to undertaking massive shifts in the diet structure. Hence, many other mechanisms available to the economic sector must be rigorously explored.

Nonetheless, pricing policies are controversial because they create an extra burden on people with higher caloric needs or lower incomes. However, if the government is able to reallocate the funds collected from its price policies towards the poor, or those with higher caloric needs, perhaps the regressive nature of such pricing policies can be alleviated.

There is also concern that food price interventions will create incompatibilities with commitments taken elsewhere, notably those taken within the WTO. Not liberalizing trade means foregoing efficiency gains from a better allocation of production, which would need to be taken into account in the overall cost-benefit analysis of such a tax. However, tax policies that include all domestic and imported edible oils are neutral when it comes to the concerns of the WTO for a level playing field with regard to pricing of imported goods.

Lastly, this paper only discusses the use of one type of demand-side intervention. Other interventions to affect the demand for edible oils include public education and health communication strategies to: (a) make people more aware of the consequences of a poor diet; (b) encourage steamed, broiled, or braised foods in place of fried food (Wallingford et al., 2004); and (c) set regulations to ensure that there is clear information about product contents (e.g., through nutrition labeling). Furthermore, there are also supply-side interventions that can be explored. These include greater public investment in technology to improve the quality of oils, eliminating incentives on growing or processing high-fat foods while relaxing restrictions on growing healthier foods, and evaluating food trade policies from a health perspective.

The use of pricing policy is relatively ignored by the public health profession, but is deserving of more research if we are to stem the massive shifts in diets globally toward more energy dense diets that contribute to the vast array of NR NCDs. Future research should consider the complex interactions between the varieties of possible supply and demand side factors, especially as China increases its trade with the rest of the world.

Acknowledgments

Financial assistance for this research was provided by the U.S. National Institutes of Health (NIH) (R01-HD30880 and R01-HD38700). The authors thank David Guilkey for methodological assistance, Tom Swasey for graphics assistance, and Frances L. Dancy for administrative assistance.

CITATIONS

Agri-Canada. China’s Vegetable Oil Industry. 2002. from http://atnriae.agr.ca/asia/e3282.htm

Bell EA, Rolls BJ. Energy density of foods affects energy intake across multiple levels of fat content in lean and obese women. American Journal of Clinical Nutrition 2001;73(6):1010–1018. [PubMed: 11382653]

Chen, X. China and the WTO: accession, policy reform, and poverty reduction strategies. World Bank; Washington DC: 2004. China’s Agricultural Development and Policy Readjustment after Its WTO Accession; p. 69-79.

ChinaGate. China’s Reform of the Edible Oil Circulation System. 2004. from http://www.chinagate.com.cn/english/2125.htm

CMPH. Report of the 1992 China National Nutrition and Health Survey. 1994 (in Chinese). Beijing, PRC: 1994.

DailyTimes. Daily Times. Mar 05. 2005 China to overtake India as top edible oils buyer.

Davison, AC.; Hinkley, DV. Bootstrap Methods and their Application. Cambridge University Press; Cambridge: 1997.

Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. Nutr Rev 1997;55(2): 31–43. [PubMed: 9155216]

Du S, Lu B, Zhai F, Popkin BM. A new stage of the nutrition transition in China. Public Health Nutr 2002;5(1A):169–174. [PubMed: 12027281]

Du S, Mroz TA, Zhai F, Popkin BM. Rapid income growth adversely affects diet quality in China--particularly for the poor! Soc Sci Med 2004;59(7):1505–1515. [PubMed: 15246178]

Duncan, R.; Jiang, T-S. China’s Accession to WTO Would Boost World Trade of Edible Oils. 2001. Unpublished manuscript

Fang C, Beghin J. Urban Household Oil and Fats Demand in China: Evidence from Urban Household Survey Sata”. Journal of Comparative Economics 2002;30(4):732–753.

Ge K, Chen C, Shen T, Zhang S. Food consumption and nutritional status in China. Food, Nutrition and Agriculture 1991;1(23):54–61.

Guo X, Mroz TA, Zhai F, Popkin BM. Structural changes in the impact of income of food consumption in China, 1989-93. Econ Dev Cult Change 2000;48:737–760.

Guo X, Popkin BM, Mroz TA, Zhai F. Food Price Policy Can Favorably Alter Macronutrient Intake in China. J. Nutr 1999;(129):994–1001. [PubMed: 10222391]

Haines PS, Guilkey DK, Popkin BM. Modelling food group decisions as a two-step process. Journal of Agricultural Economics 1988;70(3):543–552.

Kral TV, Rolls BJ. Energy density and portion size: their independent and combined effects on energy intake. Physiological Behavior 2004;82(1):131–138.

Mendez MA, Monteiro CA, Popkin BM. Overweight exceeds underweight among women in most developing countries. Am J Clin Nutr 2005;81(3):714–721. [PubMed: 15755843]

Monteiro CA, Conde WL, Lu B, Popkin BM. Obesity and inequities in health in the developing world. International Journal for Obesity Related Metabolic Disorders 2004;28(9):1181–1186.

Paeratakul S, Popkin BM, Kohlmeier L, Hertz-Picciotto I, Guo X, Edwards LJ. Measurement error in dietary data: implications for the epidemiologic study of the diet-disease relationship. Eur J Clin Nutr 1998;52(10):722–727. [PubMed: 9805218]

Popkin BM, Keyou G, Zhai F, Guo X, Ma H, Zohoori N. The nutrition transition in China: a cross-sectional analysis. Eur J Clin Nutr 1993;47(5):333–346. [PubMed: 8319669]

Popkin BM, Kim S, Rusev ER, Du S, Zizza C. Measuring the full economic costs of diet, physical activity, and obesity-related chronic diseases. Obesity Reviews 2006;7(3):271–293. [PubMed: 16866975]

Popkin BM, Lu B, Zhai F. Understanding the nutrition transition: measuring rapid dietary changes in transitional countries. Public Health Nutr 2002;5(6A):947–953. [PubMed: 12633520]

Prentice AM, Poppitt SD. Importance of energy density and macronutrients in the regulation of energy intake. International Journal for Obesity Related Metabolic Disorders 1996;20(Suppl 2):S18–23.

Qian, Y-Y.; Wu, J-L. China’s Transition to a Market Economy: How Far across the River?. Stanford; 2000. Unpublished manuscript

Rolls BJ, Drewnowski A. Changing the energy density of the diet as a strategy for weight management. Journal of American Diet Association 2005;105(5 Suppl 1):S98–103.

SSB. 1989 Statistical Yearbook for China. Beijing, PRC: 1990.

SSB. 1991 Statistical Yearbook for China. State Statistical Bureau of China; Beijing, PRC: 1992.

SSB. 1993 Statistical Yearbook for China. Beijing, PRC: 1994.

SSB. 1997 Statistical Yearbook for China. Beijing, PRC: 1998.

SSB. 2000 Statistical Yearbook for China. Beijing, PRC: 2001.

SSB. 2004 Statistical Yearbook for China. Beijing, PRC: 2005.

StataCorp. Stata Statistical Software: Release 9. StataCorp LP; College Station, TX: 2005.

Timmer, CP.; Falcon, WP.; Pearson, S. Food policy analysis. The Johns Hopkins University Press for the World Bank; Baltimore: 1984.

Today’sChina. Grain issues of today’s China. Beijing, PRC: 1988.

Wallingford JC, Yuhas R, Du S, Zhai F, Popkin BM. Fatty acids in Chinese edible oils: Evidence for unexpected impact in changing diet. Food and Nutrition Bulletin 2004;25:330–336. [PubMed: 15646310]

Wang H, Du S, Popkin BM. Trends of Body Mass Index (BMI) distribution among Chinese adults (1989 to 2000). International Journal for Obesity 2006;38:1–7.

Wang Y, Ge K, Popkin BM. Tracking of body mass index from childhood to adolescence: a 6-y follow-up study in China. Am J Clin Nutr 2000;72(4):1018–1024. [PubMed: 11010946]

WorldBank. China regional disparities (No. 14496-CHA). World Bank; Washington, DC: 1995.

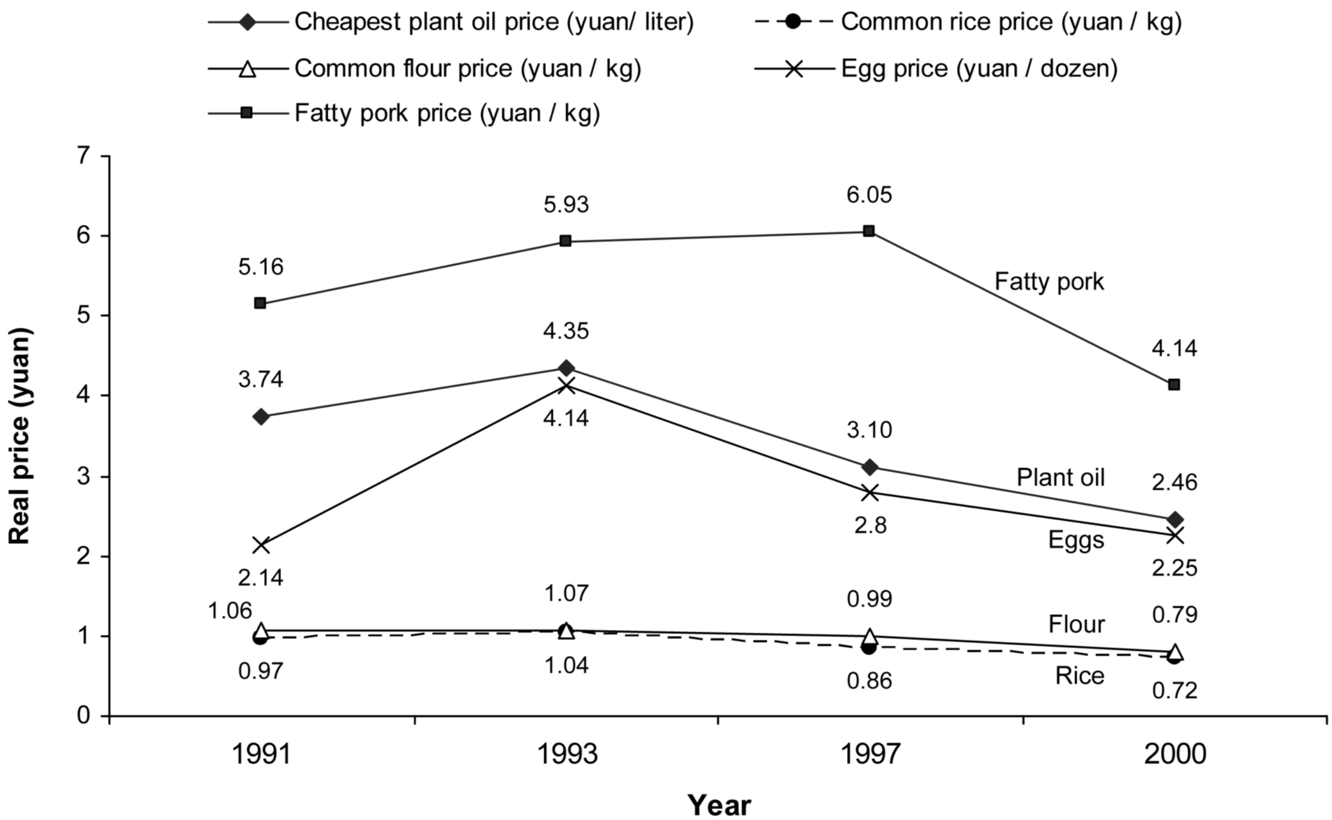

Figure 1.
Pre-WTO Real Prices of Select Food Items from 1991-2000
Source: China Health and Nutrition Surveys 1991,1993,1997,2000

NIH-PA Author Manuscript
NIH-PA Author Manuscript

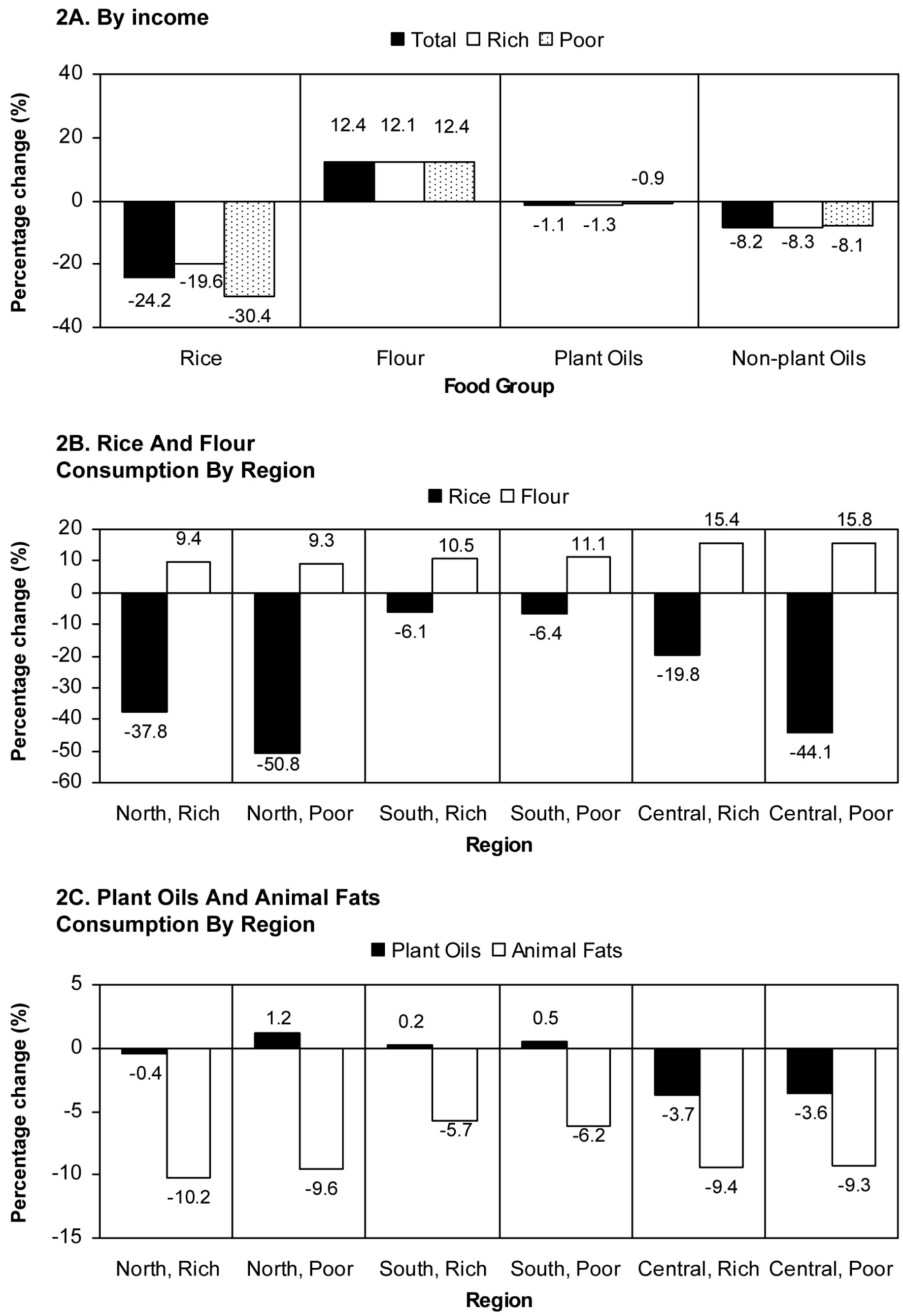

Figure 2.

Combined Effect of 10% Increase In Price of Cheapest Edible Plant Oil on Consumption of Select Foods (1991-2000)

Source: China Health and Nutrition Surveys 1991,1993,1997,2000

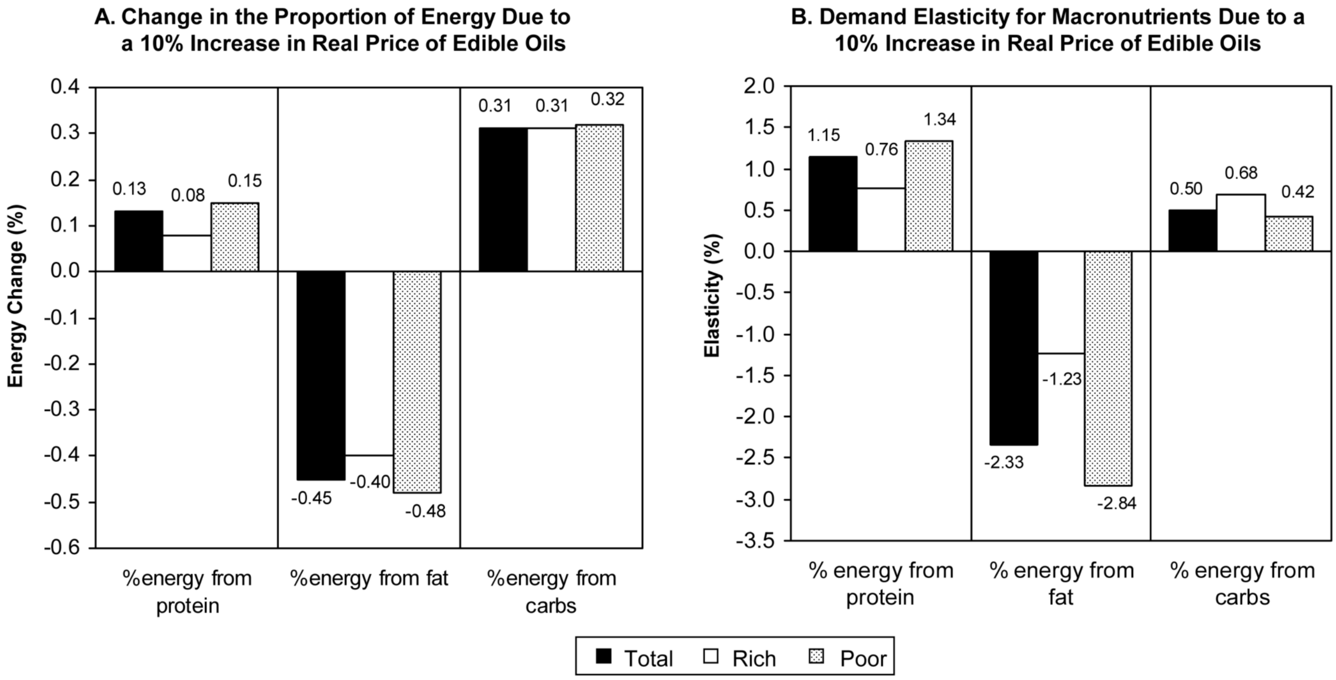

Figure 3.
The Effects of Changes in the Price of Edible Oil on Macronutrients (1991-2000)
Source: China Health and Nutrition Surveys 1991,1993,1997,2000

Table 1

Edible Oil Consumption (daily average)

Population group	YEAR			
	1991 (gm)	**1993 (gm)**	**1997 (gm)**	**2000 (gm)**
Poorest (lowest income tertile)	20.16	22.48	26.05	31.36
Middle (middle income tertile)	23.36	24.94	29.35	33.05
Richest (highest income tertile)	26.62	27.83	32.63	34.76
Rural	22.52	23.56	27.49	32.60
Urban	24.75	28.51	33.34	34.11
Average for total adult population	23.29	25.09	29.23	33.04
Proportion of calories from edible oil per capita (%)	7.94	8.83	11.35	12.80

Source: 1991-2000 CHNS among those age 20 years and older

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 2

Coefficient Estimates of Food Groups From Two-Part Models Clustered at Household Level (Using Cheapest Edible Oil Price)

	Rice		Flour		Edible Plant Oils		Edible Non-Plant Oils	
	Probit (Eq 1)	**OLS (Eq 2)**	**Probit (Eq 1)**	**OLS (Eq 2)**	**Probit (Eq 1)**	**OLS (Eq 2)**	**Probit (Eq 1)**	**OLS (Eq 2)**
Log real cheapest oil price	-2.82**	-0.58**	-0.19	0.34**	0.37	-0.05	-0.93**	-1.60**
Log real cheap oil price*1993	-1.05*	0.08	0.64*	0.07	0.16	-0.28	0.75**	0.91**
Log real cheap oil price*1997	-0.07	0.16	0.77**	-0.48**	0.33	-0.42**	1.32**	1.33**
Log real cheap oil price*2000	-0.58	-0.42**	2.08**	-0.48**	-1.39**	0.001	1.20**	1.58**
Log real cheap oil price*north	-0.80*	-0.48**	0.06	0.74**	1.05**	0.05	-0.66**	-0.83**
Log real cheap oil price*central	-1.11**	-0.28**	0.35**	0.86**	0.46**	-0.21**	-0.73**	-0.61**
1993	2.62**	0.05	-0.86*	-0.31	-0.20	0.50*	-0.67*	-0.84*
1997	1.02	-0.41*	-0.77*	0.52**	-0.14	0.63**	-1.60**	-1.72**
2000	0.63	-0.03	-1.85	0.60**	2.11**	0.25	-1.81**	-2.35**
Medium income tertile	0.36**	0.01	-0.09**	-0.05**	-0.01	0.03	0.002	-0.003
High income tertile	0.51**	0.02	-0.07*	-0.11**	0.03	0.05**	-0.003	0.08*
North	-1.77**	-0.43**	2.24**	0.14	0.60	0.16	-0.07	-0.75**
Central	0.17	0.09	0.88**	-0.46**	1.28**	0.47**	0.41**	-0.45**
Log real price rice	-1.44**	-0.17**	0.24**	0.18**	-0.41**	-0.09*	-0.05	0.02
Log real price flour	7.07**	1.32**	-0.70**	-0.70**	0.11	0.45**	0.63**	1.14**
Log real price eggs	-0.07	-0.02	0.08*	-0.03	0.11**	0.05*	-0.11**	0.002
Log real price fat pork	-3.71**	-0.83	-0.11	0.54**	0.23	-0.06	-1.18**	-1.32**
Log real price cheap grain	0.09	-0.05	0.13	0.05	0.30**	-0.001	-0.25**	-0.55**
Age (years)	0.002	-0.01**	-0.001	-0.01**	0.003*	-0.001**	-0.001	-0.002**
Household size	-0.009	-0.001	0.001	0.002	0.01	-0.07**	-0.01	-0.03**
Education (years)	0.04**	-0.004**	0.01	-0.01**	0.01	0.001	-0.01*	-0.01**
Male	-0.10**	0.13**	0.06**	0.19**	-0.03	0.06**	0.004	0.04**
Urban	0.40**	-0.28**	0.81*	-0.07**	1.10**	-0.003	-0.24**	-0.66**
Constant	12.56	8.26**	0.25	3.45**	-1.08*	3.45**	4.16**	6.57**
N	31152	26806	31152	22368	31143	24879	31142	19181
Rho	0.67	0.57	0.66	0.54	0.73	0.31	0.25	0.56

Reference categories for year: 1991; income tertile: poor; and region: South.

** Denotes significance at the 1% level

* Denotes significance at the 5% level; from bootstrapped standard errors

Table 3

Macronutrient Coefficient Estimates From Random Effects Models Clustered at Household Level Using Cheapest Edible Oil Price (N=31,097)

Equation 3 Estimates	Energy from protein	Energy from fat	Energy from carbs	Log Energy from protein	Log Energy from fat	Log Energy from carbs
Log real cheapest oil price	2.42**	-5.67**	2.92	0.21**	-0.55**	0.001
Log real cheap oil price*1993	-0.84	-1.77	2.82	-0.08*	0.13*	0.08*
Log real cheap oil price*1997	-0.71**	-0.66	1.65	-0.05	0.33**	0.09**
Log real cheap oil price*2000	-1.84**	4.76*	-2.88	-0.13**	0.52**	-0.004
Log real cheap oil price*medium income	-0.28	0.20	0.10	-0.02	0.08*	0.01
Log real cheap oil price*high income	-0.71**	0.88	-0.10	-0.06**	0.17**	0.03
1993	0.61	5.71*	-6.58**	0.06	-0.03	-0.16**
1997	0.73	3.83	-4.96*	0.04	-0.30**	-0.17**
2000	2.34**	-0.88	-1.60	0.17**	-0.39**	-0.07
Medium income tertile	0.45*	1.24	-1.66	0.04*	-0.03	-0.04*
High income tertile	1.19**	2.13	-3.26**	0.10**	-0.07	-0.09**
North	0.55**	-3.16**	2.58**	0.05**	-0.11**	0.05**
Central	-0.17**	-3.48**	3.64**	-0.01	-0.13**	0.07**
Log real price rice	0.32**	-1.39**	1.10**	0.03**	-0.05*	0.02**
Log real price flour	-2.43**	-0.63	3.05**	-0.21**	-0.004	0.07**
Log real price eggs	-0.04	-0.18	0.20	-0.002	-0.001	0.004
Log real price fat pork	2.35**	-0.33	-1.85*	0.20**	0.04	-0.02
Log real price cheap grain	0.39**	0.14	-0.58	0.04**	0.01	-0.01
Age (years)	0.00	0.06**	-0.06**	-0.00	0.002**	-0.001**
Household size	0.06**	-0.69**	0.62**	0.01**	-0.03**	0.01**
Education (years)	0.04**	0.24**	-0.27**	0.003**	0.01**	-0.01**
Male	-0.07**	-1.28**	1.34**	-0.006**	-0.05**	0.03**
Urban	1.18**	4.38**	-5.64**	0.10**	0.22**	-0.09**
Constant	3.74**	29.24**	67.05**	1.76**	3.55**	4.24**
Rho	0.27	0.31	0.33	0.28	0.33	0.29

Reference categories for year: 1991; income tertile: poor; and region: South.

** Denotes significance at the 1% level

* Denotes significance at the 5% level