Rising Incomes and Nutrition in China

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Abstract. Rising incomes in China have not lead to a smaller degree of undernutrition as measured by percent of population below calorie and protein recommended daily allowances (RDA). The weak relationship between income and nutrition is further demonstrated by our income elasticity estimates for calories and protein that are generally zero. We do find that the percentage of fat in the calorie source is a normal good.

Key words: Chinese undernutrition; income elasticity; concentration curves

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I. Introduction

China has experienced a dramatic income growth over the past two decades. However, several economic factors confounded with the overall economic growth and the low income groups could have failed to improve their health and nutrition status. These factors include widening income inequality, rising food prices, and income uncertainty. In this paper we examine the combined effect on undernutrition of a secular increase in incomes with a one-time increase in food prices that occurred in the middle 1990's. We use Kakwani's (1977) method to estimate nutrient elasticities. In addition, we estimate elasticities with respect to food prices, women's earnings, and women's schooling.

II. Estimating Elasticity with Concentration Curves

Kakwani (1977) provides a method to estimate nutrient-income elasticities at various percentiles of the income distribution. Let $0 \le F^{-1}(p) \le \infty$ be the inverse c.d.f. of *x*, and without loss of generality, let $\tau = F^{-1}(p)$. Following Bishop, Chow and Formby (1994), the Lorenz ordinates of *x* and the concentration ordinates of *y* can be written as follows:

$$(2) \qquad L(\tau; x) = \mu_x^{-1} \int_0^{\tau} x f(x) dx = \mu_x^{-1} \int_0^{\infty} x I_{\tau}^{x} dF(x) = E\left[x I_{\tau}^{x}\right] / E[x],$$

where μ_x is the mean of *x*, $I_{\tau}^{x} = 1$ if $x \le \tau$ and $I_{\tau}^{x} = 0$ otherwise,

$$(2) \qquad C(\tau; y) = \mu_y^{-1} \int_0^{\tau} \int_0^{\infty} y f(x, y) dy dx = \mu_y^{-1} \int_0^{\infty} \int_0^{\infty} y I_{\tau}^{x} f(x, y) dy dx = E\left[y I_{\tau}^{x}\right] / E[y].$$

$L(\tau; x)$ represents the proportion of income of *x* received by individuals with incomes *x* less than or equal to τ. $C(\tau; y)$ indicates the proportion of *calories* (y) received by individuals with *incomes x* less than or equal to τ. Comparing the concentration curve to the 45 degree line allows us to evaluate the goods' income elasticity. If the concentration curve lies on the 45 degree line at any points along the curve then the income elasticity equals zero at those points; if

the concentration curve lies below the 45 degree line then the good is normal, and if, the concentration curve lies above the 45 degree line then the good is inferior.

III. Changes in Nutritional Status, Rural and Urban China

The China Health and Nutrition Surveys (CHNS) were conducted by the Carolina Population Center at the University of North Carolina (see Liu, 2008). We examine three years of CHNS, 1991, 1997, and 2004.

Table 1 presents the changes in calorie and protein intakes, adjusted by the recommended daily allowances (RDA's) (Chinese Nutrition Society, 2000) for both rural and urban China, in 1991, 1997, and 2004 respectively. In addition, the table reports the share of fat in diet, household income and household size. This higher income growth is reflected in the growing percentage of calories that are consumed in the form of fat. However, equivalent calories and protein consumption has not grown with higher incomes. In particular, the percentage of people below two-thirds of the calorie and protein RDA grew rapidly between 1991 and 1997. Meng et al. note that between 1993 and 1996 "food prices increased significantly and then stabilized (p.3)."[1] This pattern of food prices is consistent with our finding that calorie and protein consumption dropped between 1991 and 1997 and stabilized thereafter.

Table 1 also presents the familiar Gini coefficient of inequality for each of the three nutrient sources as well as for income. Our household income Gini coefficients verify the well documented fact that income inequality in China has risen dramatically along with the economic reforms of the 1990's. The distribution of calories and protein are clearly more equal than that of income (smaller Gini's) but in each case inequality is increasing over time. Together the findings of Tables 1 and 2 imply that nutrient intakes are both declining and are more concentrated among the few.

[1] The urban food CPI for 1986-2000 is reported in Figure 7 of Meng et al. (2005) Figure.

While rising incomes did not to improve Chinese nutritional outcomes it is also of interest to ask: Do lower income households spend a higher fraction of their income on nutrients? Table 2 illustrates the Lorenz-concentration curve elasticity estimates. The table gives the calorie and share of fat concentration curve ordinates at deciles, ordered by household income for 2004. In the first example, calories , we observe that each concentration ordinate is very close its decile value—i.e., the concentration curves lies nearly on top the 45 degree line in the Lorenz curve unit square. Furthermore, each of the nine calorie test statistics is less than the five percent critical value of 1.96, or the ten percent critical value of 1.67. The small test statistic on the Concentration index, $C_{y,}$ suggests reinforces this finding, and we conclude that we cannot reject the null hypothesis of zero income elasticity. In the second example, seven of the nine test statistics are greater than 1.96, indicating that fat is a normal good. However, the concentration index is still quite small, suggesting that while share of fat is normal, the relationship with income is still quite weak.

Table 3 provides a summary index of the elasticities as we vary the income concept. The first entry in any cell is for 1991, the second entry is for 1997, and the third entry is for 2004. A '1' implies that the nutrient is normal and a '0' denotes zero elasticity. The first row of Table 8 summaries the results using household income as in Table 3's examples.

The additional rows in Table 3 consider nutrient elasticities with respect to household size adjusted income,[2] food prices, and the status of the households' primary female. When we adjust for either household size or deflate by food prices we find zero elasticities for both calories and protein. In contrast we find that the share of fat in consumed calories is generally a normal good. It is the conventional wisdom that by improving the status of women, household

[2] We use the familiar "square-root rule" to adjust for differences in household size.

nutrition outcome will improve. While we cannot address this issue directly, we do observe that the nutrient elasticities with respect to women's schooling or women's wages are also zero.

How do our income elasticities compare to the previous literature? Du et al. (2004) use the CHNS data (through 1997) and a two step random effects model to estimate income elasticities. In their model they control for food prices, fuel prices, family size, age, education, urban status and region. They find that flour and rice are inferior goods, and animal food and edible oil are normal but inelastic. Popkin (2007) instead finds that "in China, the poor spend a larger share of their food expenditure on vegetable oil than do the rich (p.92)."

V. Conclusions

To evaluate the changes in nutrition status that occurred during a period of rapid economic growth in China we ask three questions: First, have average nutrition intakes risen with rising incomes? Second, how has the *inequality* in nutrient intakes changed? Finally, is nutritional intake a "normal good?" Our findings imply that in spite of rising incomes nutrient intakes are both declining and are more concentrated among the few. We find that the income elasticity for calorie and protein intakes are generally zero, while we find some evidence that the percentage of fat in the calorie source is a normal good. Finally, we note that nutrient elasticities with respect to women's schooling or women's wages are also zero.

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Table 1
Changes in Nutritional Intakes
Rural and Urban China: 1991, 1997 and 2004

	Rural			Urban		
	1991	**1997**	**2004**	**1991**	**1997**	**2004**
Calorie/RDA	1.08	0.93	0.95	1.00	0.95	0.95
% below 2/3 RDA	0.060	0.157	0.169	0.079	0.145	0.186
Calorie Gini	0.102	0.107	0.118	0.088	0.105	0.130
Protein/RDA	0.97	0.83	0.87	0.94	0.91	0.95
% below 2/3 RDA	0.162	0.286	0.286	0.153	0.216	0.224
Protein Gini	0.128	0.130	0.145	0.105	0.126	0.154
Share of Fat in Calories	0.20	0.24	0.27	0.26	0.32	0.32
Fat Gini	0.201	0.192	0.153	0.158	0.156	0.158
HH Income	4450	5306	8816	6400	7585	10664
Income Gini	0.269	0.322	0.393	0.240	0.256	0.365
HH Size	4.7	4.6	4.3	4.3	4.2	3.8

Notes: Standard Errors: Calories ~ 15; Protein ~ 0.5; %Fat ~ 0.005; Gini Standard Errors: 0.002 – 0.005; Average recommended daily allowances are 2480 calories and 75 grams of protein.

Table 2
Lorenz – Concentration Curve Income Elasticities
Rural China – 2004

	Calories		Share of Fat in Diet	
Decile	**Concentration Ordinate**	**z-statistics**	**Concentration Ordinate**	**z-statistic**
1	0.097	-0.50	0.091	-1.60
2	0.193	-0.72	0.184	-2.05
3	0.291	-0.81	0.274	-2.85
4	0.392	-0.53	0.368	-3.24
5	0.492	-0.50	0.465	-3.55
6	0.595	-0.32	0.568	-3.34
7	0.699	-0.04	0.673	-3.14
8	0.800	0.00	0.778	-2.85
9	0.902	0.20	0.886	-1.47
Cy	0.007	0.21	0.040	3.58
N	7704		7704	

Notes: Protein consumption ordered by household income.

Table 3
Elasticity Summary
Rural and Urban China: 1991, 1997 and 2004

	Rural			Urban		
	Calories	**Protein**	**Fat**	**Calories**	**Protein**	**Fat**
Household Income	0,0,0	0,0,1	1,1,1	0,1,0	0,0,0	1,1,1
Food Price Adjusted	0,0,0	0,0,0	1,1,1	0,0,0	0,0,0	1,1,1
HH Size Adjusted	0,0,0	0,0,0	1,1,1	0,0,0	0,0,0	1,1,1
Women's Schooling	0,0,0	0,0,0	1,1,1	0,0,0	0,0,0	1,1,1
Women's Wages	0,0,0	0,0,0	1,1,1	0,0,0	0,0,0	1,1,1

Notes: "0" indicates elasticity being zero; "1" indicates normal good at 5% significance level.