China's Nutrition Intake Inequality: 1991-2004

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Abstract. This paper applies advances in the measurement of poverty and inequality to the study of undernutrition in China. Using distribution-sensitive methods, we examine the combined effect of a secular increase in incomes with a one time increase in food prices that occurred in the middle 1990's. We find a dramatic increase in undernutrition between 1991 and 1997, and little change in undernutrition after 1997. Traditional headcounts, which are not distributional-sensitive provide misleading results in some cases. Our income elasticity estimates for calories and protein are generally zero, while we find some evidence that the percentage of fat in the calorie source is a normal good. Overall, it appears that rising incomes in China have not led to improvements in nutrition.

Key words: Chinese undernutrition; distribution-sensitive; Sen index; income elasticity

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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.

Malnutrition is one of the most important measures of poverty and, therefore, it is crucial to examine nutrition intake in China during a period of rapid change.[1] Clearly, eliminating malnutrition has its own intrinsic value; however, as pointed out by Alderman, Behrman and Hoddinott (2005), among others, malnutrition can also be linked to productivity losses. These links include greater cognitive ability, physical stature and strength, greater school attendance as well as the saving of resources used to combat the effect of past undernutrition. Direct measures of nutrition adequacy are difficult (see Osmani, 1992) to obtain; two types of proxies are used in practice, anthropometric measures relative to some reference standard and nutrient intake relative to some standard allowances. We use data on nutrient intakes to access malnutrition.

To study undernutrition this paper applies the advances in the study of poverty over the 25 years. This approach to studying undernutrition has its roots in the seminal works of Kakwani (1989) and Ravallion (1991). We employ several well-known poverty and inequality tools to the study of malnutrition. First, we adapt Sen's (1977) poverty index to evaluate undernutrition. The components of Sen's index measure the amount and depth of undernutrition as well as the inequality of nutrient status among the malnourished. Second, we use Kakwani's

[1] Reddy and Minoiu (2007) provide a well-researched survey of current poverty in China.

(1977) method to estimate nutrient-income elasticities. Finally, we exploit the panel nature of our data — the China Health and Nutrition Survey (CHNS) 1991-2004 — to evaluate the effect of nutrient averaging over time.

III. Measurement Methods

The Sen Index

In Sen's (1976) view, poverty should be measured and evaluated using an approach that combines three dimensions of poverty: the headcount of a population living below the poverty line, the income shortfalls of the poor (poverty gap), and the inequality of incomes among the poor. An acceptable measure of poverty must be distribution sensitive, which means that a redistribution of income among families below the poverty line must affect the poverty index. We adapt Sen's method to study undernutrition.

To see the need for a distribution sensitive malnutrition measure consider a transfer from the least nourished to an individual just below the daily allowances.[2] This transfer always increases relative inequality among the undernourished (and this is reflected in distribution sensitive measures) but does not change the universally employed headcount malnutrition measure.

Due to the limit of the headcount measure, we adapt Sen's index and propose an index which equals the aggregated nutrient gaps between each undernourished individual and the nutrient cutoff, weighted by each individual's relative rank among the poor. Sen Index, which is denoted as *S*, can be written as:

(1) $$S = H\left[I + (1 - I)G_u(q/q+1)\right],$$

[2] Kakwani (1992) among others have expressed the need for a distribution sensitive malnutrition index.

where H is the headcount undernutrition ratio, I is the ratio of the average nutrient shortfall-to-the daily allowances line (hereafter referred to as nutrient gap), G_u is the Gini coefficient of nutrient inequality among the undernourished, and q is the number of people below the nutrient threshold.

Lorenz and Concentration Curves

Following Kakwani (1977) we can 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) $$L(\tau; x) = \mu_x^{-1} \int_0^{\tau} x f(x) dx = \mu_x^{-1} \int_0^{\infty} x I_{\tau}^{x} dF(x) = E\left[x I_{\tau}^{x}\right] / E[x],$$

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

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

$L(\tau; x)$ 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 elasticitiy. 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.

We can also define the Gini and concentrations indices: given a continuous distribution *F*(*x*), the covariance definition of the Gini index is

(3) $$G_x = \frac{2}{\mu_x}\int_0^{\infty} xF(x)dF(x) - 1 = (2/\mu_x)\operatorname{cov}\{x, F(x)\}$$

and the associated concentration index for $y = g(x)$ is

(4) $$C_y = \frac{2}{\mu_y}\int_0^{\infty} g(x)F(x)dF(x) - 1 = (2/\mu_y)\operatorname{cov}\{g(x), F(x)\}.$$

III. Chinese Health and Nutrition Survey Data

The China Health and Nutrition Surveys (CHNS) were conducted by the Carolina Population Center at the University of North Carolina in 1989, 1991, 1993, 1997, 2000, and 2004. The data were collected on about 4,400 households (16,000 individuals) in nine provinces in China. Within each province, 4 counties were selected using a multistage, random cluster process. The provincial capital and a lower income city were also selected when feasible. Villages and townships within the counties as well as urban and suburban neighborhoods in the cities were randomly selected. All individuals in each household were surveyed in 1991, 1993, 1997 and 2000 for all data; however in 1989, health and nutritional data were only collected from preschoolers and adults aged 20-45. Our Sample contains individuals between 16 and 60 so we omit the 1989 data.

The CHNS data provide detailed data on many variables of interest and are ideal for researchers who study income and nutrition inequality. In particular, the data have detailed demographic, economic, and nutritional information. Household income variables are constructed to include both earned (wages, farming and gardening income, and business income), and unearned (income derived from assets), as well as income from subsidies and bonuses (welfare subsidies and ration coupons). In this paper, all income and price variables were deflated (by the consumer price index) to Chinese currency measured in 1988 yuan. More importantly, all household members in 1991 and subsequent surveys provided individual data on dietary intake. The interviewers collected detailed household food consumption data during three consecutive days with a starting date randomly selected from Monday to Sunday. On each interview day,individuals were asked to report at-home individual consumption as well as all food consumed away from home for each day on a 24-hour recall basis. The 1991 Food Composition Table (FCT) for China was then utilized to convert food consumption to nutrient values for the dietary data.

The Recommended Daily Allowances (RDAs) are based on the principle that most, if not all, individuals of a specific population group should obtain an adequate nutrient intake to satisfy their requirements. In this paper, we use a set of age and gender-specific RDAs sanctioned by the Chinese Nutrition Society (2000). For each specific age and gender group, recommended energy allowances, i.e. calorie intake, represent the *average* needs of individuals. In contrast, recommended protein allowances are high enough to meet an upper level of requirement variability among individuals within the groups

IV. Changes in Nutritional Status, Rural and Urban China, 1991-2004

Table 1 presents the average calorie, protein and percentage of fat in calorie source of both rural and urban China, 1991 to 2004. For calories and protein we can compare these averages to the average daily allowances to evaluate the average nutritional status over time. For calories, the average daily allowances are approximately 2480 calories for our sample—using this cutoff we find that the average rural individual was above the average daily allowances in 1991 and 1993 and below the average daily allowances in the three latter years. Urban individuals did not fare as well, with the average individual below the cutoff for all years after 1991. It is important to note that many researchers believe that the calorie cutoffs are set too high (see Osmani, 1992, p.5 and Scholl et al., 1994) and we report the Sen index and its components at two-thirds and three-quarters of the established daily allowances.

Table 1 also provides nutrient intakes for protein. For the urban data the average protein consumption is below the (average) daily allowances for all years examined, while for the rural areas only 1991 is above the daily allowances. Again, like calories these daily allowances are thought to be "too high" and we use two-thirds and three-quarters of the daily minimum as are our threshold values.

The final nutrient considered in Table 1 is the percent of calories derived from fat. For both urban and rural areas the percent fat is growing over time, particularly between 1991 and 2000. Du et al. (2004) address the relationship between rapid income growth and diet quality during the period 1989 to 1997 using the CHNS data. Our findings are consistent with their conclusion that "the structure of the Chinese diet is shifting away from high-carbohydrate foods toward high-fat, high-energy density foods (p.1505).

Du et al. (2004) and Meng et al. (2004) also show declines in calorie and protein consumption during the 1990's. Meng et al. note that between 1993 and 1996 "food prices increased significantly and then stabilized (p.3)."[3] This pattern of food prices is consistent with our finding that calorie and protein consumption dropped between 1991 and 1997 and stabilized thereafter.

The Sen Index of Undernutrition and its' Components

In this section we estimate the Sen Index as applied to undernutrition.[4] As noted above there is reason to believe that that nutrition cut offs are set "too high;" in the case of China using the daily recommended allowances results in more that half the population identified as malnourished. We present in Table 2 the results for both three-fourths and two-thirds of the

[3] Meng et al. (2005) report the urban food CPI for 1986-2000 in Figure 7.
[4] For inference procedures used in this section, see Bishop, Formby and Zheng (1997).

daily recommended allowances for calories and protein. While the daily allowances vary by age, gender, and activity level, on average, two-thirds and three-quarters of the daily allowances are approximately 1650 and 1850 calories, and 50 and 56 grams of protein.

A quick glance at Tables 2a and 2b shows large changes in nutrition status over time. Between 1991 and 2004 calorie headcounts at the two-thirds threshold increased from 5.0 percent to 17.5 percent in rural areas and in urban areas from between 10.0 percent to 21.3 percent. Similarly, protein headcounts increased from 11.0 percent to 25.0 percent in rural areas and from 13.1 percent to 21.4 percent in urban areas. Clearly, undernutrition has increased at the same time that average incomes in China are rapidly rising.

Several general conclusions can be made from Table 2 beyond the comparison of headcounts made above. First, of all during the period 1991 to 1997, the time period of rapid increases in food prices, undernutrition grew rapidly in both rural and urban areas, regardless of the nutrition threshold used, the nutrient considered, or the index employed.[5] Secondly, the period 1997 to 2004 shows no such clear patterns. Thirdly, there are important changes in the relative nutrition status of rural and urban residents over time. Furthermore, we identify two additional questions: to what degree do individuals substitute protein for calories, and what is the effect on undernutrition of averaging nutrient intakes over time using panel data? To more fully develop these themes we provide separate tables that examine them in more detail.

Table 3 presents inference results and percentage changes for the nutrient headcounts, nutrient gaps, and nutrient Sen indices for two time periods, 1991 to 1997 and 1997 to 2004. Entries with "0" imply no statistical difference; entries with percentage changes imply that the differences are statistically significant. The first entry in any cell gives the result for the lower

[5] The exception to this generalization is the Gini among the undernourished; it shows little variation across location, time, or nutrient.

threshold, two-thirds of the daily allowances; the second entry provides the results for the upper threshold, three-fourths of the daily allowances. For example, in the first cell, 204% and 119% imply that the rural calorie headcount increased by 204 percent at the two-thirds threshold and 119 percent at the three-quarters threshold.

There is no doubt that the period 1991 to 1997 was one of large increases in undernutrition. However, some further generalizations are possible. First, the results are not particularly sensitive to the index chosen, e.g., rural calorie headcounts, gaps and Sen indexes all increase by over 200 percent. Second, the degree of undernutrition is greater when we measure in terms of calories rather than in terms of protein. Finally, the impact of rising food prices that occurred during this time period is more dramatic in rural areas than in urban areas.

The bottom of Table 3 examines the period 1997 to 2004, a period of relatively stable food prices and rising incomes. Here the results are sensitive to all of the parameters, the threshold selected, the index chosen, the nutrient examined, and location of the residence. For example, if we look only at the calorie headcounts we find significant increase in undernutrition between 1997 and 2004. However, if we focus on protein headcounts the problem appears less severe and concentrated in the rural areas. Switching to the calorie gap, the rural areas show strong improvement between 1997 and 2004 while the urban areas show little change in the calorie gaps. Alternatively, if we look at protein gaps or calorie Sen indices we find no change between 1997 and 2004. Finally, the urban protein Sen index rises between 1997 and 2004. In sum, a while wide variety of conclusions regarding this time period seem to be possible, a prudent conclusion might be that rising incomes in China did little to improve undernutrition between 1997 and 2004.

Table 4 presents rural versus urban comparisons for 1991, 1997, and 2004, by nutrient and index. ‘R’ denotes that the rural area dominates the urban area; ‘U’ denotes that the urban area dominates, and ‘0’ denotes no statistical difference. The first entry is for the two-thirds threshold, the second entry is for the three-quarters threshold. In 1991 rural areas dominate urban areas in all comparisons except the protein Sen index, where there is no difference between locations. In contrast, by 1997 urban areas dominate rural areas in all protein comparisons and in calorie gaps at the lowest thresholds. The 2004 comparison is more mixed with the evidence suggesting less calorie undernutrition in rural areas and less protein undernutrition in urban areas. In sum, the urban areas appear to be improving relative to the rural areas.

Table 5 restricts our sample to individuals with at least two-thirds of the daily protein allowances and recalculates the calorie headcounts. For rural areas this results in reductions in the calorie headcount of up to 28 percent while for urban areas the reduction exceeds fifty percent. This finding of nutrient substitution is in contrast to Meng et al. (2004) who argue that nutrient substitution is not occurring in China during this time period.

Table 6 exploits the panel nature of the CHNS data to study the effect of income averaging on undernutrition. We begin with the 1991 data and incrementally average additional years of data, normalized to the 1991 average. While 10 percent of the rural population lies below the 1991 lower calorie threshold, if we average the 1991 and 1993 intakes the percent below the lower threshold falls to 6.2 percent. Averaging the entire five years leads to a calorie headcount below two percent. We observe declines in headcounts for rural protein that are significant but less dramatic than for rural calories. Furthermore, the effect of averaging appears to be smaller in urban areas than in rural areas. In sum, absence of the trend in lower average calorie and protein consumption over time, averaging has a significant impact on the nutrient headcount measures of undernutrition.

Income Elasticities

In this section we present the Lorenz-Concentration and Gini-Concentration Index elasticities for rural China.[6] As noted above a comparison of the nutrient concentration curve (ordered by income) relative to the 45 degree line allows us to identify whether the nutrient is considered a normal or inferior good at various percentiles of the income distribution. The concentration index, as a summary measure, provides an overall indicator of the relationship between the nutrient and income.

Table 7a provides the calories concentration curve at deciles, ordered by household income, for 1991 and 2004. For 1991, each of the nine test statistics are negative indicating the possibility of calories being an inferior good; however, none of the test statistics reaches the five percent critical value of 1.96 or the ten percent critical value of 1.67. In addition, the test statistic on the Concentration index, $C_{y,}$ suggests that we can not reject the null hypothesis that the overall income elasticity is zero. Similarly, for 2004 we can not reject the null of zero calorie income elasticity.

Table 7b provides concentration ordinates and indices for protein. As with calories the 1991 test statistics are all less than 1.67 (in absolute value), implying zero protein income elasticity. However, for 2004 we find that at the ten percent level deciles 4, 5, and 6 all have test statistics greater than 1.67, implying that in the middle income range protein is a normal good.

[6] We focus on rural China as the results for urban China are similar, but weaker (i.e., all income elasticities are not significantly different from zero). For inference procedures used in this section see, Bishop, Formby and Zheng (1998)

Furthermore, the concentration index is also greater than zero at the ten percent level, again implying that in 2004 protein is a normal good.

Table 7c presents the *percent fat* Concentration curve elasticities. For 1991 all nine decile test statistics are greater than 1.96 implying that at each point in the income distribution *percent fat* is a normal good. For 2004 percent fat also is a normal good, but the declining value of the concentration index implies that it is becoming “less normal’ over time.

Table 8 provides a summary index of the elasticities as we vary the income concept. The first entry in any cell is for 1991 and the second 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 of Tables 7a-7c.

The additional rows in Table 8 consider nutrient elasticities with respect to alternative income concepts 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 all three nutrients. It is the conventional wisdom that by improving the status of women, household nutrition outcome will improve. While we can not 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).”

Meng et al. (2004) use food expenditure data (and an approximation procedure to adjust for meals eaten out) which they convert to nutrition content. They estimate calorie demand as a function of demographic variables and a proxy for uncertainty. They find elasticities greater than 0.5 and comment that their finding is in contrast to many studies "where it is common to observe low income elasticities using data from surveys designed to monitor nutrition. (p. 13)."

V. Conclusions

This paper applies advances in the measurement of poverty and inequality to the study of undernutrition in China. In particular, we adapt the Sen's distribution-sensitive poverty index to evaluate undernutrition. Furthermore, we employ Kakwani's (1977) Lorenz-concentration curve method to measure income elasticity for food nutrients. In each case we provide formal inference procedures to test for the statistical significance of our findings.

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. Our findings suggest: rising income has little impact on undernutrition; urban areas are improving relative to rural areas; some nutrient substitution is occurring between calories and protein; headcounts of the undernourished may provide misleading results in some cases due to aggregation bias as nutrient averaging can dramatically reduce the degree of undernutrition.

We identify two unique sub-periods, 1991 to 1997—a time of rising incomes and stable prices, and 1997 to 2004—a period of rising incomes and relatively stable food prices. The period 1991 to 1997 can be characterized as one in which a dramatic increase in Chinese undernutrition occurred. This conclusion is independent of the nutrient examined, the threshold value selected, the undernutrition measure employed, or urban status. The period 1997 to 2004 is not so easily characterized and the results are sensitive to all of the parameters, the threshold selected, the index chosen, the nutrient examined, and urban status. In particular, we find that nutrient headcounts provide misleading results relative to Sen's distribution sensitive index. Overall, the period 1997 to 2004 is one of little change in the degree of undernutrition in China.

Our evidence from analyzing the Sen index and its components points to a limited role of rising incomes in mitigating undernutrition. We follow up this finding by estimating income elasticities using Kakwani's (1977) method. Our income elasticity estimates for calories and protein income are generally zero, while we find some evidence that the percentage of fat in the calorie source is a normal good. It is the conventional wisdom that by improving the status of women, household nutrition outcome will improve. While we can not address this issue directly, we do observe that the nutrient elasticities with respect to women's schooling or women's wages are also zero.

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Table 1

Table 1. Changes in Mean Nutritional Intakes among Adults: Rural and Urban China, 1991-2004

	Rural				Urban			
Year	OBS	Calories	Protein	% Fat	OBS	Calories	Protein	% Fat
1991	5803	2781	77.7	19.8	2632	2508	73.1	25.6
1993	5523	2681	75.9	21.1	2324	2417	71.8	29.0
1997	5505	2396	66.7	23.1	2660	2345	70.3	31.8
2000	5943	2397	66.2	26.0	2833	2265	69.0	33.7
2004	5135	2331	66.7	27.0	2645	2260	71.1	31.7

Notes: Standard errors: calories ~ 15; protein ~ 0.5; % fat ~ 0.005; The average daily allowances are 2480 calories and 75 grams of protein

Table 2a. Sen Index and Components, Calories: Rural and Urban China, 1991-2004

		Rural		Urban	
		2/3 RDA	3/4 RDA	2/3 RDA	3/4 RDA
1991	Headcount	0.050	0.112	0.100	0.186
		(.003)	(.004)	(.006)	(.006)
	Gap	0.047	0.058	0.080	0.094
		(.003)	(.005)	(.008)	(.006)
	Gini	0.198	0.179	0.159	0.160
		(.005)	(.005)	(.009)	(.009)
	Sen	0.012	0.025	0.023	0.044
		(.001)	(.001)	(.002)	(.002)
1993	Headcount	0.073	0.141	0.134	0.223
		(.003)	(.005)	(.007)	(.007)
	Gap	0.107	0.100	0.104	0.116
		(.009)	(.006)	(.008)	(.007)
	Gini	0.200	0.195	0.146	0.179
		(.006)	(.006)	(.008)	(.010)
	Sen	0.021	0.039	0.031	0.061
		(.002)	(.002)	(.001)	(.003)
1997	Headcount	0.142	0.235	0.175	0.270
		(.005)	(.006)	(.007)	(.006)
	Gap	0.173	0.154	0.134	0.152
		(.007)	(.006)	(.008)	(.006)
	Gini	0.193	0.205	0.183	0.173
		(.006)	(.006)	(.008)	(.008)
	Sen	0.047	0.077	0.051	0.081
		(.002)	(.002)	(.001)	(.003)
2001	Headcount	0.152	0.245	0.216	0.311
		(.005)	(.006)	(.008)	(.005)
	Gap	0.119	0.133	0.140	0.164
		(.005)	(.006)	(.007)	(.007)
	Gini	0.182	0.174	0.185	0.179
		(.004)	(.004)	(.007)	(.007)
	Sen	0.042	0.071	0.065	0.099
		(.002)	(.002)	(.002)	(.003)
2004	Headcount	0.175	0.280	0.213	0.321
		(.005)	(.006)	(.008)	(.005)
	Gap	0.130	0.143	0.127	0.150
		(.006)	(.005)	(.006)	(.005)
	Gini	0.185	0.176	0.158	0.171
		(.004)	(.004)	(.006)	(.007)
	Sen	0.051	0.082	0.056	0.095
		(.002)	(.002)	(.002)	(.003)

Table 2b. Sen Index and Components, Protein:
Rural and Urban China, 1991-2004

		Rural		Urban	
		2/3 RDA	3/4 RDA	2/3 RDA	3/4 RDA
1991	Headcount	0.110	0.195	0.131	0.231
		(.004)	(.005)	(.006)	(.008)
	Gap	0.085	0.114	0.109	0.124
		(.005)	(.004)	(.006)	(.008)
	Gini	0.158	0.139	0.129	0.132
		(.010)	(.007)	(.010)	(.006)
	Sen	0.025	0.046	0.029	0.055
		(.001)	(.002)	(.002)	(.003)
1993	Headcount	0.134	0.230	0.149	0.259
		(.005)	(.006)	(.007)	(.009)
	Gap	0.125	0.137	0.133	0.141
		(.006)	(.004)	(.007)	(.009)
	Gini	0.158	0.153	0.155	0.142
		(.007)	(.006)	(.013)	(.006)
	Sen	0.035	0.062	0.040	0.068
		(.002)	(.002)	(.003)	(.003)
1997	Headcount	0.225	0.340	0.192	0.301
		(.006)	(.006)	(.008)	(.009)
	Gap	0.180	0.189	0.152	0.168
		(.006)	(.004)	(.008)	(.009)
	Gini	0.165	0.161	0.157	0.146
		(.006)	(.005)	(.009)	(.006)
	Sen	0.071	0.109	0.055	0.087
		(.002)	(.003)	(.003)	(.003)
2001	Headcount	0.253	0.369	0.252	0.354
		(.006)	(.006)	(.008)	(.009)
	Gap	0.160	0.183	0.178	0.201
		(.004)	(.003)	(.008)	(.009)
	Gini	0.151	0.141	0.147	0.148
		(.005)	(.004)	(.006)	(.005)
	Sen	0.072	0.110	0.075	0.113
		(.002)	(.002)	(.003)	(.003)
2004	Headcount	0.250	0.361	0.214	0.308
		(.006)	(.007)	(.008)	(.009)
	Gap	0.177	0.195	0.168	0.189
		(.006)	(.004)	(.008)	(.009)
	Gini	0.143	0.148	0.138	0.140
		(.005)	(.004)	(.007)	(.005)
	Sen	0.073	0.114	0.061	0.093
		(.002)	(.003)	(.003)	(.003)

Table 3. Sen Index Inference Results and Percentage Changes: Rural and Urban China

	Rural		Urban	
1991 - 1997	Calories	Protein	Calories	Protein
Headcount	204%, 119%	104%, 74%	116%, 67%	46%, 30%
Gap	268%, 166%	112%, 66%	68%, 31%	39%, 35%
Sen	292%, 208%	184%, 137%	122%, 33%	90%, 55%
1997 - 2004				
Headcount	23%, 19%	11%, 6%	22%, 19%	0, 0
Gap	-25%, 0	0, 0	0, 0	0, 0
Sen	0, 0	0, 0	0, 17%	0, 0

Notes: "0"”indicates no difference at 5% significance level; First entry is lower nutrient threshold; second entry is upper nutrient threshold

Table 4. Rural vs. Urban Undernutrition, 1991, 1997, and 2004

1991	Calories	Protein
Headcount	R, R	R, R
Gap	R, R	R, R
Sen	R, R	0, R
1997		
Headcount	R, R	U, U
Gap	U, 0	U, U
Sen	0, 0	U, U
2004		
Headcount	R, R	U, U
Gap	0, 0	0, 0
Sen	0, R	U, U

Notes: "R" indicates rural area dominates at 5% significance level; "U" indicates urban area dominates at 5% significance level; "0" indicates no difference at 5% significance level; First entry is lower nutrient threshold; Second entry is upper nutrient threshold.

Table 5. Calorie Headcounts for Individuals above Two-Thirds Protein Cutoff

Year	Rural	% Change	Urban	% Change
1991	0.040	-25%	0.071	-41%
1993	0.057	-28%	0.085	-58%
1997	0.117	-21%	0.118	-48%
2000	0.126	-21%	0.160	-35%
2004	0.146	-20%	0.142	-50%

Note: Calorie cutoff = two-thirds recommended daily allowances

Table 6. Effect of Averaging on Undernutrition Headcounts - Normalized Data

	Rural		Urban	
	Calories	Protein	Calories	Protein
1991	0.102	0.204	0.178	0.273
	(.007)	(.010)	(.014)	(.017)
+1993	0.062	0.160	0.128	0.202
	(.006)	(.009)	(.013)	(.016)
+1997	0.043	0.119	0.114	0.198
	(.005)	(.008)	(.013)	(.016)
+2000	0.024	0.096	0.100	0.179
	(.004)	(.007)	(.012)	(.015)
+2004	0.016	0.078	0.073	0.160
	(.006)	(.006)	(.011)	(.014)

Note: Normalized to 1991 calorie or protein levels

Table 7a. Calorie Lorenz-Concentration Curve Elasticities: Rural China, 1991 and 2004

Decile	1991		2004	
	Concentration Ordinate	z-statistics	Concentration Ordinate	z-statistic
1	.1052	-1.19	.0949	0.91
2	.2066	-1.06	.1904	1.09
3	.3101	-1.04	.2892	1.02
4	.4100	-1.30	.3880	1.08
5	.5084	-1.05	.4894	0.96
6	.6094	-1.19	.5916	0.76
7	.7079	-1.08	.6963	0.31
8	.8074	-1.15	.7977	0.21
9	.9056	-0.81	.9010	-0.10
Cy	-0.014	-1.47	0.0127	0.88
N	5987		5205	

Note: Calorie consumption ordered by household income.

Table 7b. Protein Lorenz-Concentration Curve Elasticities: Rural China, 1991 and 2004

Decile	1991		2004	
	Concentration Ordinate	z-statistics	Concentration Ordinate	z-statistic
1	.1035	-0.59	.0922	0.95
2	.2024	-0.29	.1847	1.42
3	.3047	-0.51	.2799	1.64
4	.4021	-0.21	.3761	1.87
5	.5006	-0.06	.4762	1.82
6	.6022	-0.22	.5786	1.68
7	.7004	-0.05	.6856	1.18
8	.8035	-0.42	.7879	1.14
9	.9023	-0.33	.8913	0.76
Cy	-0.0045	-0.36	0.0295	1.85
N	5985		5203	

Note: Protein consumption ordered by household income.

Table 7c. Percent Fat Lorenz-Concentration Curve Elasticities: Rural China, 1991 and 2004

Decile	1991		2004	
	Concentration Ordinate	z-statistics	Concentration Ordinate	z-statistic
1	.0800	2.64	.0899	1.41
2	.1676	2.17	.1823	1.87
3	.2564	2.59	.2723	2.44
4	.3491	2.87	.3673	2.73
5	.4512	2.71	.4656	2.86
6	.5516	2.82	.5679	2.78
7	.6544	2.89	.6726	2.55
8	.7640	2.66	.7790	2.27
9	.8793	1.45	.8867	1.16
Cy	.0677	3.55	.0433	2.98
N	6034		5237	

Note: Percent fat consumption ordered by household income.

Table 8. Gini-Concentration Index Elasticity Summary: Rural China, 1991 and 2004

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

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