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INCOME GROWTH AND NUTRIENT INTAKE IN A PROSPEROUS RURAL AREA OF NORTHERN CHINA

by
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Abstract

This paper presents estimates of income and food expenditure elasticities of food and nutrient demand for a relatively prosperous rural area in China, using a two-stage econometric model.* Findings reveal that grain accounts for four-fifths of calories and nine-tenths of protein intake in poor households. The nutritional importance of grains declines at higher incomes; however, even in this relatively prosperous rural area, grain is by far the most important source of calories and protein. This finding highlights the importance of policies to ensure total national grain availability. Although income elasticities of protein intake are low, the food-expenditure elasticity of protein intake from meat is fairly high for most household, which implies that the quality of protein intake improves as income rise. Improvement in nutrient quality (as opposed to quantity) has not been emphasized in the past nutritional economics research. The availability of meat at relatively low prices is important to support a transition toward higher-quality nutrient intake while reducing the inflationary pressures of rapid income growth on food prices.

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* While the income elasticity is straitforward, the food expenditure elasticity refers to that if total food expenditure increases x percent, the expendure of a specific food iterm will increase y percent.

I
Introduction

The effect of per-capita household income on nutrient intake in less-developed countries has been a subject of controversy in the nutritional economic literature. Income can influence nutrient intake in two ways: first, by affecting the quantity of nutrients consumed, and second, by affecting nutrient quality. Empirical studies have produced conflicting findings with regard to the magnitudes of income elasticities of nutrient demand, even when income elasticities of food demand are high (see below). The effect of income on nutrient quality has not been the subject of nutritional economics research.

This paper presents econometric evidence that even when income elasticities of nutrient intake are low, changes in income may influence the quality of nutrients by shifting food demands towards higher-density nutrient sources. Our estimates of income elasticities of food and nutrient demand for a relatively prosperous area of rural China reveal that the nutritional importance of grains declines at higher incomes. However, although income elasticities of protein intake are low, the food-expenditure elasticity of animal protein intake is relatively high, implying an improvement in the quality of protein as incomes rise. Our findings suggest the relevance of income growth in improving nutrition in rural China even when the income elasticity of total nutrient intake is low. The policy implication of this finding is to encourage meat production and thus increase supplies. Increasing meat suppy will satisfy consumer demands in the context of rapid income growth that characterizes much of rural China, as well as reduce inflationary pressure on food prices.

II
Economic Development and Nutrient Demand

Rural China has offered an unusually good opportunity to test the effects of income change on household nutrient demands. In 1978 China introduced market incentives into its previously collective and subsistence-oriented agricultural sector. This set of policies was called the Household Responsibility System (HRS). Chinese farmers have enjoyed rapid income growth under the new policies.[1] Rural production increased rapidly from 1978 to 1988, with a 9.3 percent average annual increase in agricultural production and a 20 percent average annual increase in non-agricultural industry.[2]

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[1] Different figures on income growth rates are available according from different sources and calculation methods. Based on *Statistical Yearbook of the Rural Areas of China,* taking into account inflation, we calculate an average annual growth rate of per capita income of 7.3 percent from 1978 to 1988.

[2] Agricultural production includes crop production, forestry, livestock, fishery, and crafts. Non-agricultural industry includes rural industry, construction, transportation services and commerce. Again, the figures are based on my calculation according to *Statistical Yearbook of the Rural Areas of China,* 1985-1989.

Improving nutritional status is usually not an explicit objective of rural development strategies. In general, the implicit assumption is that increased income will lead to higher expenditures on food, and thus higher nutrient intake.[3] These effects ultimately will lead to improvements in nutritional status, health, and the quality of life (Galal *et al.*, 1987). However, empirical results of estimated income elasticities of nutrient intake are controversial (see below). Given the sustaining living standard prevalent in rural China before the economic reform, non-food items such as clothing, housing and consumer durable goods all compete with food consumption for increased income. Empirical tests of the link between income and nutrient intake in rural China are critical to monitor the nutritional impact of economic growth and to formulate policies to improve the nutritional benefits of this growth.

There is general agreement that as income increases food expenditure usually rises and lower income groups have a higher income elasticity with respect to food expenditure (Behrman, 1988). However, higher food expenditure does not necessarily mean higher nutrient intake. In a country-wide study in Nicaragua, Behrman, Deolalikar and Wolfe (1988) found a statistically significant inverse association between nutrient income elasticity and per capita income. They suggest that when income increases for fairly poor people, food expenditures increase almost proportionally. However, at the margin the poor concentrate on non-nutrient food attributes including taste, appearance, odor, degree of processing, variety, and status. These are not necessarily positively correlated with nutritive value. As a result, the income elasticity of nutrient intake is quite low, even when the income elasticity of the food expenditure is high. Using food expenditure data from Managua, Nicaragua, Wolfe and Behrman (1983) found that income elasticities at the sample means are only .01 for calories and iron, .02 for protein, and .04 for vitamins. This study concludes that increasing income is not an effective way to increase nutrient intake, given that the income elasticities of nutrient intake are so small.

These studies were challenged by Ravallion (1990), who points out that nutritional responses to budget shifts are likely to be larger for the least-nourished people. His analysis of Indonesian data found that the income elasticity of calorie intake rises sharply as income falls. Households that consume less than 1,900 calories per day respond to an income decrease with an elasticity of about unity. Ravallion argues that more undernourished individuals should be given a higher weight when assessing the extent of nutritional deprivation.

These studies do not, however, address nutrient quality changes implied by income-induced shifts in nutrient sources. The present study addresses the following questions about the nutritional impacts of China's rural economic growth: Does higher income lead to higher per-capita food expenditure? Does higher food expenditure in turn result in a higher quantity or quality of nutrient

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[3] Protein and calorie deficiencies are recognized as the most prevalent malnutrition problems resulting from poverty in developing countries. Protein and calorie deficiencies are the main concern of this study.

intake? In other words, is increasing income an effective way to improve the quantity or quality of nutrient intake?

We propose a model to test the effect of income change on household nutrient demand and present estimates of this model for a small rural area of China. Although the study area is relatively prosperous, we believe that our findings are relevant on the policy implications on the link between income and nutrient intake in less developed regions, which are experiencing income growth.

III
Methodology and Findings

Two econometric modeling methods are commonly used to estimate income elasticity of nutrient intake. One is a reduced-form model, in which nutrient intake is regressed directly on income (i.e., Ravallion, 1990). A disadvantage of this method is that food consumption patterns, which often are very informative to policy makers and may be a target for nutrition policy intervention, are not obtained from the model. The second method is to estimate a structural model in which food demands are regressed on total food expenditure and to then calculate the food-expenditure elasticity of nutrient intake. It is assumed that the food-expenditure elasticity is a good approximation of the income elasticity of nutrient intake (i.e., Strauss, 1986). The shortcoming of this approach is that it assumes food expenditure increases as income increases, rather than testing this hypothesis.

To overcome these disadvantages, we propose a two-stage procedure, which produces a structural model of consumption patterns and food demand. In the first stage, a household allocates its income among food, clothes, housing, consumer durable and consumer non-durable goods. In the second stage, assuming weak separability among these major consumption categories, the household's food budget is allocated among food items. Income elasticities of nutrient intake per adult equivalent are estimated using elasticities from the two stages of the model together with nutrient conversion coefficients for each food item.

Our model to analyze the relationship between household food consumption and nutrient intake postulates that differences in food consumption among households are a function of per-capita household income and household education, age composition and family size. The Stage-I model takes on a quadratic double log ad hoc functional form:[4]

(1) $$\ln E_i = \alpha_{0i} + \alpha_{1i}\ln y + \alpha_{2i}(\ln y)^2 + \alpha_{3i} Z + u_i$$

for expenditure categories $i = 1,\ldots,5$, where E_i denotes expenditure on category i, y is per-capita income and Z is a vector of household characteristics. When estimated, one equation (consumer non-durable goods) is dropped from the system, as it is implicit from the adding-up property.

[4] This specification allows for non-homothetic demands for the major consumption categories, and it permits us to test the effects of household characteristics on consumption.

The Stage-II model is

(2) $$w_j = \beta_{0j} + \beta_{1j} E_F + \beta_{2j} Z + \varepsilon_j$$

for food items j = 1,...12,[5] where $w_j = x_j/E_F$ denotes the share of food item j (x_j) in the total food budget (E_F). The adding up property is satisfied by dropping one of the food-demand equations (sugar). Total nutrient intakes are estimated from food demands as:

(3) $$n_k = \sum_{j=1}^{J} \theta_{kj} x_j$$

for nutrients k = 1,...,k, where θ_{kj} denotes the nutrient-k content per unit of food j. At each stage, the error terms (u_i and ε_j, respectively) are assumed to be distributed as $\sim N(0,\sigma^2)$, independently across observations but with the possibility of non-zero cross-equation error correlations.

Once we have obtained parameter estimates from the first and second-stage regressions, the income elasticities of total food demand and nutrient intakes and the expenditure elasticities of demand for specific food items can be calculated. The income elasticity of nutrient-k intake from food j, η_{ik}, can be derived from the equation

(4) $$\eta_{kj} = \delta_F \frac{E_F}{n_k} \sum_{j=1}^{J} \frac{\partial n_k}{\partial x_j}$$

where δ_F is the income elasticity of total food expenditure and the other terms are defined as above. Estimation of the equations was carried out for two nutrients: calories and protein. The sensitivity of nutrient elasticity to income level was then explored by comparing elasticities across household income groups.

Economic theory and empirical findings from other country settings lead to a number of hypotheses concerning relationships among income, food expenditure and nutrient intake. In the first-stage regressions, we anticipate that the income elasticity of total food demand will be positive but decreasing with total income. At the second stage, we expect to find a shift in household food demands away from inexpensive nutrient sources (grains) towards meats, fruits, alcohol and cigarettes as per-capita household incomes increase. As a result, grains should lose importance as a source of household nutrients at higher incomes. If income elasticities of total food expenditure decrease with income, and if higher income favors expenditure on inefficient nutrient sources (alcohol, cigarettes), nutrient elasticities will tend to decline as incomes increase.

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[5] They are grains (wheat, rice and other), vegetables (including soybean product), pork, beef and mutton, fowl, eggs, fruits, sweets, sugar, tea, alcohol, and cigarettes.

III.1. Data and Estimation

Household survey data were collected from one hundred households in a northern county in China in 1989. The survey gathered detailed information on household demographic characteristics, income, expenditures and quantity consumed of food, clothing, housing, and consumer durable and non-durable goods. These data are the basis for our econometric estimation of the Stage I and II equations. To exploit the information contained in cross-equation error correlations, the demand equations in each of stages I and II were estimated jointly. To correct for censorship (zero demands) for some food items (e.g., consumer durables), Inverse Mills ratios were included as right-hand side variables in the equations for housing and consumer durables for the first stage equations, and in the second-stage fowl and beef equations. This procedure follows Amemiya's (1974) extension of Heckman's two-step estimator (for an application to food demand, see Heien and Wessels). Under the assumption of separability among first-stage demands, this procedure yields parameter estimates that are both consistent and asymptotically more efficient than other two-step methods to correct for problems arising from censored dependent variables (Lee, 1978).

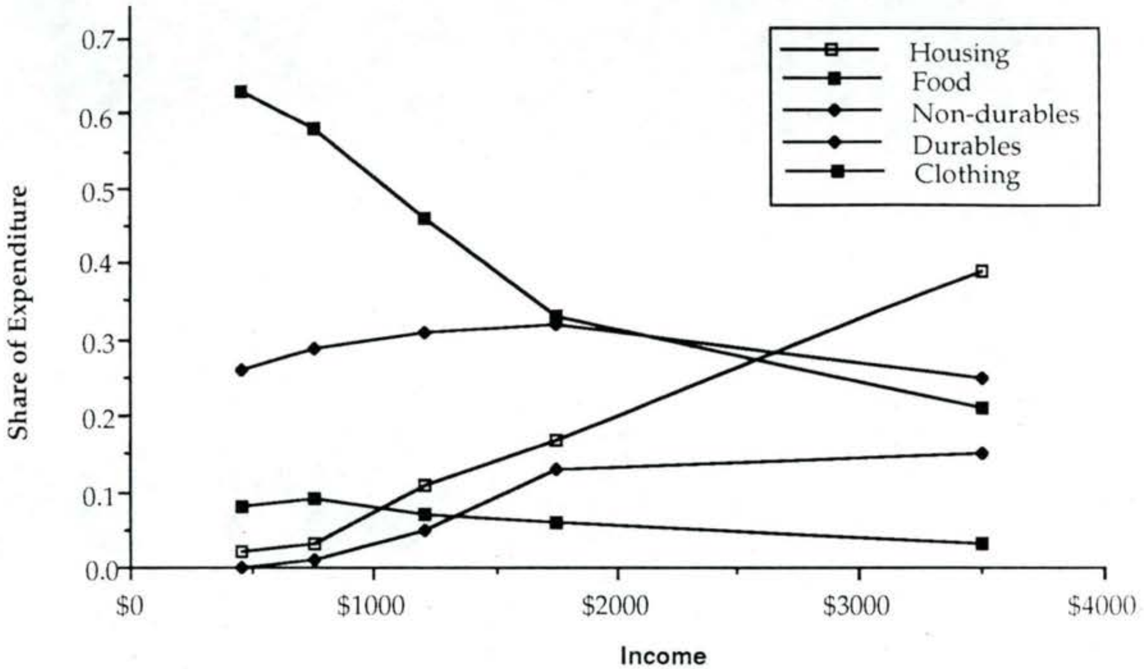
III.2. Findings

Figure 1 illustrates Engel curves of the different consumption categories. It shows consumption patterns of different per-capita household income groups. As income increases, the share of food expenditure decreases drastically. The share of consumer non-durable goods first increases slightly and then gradually decreases. The share of clothing first increases slightly, then decreases and basically levels off. The share of durable goods increases sharply at first and then levels off. The share on housing grows at a relatively high rate throughout the income range covered by the data.

The estimated coefficients of the Stage-I model (see Appendix, Table A.1) indicate that besides income, family size and the age of family members also play significant roles in what to consume. Larger families tend to spend a smaller share of income on food and clothing, but a larger share on housing and consumer durable goods. Families with children under seven spend larger share on food and housing. Families with children between 15 and 17 emphasize on better housing but sacrifice consumption of durable goods.

Although the data used to estimate this demand system are from a small area in China, the consumption patterns depicted in Figure 1 are broadly consistent with those in rural LDC households. It is reasonable to believe that they reflect patterns prevalent elsewhere in rural China. Understanding this consumption pattern is informative for planning national economic development. As rural demand for consumer durable goods expands, rural economic growth creates consumer-goods markets in the countryside which stimulate urban economic development (Johnston and Mellor, 1961). A larger sample size from different parts of China would make possible a more detailed study of consumer durable good demand and forecasting of commodity demands in rural areas. This would assist in understanding demand patterns shaping industrial development and in planning industrial production. Given the strong trend in housing expenditures, it may be worthwhile to create incentives to encourage farmers to upgrade rather than expand their housing, which has been competing for scarce land with agriculture. We wish to do more study on this topic when more data become available. The present study concentrates on food and nutrient demand in farm households.

Figure 1
Engel Curves of Consumption Categories



Tables 1 through 4 report food budget shares, demand elasticity, nutrient sources, and elasticities of nutrient demand, respectively, by per-capita household income group. The parameter estimates, t-statistics and nutrient conversion coefficients used to calculate these elasticities appear in Tables A.1 and A.2 of the Appendix.

Table 1 shows that the share of food expenditure in total income is 63 percent for the lowest income group (<500 yuan per capita), and it declines to 16 percent in the highest income group (>2000 yuan per capita). The share of grain in total food expenditure is higher in the lowest income group (53 percent) than in the highest income group (33 percent). By contrast, the share of meat and vegetables is lower in the lower income groups than in the higher income groups. Farmers switch from grains to more expensive, preferred foods (meat and vegetables) as their incomes rise.

Table 1

Food Budget Shares by Income Group (percent)

	Per Capita Household Income				
	< 500 yuan	500~1000 yuan	1000~1500 yuan	1500~2000 yuan	> 2000 yuan
Total food expenditure	350	514	650	640	683
Share of food expenditures in total income	0.63	0.58	0.49	0.32	0.16
Share in total food expenditure:					
Grain	0.53	0.42	0.32	0.31	0.33
Meat	0.18	0.20	0.23	0.27	0.25
Vegetables	0.07	0.10	0.12	0.11	0.16
Alcohol and Cigarettes	0.11	0.17	0.16	0.18	0.18

The different food consumption patterns are reflected in income elasticities of consumption categories and food expenditure elasticities of food items, which are shown in Table 2. A one-percent increase in total income results in fairly high percentage increases in total food demand for the bottom two income groups (.62 and .54, respectively). Food-demand elasticities decline drastically for the higher income groups, with a .12-percent decrease for the richest group. This pattern is consistent with the experience of other developing countries.

Table 2

Income and Expenditure Elasticity by Income Group

	Per Capita Household Income				
	< 500 yuan	500~1000 yuan	1000~1500 yuan	1500~2000 yuan	> 2000 yuan
Elasticity of total food expenditure w.r.t. income	0.62	0.54	0.34	0.17	−0.12
Expenditure elasticity of food demand:					
Grain	0.59	0.39	0.11	0.11	-0.003
Vegetables	1.82	1.51	1.52	1.88	1.23
Fowl	1.08	0.62	2.08	1.61	1.23
Beef	2.04	2.03	1.71	1.30	1.93
Pork	1.45	1.90	1.82	1.40	1.26
Eggs	−0.28	−0.14	−0.06	−0.03	−0.02
Fruit	1.30	1.55	1.63	1.70	2.38
Sweets	0.68	0.56	0.54	0.59	0.78
Alcohol	1.56	1.50	1.83	2.01	1.48
Cigarettes	2.18	1.60	1.59	2.04	2.20

Expenditure elasticities of food are all positive with the exception of grains for the highest income group and eggs for all income groups.[6] The magnitudes of these elasticities vary across household income levels. Food-expenditure elasticities for grain are .59 for the lowest income group, but decline to -.0029 for the highest income group. This reflects the decreasing importance of grain in farmers' diets as household income increases. By contrast, vegetables, meats, fruit, alcohol and cigarettes have elasticities that are above unity at all income levels. On one hand, these estimated elasticities indicate that income increases have a less and less positive impact on total food expenditure as household incomes increase. On the other hand, household food expenditures increasingly favor more expensive foods (e.g., meat, alcohol and cigarettes) as income levels rise. The high expenditure share and elasticities of cigarettes and alcohol indicate that these non-nutritious items compete with nutritious food (meat and vegetables) for food expenditure.

Table 3 reports the calorie and protein intake levels and principal sources of calories and protein in household diets for each of the household-income groups. These were calculated by multiplying food demands by their corresponding nutrient-conversion coefficients (Table A.2., in the Appendix), as in equation (3). The poorest households in the sample obtain more than four-fifths of their total calories and nine-tenths of their total protein from grains. They obtain only a small share of their total calories and protein from meat and other animal products (13 percent and 7 percent, respectively). At higher income levels, the importance of grains in providing these nutrients is lower, and the importance of animals and animal products increases.

Table 3

Nutrient Sources and Nutrient Intake (per capita, per day), by Income Group

	Per Capita Household Income				
	< 500 yuan	500~1000 yuan	1000~1500 yuan	1500~2000 yuan	> 2000 yuan
Total Calorie intake	2739	2770	2890	2980	3030
Percentage of Calories from:					
Grain	0.83	0.74	0.68	0.71	0.67
Meat (non-lard)	0.05	0.08	0.12	0.13	0.14
Lard	0.07	0.10	0.10	0.10	0.07
Total Protein intake (gram)	68.8	66.7	68.7	72.5	71.6
Percentage of Protein from:					
Grain	0.90	0.84	0.78	0.80	0.78
Soybean Products	0.006	0.008	0.020	0.014	0.008
Animal Product*	0.07	0.12	0.15	0.15	0.16

* Including meats, eggs, seafood and milk.

[6] Expenditure elasticities refer to that as total food expenditure increase x percent, a specific food item expenditure will increase y percent. We suspect the negative elasticity of eggs results from the poorer households' selling eggs for cash instead of consuming them.

Income and expenditure elasticities (Table 2) were used together with the nutrient-conversion coefficients to estimate the food-expenditure and income elasticities of nutrient demands as in equation (4), which are reported in Tables 4 and 5 respectively. We also calculated elasticities of calorie and protein obtained from pork and from grain, the most commonly consumed food items in this region. The findings in Table 4 reveal that food-expenditure elasticities of protein intake are fairly low and, as we expected, decrease as income levels increase. However, the elasticity of protein obtained from pork is relatively high for all income groups. For example, the overall expenditure elasticity of protein intake is .003 for the highest income group, but the elasticity of protein obtained from pork is .73. This implies that although total protein intake increases little as food expenditure increases, the quality of protein increases substantially. The economic impact of nutrient quality is important because the quality of nutrients is critical in improving nutrition, expecially for young children, and lactating women.

The low expenditure elasticities of calorie intake most likely reflect an adequate calorie intake in this area (2739 for the lowest income group and 3030 for the highest income group).[7] However, protein intake is somewhat low (69 grams for the lowest income group and 71 grams for the highest income group). Table 5 shows that income elasticities of protein intake are not very high (from .00 to .38) compared with food-expenditure elasticities (from .36 to .95).

Table 4

Food-expenditure Elasticity of Nutrient Demand by Income Group

	Per Capita Household Income				
	< 500 yuan	500~1000 yuan	1000~1500 yuan	1500~2000 yuan	> 2000 yuan
Calorie Intake Elasticity	0.072	0.012	0.004	0.004	0.004
Grain calorie	0.080	0.013	0.0002	0.012	-*
Pork calorie	0.004	0.013	0.016	0.012	0.012
Protein Intake Elasticity	0.087	0.012	0.003	0.003	0.003
Grain protein	3.5	0.47	0.006	0.007	-*
Pork protein	0.36	0.79	0.95	0.75	0.73

* Less than .0001.

[7] According to the Hygiene Research Institute of the Chinese Academy of Medical Science, the calorie intake requirement for labors of medium and heavy level physical work is from 2900 to 3500 calories, and the protein requirement is 78 to 88 grams daily (Food Composition Table, 1977).

Table 5

Income Elasticity of Nutrient Demand by Income Group

	Per Capita Household Income				
	< 500 yuan	500~1000 yuan	1000~1500 yuan	1500~2000 yuan	> 2000 yuan
Calorie intake elasticity	0.045	0.006	0.0013	0.0009	-*
Grain calorie	0.050	0.008	-*	-*	-*
Pork calorie	0.004	0.008	0.010	0.0026	-*
Protein intake elasticity	0.054	0.006	0.0009	0.0006	-*
Grain protein	2.17	0.23	0.002	0.0015	-*
Pork protein	0.22	0.38	0.31	0.17	-*

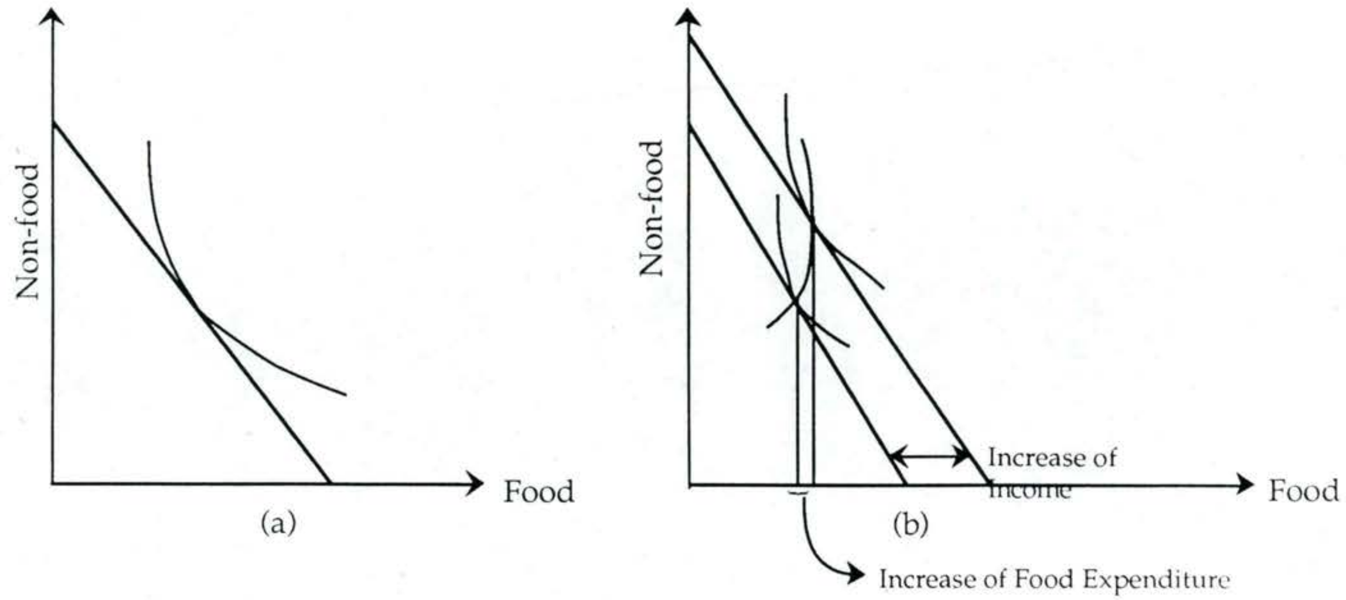
* Less than .0001.

The high food-expenditure elasticity and relatively low income elasticity of protein intake from pork has interesting policy implications. Figure 2 shows that when income elasticity is low and expenditure elasticity is high, policies that increase the supply (and thus lower the price) of meat will be more effective than income growth at encouraging meat protein intake. In our sample, this policy would be effective for the upper four income groups. In the poorest income group, the expenditure elasticity of protein intake from pork is low (.36); these households may not be able to afford sufficient meat even at a lower price. Given their relatively high income elasticity of food consumption (.62), the combination of increasing both income and the supply of meat would be more effective in these households.

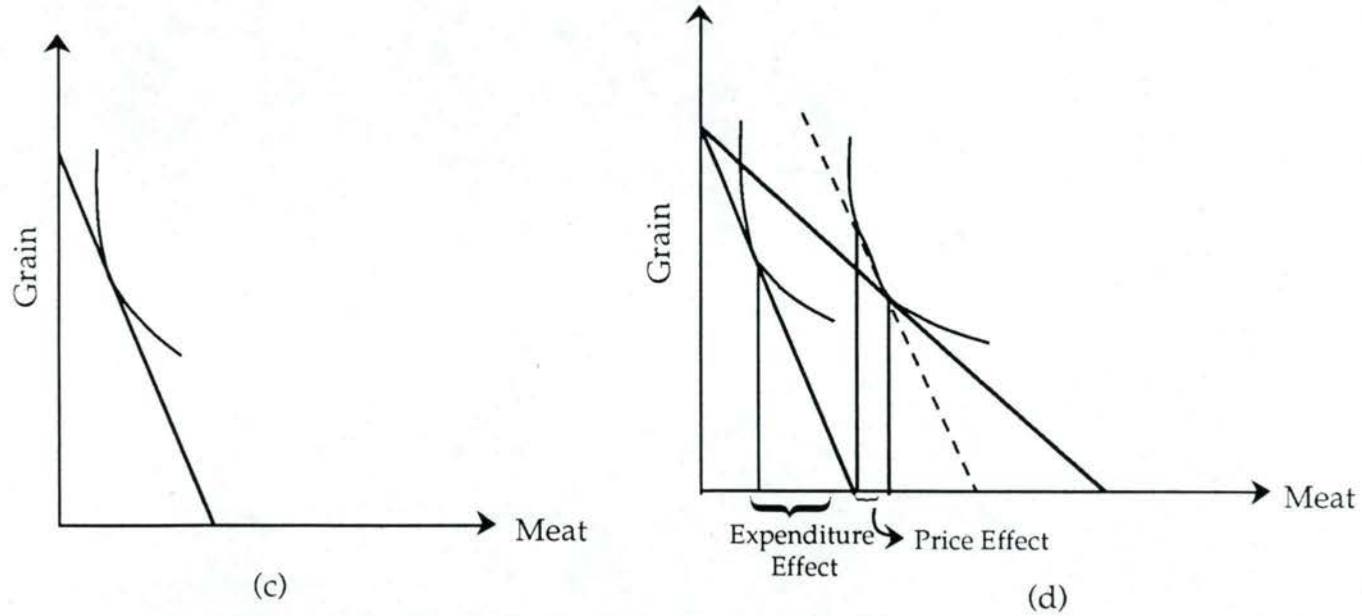
A surprising finding from these data is that farmers in this region consume very little soybean product. We suspect that this is because the region does not grow soybeans, and soybeans are not widely available in the area. Given the low price and high quality of soybean protein, it would be cost effective from a protein-nutrient point of view for the local government to take steps to increase soybean availability. By international standards, the protein obtained from animal products is low in this region.[8] Promoting soybean and chicken consumption will provide low fat and high density protein sources.

[8] Discussions with Dr. Kenneth Brown, International Nutrition Program, U.C. Davis.

Figure 2



Diagrams (a) and (b) show that when income elasticity of food consumption is low, increasing income will not be an effective way to increase food expenditure. (In this case, because food-expenditure elasticities of nutrient intake are positive, higher food expenditure means higher nutrient intake.)



Diagrams (c) and (d) show that when food-expenditure elasticities are high for meat consumption, lowering meat price by increasing its supply (which is equivalent to loosening the food expenditure constraint and making meat cheaper relative to grain) will be effective at increasing meat consumption, which provides high-density protein.

IV

Conclusions

The econometric estimates of food and nutrient demand presented in this paper illustrate the sensitivity of food and nutrient-intake elasticities to income and food expenditure level, and they yield some nutritional implications for Chinese development policy. Consistent with findings from other LDCs, food demand elasticities are high in low per-capita income rural households but decline at higher incomes. The composition of food expenditures changes significantly across the income spectrum; household food expenditures progressively favor more expensive foods (e.g., meats) as incomes rise. In this relatively prosperous rural area, poor households obtain four-fifths of their calories and nine-tenths of their protein from grains. At higher income levels, the nutritional importance of grains declines and that of meats rises. At all incomes, the income elasticity of protein intake is low, but the food-expenditure elasticity of protein intake from meat (pork) is relatively high. This finding implies that the quality of protein intake increases as incomes rise. The improvement in nutrient quality (as opposed to quantity) has not been an emphasis in the past nutritional economics research.

Our study reveals that in this prosperous area of rural China grain is still the most important source of calories and protein. Grain is likely to play a more important role in the food budgets and nutrition of households in less affluent areas. Our findings highlight the importance of policies to ensure total national grain availability and farm households' continued access to inexpensive grains. This will be necessary to guarantee the sufficient nutrient intake for Chinese farmers. Even in the presence of rapid income growth, grains will most likely continue to play an important role in both the budgets and the nutrition of households at the bottom of the income spectrum.

Expanding meat supplies will be necessary to keep pace with the rising demand for meat as household incomes increase. From a nutritional point of view, the availability of meat at relatively low prices is important to support a transition toward higher-quality nutrient intake. Given health problems related to high-fat diets in developed countries, meat (e.g., chicken, which is also more grain-efficient than pork) and other (e.g., soybean) alternatives to high-fat meats (e.g., pork) should be considered as a nutritional complement to programs that encourage meat production. From an economic point of view, expanding supplies of goods with high income (or expenditure) elasticities of demand is important to reduce the inflationary pressures of rapid inçome growth on food prices. The danger of smoking should be made widely available to the public because it is not only harmful to health but also competes with nutritious food in household food budgets.

Income inequality is likely to accompany income growth in the context of market incentives like those introduced under China's Household Responsibility System. However, we have not found evidence that there are significant nutritional implications of income inequality in this area. We have calculated that the Gini coefficient for per capita income is .33, while the nutrient-intake Ginis are on the order of .11 (although higher income households consume higher quality protein). Households at higher incomes spend most of their marginal income on non-food items.

Our research reveals some limitations of existing data and directions for future nutritional economics research. Nutrient intakes in this study are derived from annual household consumption data and are approximated using average nutrient-conversion coefficients for each food item. For example, even though different cuts of pork contain different proportions of fat and lean meat, the nutrient conversions used in this study are approximations for pork with average fat. Data on the quality of specific foods were not available. This study also uses data on average per capita nutrient intake within households; data on the distribution of food and nutrient intake within households were not available. Adequate levels of per-capita nutrient intake do not necessarily imply that persons with special needs, such as lactating women or young children, have sufficient nutrient intake. Low average protein intake from animal products poses special concerns for lactating women and young children, who need more high density protein than average. Finally, annual data do not reflect seasonal fluctuations in nutrient intake, and thus seasonal nutrient surpluses or shortfalls. For example, more meat may be consumed in winter time because meat is easy to store and there are several traditional Chinese holidays during this season. More detailed panel data on individual food consumption with a seasonal focus would enable further research on these important topics.

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APPENDIX

Table A.1
Estimated Parameters of Two-Stage Demand Model

STAGE I

Variable Name	Estimated Coefficient	Asymptotic T-ratio
	Dependent Variable: Log of Per-capita Food Expenditure	
LPINC	3.4374	4.4818
LPINC2	-0.21887	-4.1065
FMSZ	-0.46282E-01	-2.2475
YKID	0.13976	3.0644
AG1117	0.28465E-01	0.80705
CONSTANT	-6.8312	-2.4903
	Dependent Variable: Log of Per-capita Housing Expenditure	
LPINC	-7.4488	-2.4407
LPINC2	0.71237	3.3574
FMSZ	0.51549	6.2166
YKID	0.74398	4.6438
AED	-0.12323	-1.9785
AGE17	0.70437	3.8440
HSIMR	2.3846	18.545
CONSTANT	17.666	1.6195
	Dependent Variable: Log of Per-capita Clothing Expenditure	
LPINC	7.1884	3.6070
LPINC2	-0.47871	-3.4544
FMSZ	-0.43766E-01	-0.80671
AED	0.94305E-01	2.1912
AGE17	0.16519	1.4398
CONSTANT	-23.255	-3.2646
	Dependent Variable: Log of Per-capita Durable Expenditure	
LPINC	9.3389	3.4400
LPINC2	-0.52598	-2.7862
FMSZ	0.18019	2.4921
AGE17	-0.49566	-3.1866
DRIMR	2.4437	20.140
CONSTANT	-38.141	-3.9335

System R-Square = 0.9933
Chi-Square (df) = 501.22 (22)

STAGE II

Variable Name	Estimated Coefficient	Asymptotic T-ratio
Dependent Variable: Grain Expenditure Share		
PTEX	-0.38496E-03	-9.2687
FMSZ	0.92921E-02	1.4687
AG1117	0.77631E-02	0.76448
CONSTANT	0.58369	14.716
Dependent Variable: Vegetable Expenditure Share		
PTEX	0.63150E-04	2.6695
FMSZ	-0.78711E-02	-2.1536
AED	-0.61052E-02	-2.3431
AG1117	-0.38129E-02	-0.65197
CONSTANT	0.16551	5.7418
Dependent Variable: Fowl Expenditure Share		
PTEX	0.17376E-05	0.27830
FMSZ	0.13840E-03	0.14210
AED	0.40880E-03	0.54039
YKID	0.79932E-02	4.1453
FLIMR	0.72791E-02	5.6141
CONSTANT	0.26454E-02	0.32735
Dependent Variable: Beef Expenditure Share		
PTEX	0.16173E-04	3.0314
FMSZ	0.24733E-02	3.0431
AG1117	-0.50682E-02	-3.9217
BFIMR	0.95690E-02	8.4392
CONSTANT	-0.22194E-02	-0.43565
Dependent Variable: Pork Expenditure Share		
PTEX	0.94347E-04	3.6701
FMSZ	0.23450E-02	0.59884
AG1117	0.73046E-02	1.1631
CONSTANT	0.53447E-01	2.1772
Dependent Variable: Egg Expenditure Share		
PTEX	0.16589E-04	0.72437
FMSZ	0.84996E-03	0.23915
AED	0.40913E-02	1.5274
YKID	-0.16606E-01	-3.0694
AG1117	-0.44689E-02	-0.75615
CONSTANT	0.26456E-01	0.92545

STAGE II (continued)

Variable Name	Estimated Coefficient	Asymptotic T-ratio
Dependent Variable: Fruit Expenditure Share		
PTEX	0.36889E-04	2.2410
FMSZ	-0.33261E-02	-1.2982
AED	0.26313E-02	1.2815
YKID	0.99182E-02	2.2203
AG1117	-0.19965E-02	-0.46727
CONSTANT	0.10482E-01	0.49607
Dependent Variable: Dessert Expenditure Share		
PTEX	0.33414E-05	0.34880
FMSZ	-0.97924E-03	-0.65654
AED	-0.29585E-03	-0.24868
YKID	0.12359E-02	0.44840
AG1117	-0.27166E-02	-1.0816
CONSTANT	0.31944E-01	2.6034
Dependent Variable: Tea Expenditure Share		
PTEX	0.47237E-05	0.44646
FMSZ	-0.36110E-02	-2.2045
AED	-0.37782E-03	-0.30141
AG1117	0.20581E-02	0.77573
CONSTANT	0.37864E-01	2.8528
Dependent Variable: Alcohol Expenditure Share		
PTEX	0.62531E-04	2.9986
FMSZ	0.11751E-02	0.36440
AED	-0.93141E-03	-0.39146
AG1117	0.81711E-03	0.15656
CONSTANT	0.53859E-01	2.0911
Dependent Variable: Cigarette Expenditure Share		
PTEX	0.87033E-04	4.6386
FMSZ	-0.41741E-03	-0.14404
AED	0.87594E-03	0.42711
AG1117	0.31985E-03	0.68212E-01
CONSTANT	0.14307E-01	0.62776

System R-Square = 0.8271
Chi-Square (df) = 167.49 (46)

Table A.2

Nutrient Conversion Coefficients (per 500 kg)	Protein	Calorie
Wheat flour	49.5	1770
Rice	41	1755
Corn	42	1765
Pork (with lean meat and fat)	47.5	2900
Beef and mutton (average)	78	1150
Fowl	36.6	189
Eggs	62.5	723
Milk	16	345
Seafood	55.8	354
Soybean product	37	300
Vegetables	3	50
Fruits	--	180
Dessert	35	2000
Sugar and candy	--	1790
Lard	--	2227
Vegetable and oil	--	2250
Tea	--	1705
Beer	--	190
Liquor	--	1870

There is no information on expenditure for milk, seafood, vegetable oil and lard. We assume that these items have the same expenditure propensity as pork.

Table A.3
Definition of Independent Variables

LPINC	Log of per capita income
LPINC2	Square of LPINC
FMSZ	Number of family members
YKID	Number of children under 7
AG1117	Number of children between 7 and 17
HSIMR	Inverse Mills Ratio for housing expenditure
AGE17	Number of children between 15 and 17
AED	Average years of schooling for family laborers
DRIMR	Inverse Mills Ratio for consumer durable expenditures
PTEX	Per-capita food expenditure
FLIMR	Inverse Mills Ratio for fowl expenditure
BFIMR	Inverse Mills Ratio for beef expenditure