Household Demand in Rural China: A Two-Stage LES-AIDS Model

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A complete demand system of Chinese rural households is estimated using a two-stage LES-AIDS model and pooled provincial and time-series data from 1982 to 1990. For commodity groups (food, clothing, fuel, housing, and other commodities), demand is price-inelastic. Housing and other commodities are luxury goods, while clothing and food are necessities. Within the food group, price elasticities range from −0.005 to −0.63. Expenditure elasticities are lower for grains and higher for meat, tobacco, and alcohol. The results imply a gap between food demand and supply growth. Therefore, China will face pressure to import food.

Key words: AIDS model, Chinese rural households, household demand, LES model, two-stage budgeting

China's rural reforms, initiated in 1978, have had significant effects on agricultural production and productivity as well as rural household demand in China. While much has been written on the production and productivity effects of these reforms, very few studies have analyzed rural household consumption behavior.[1] China has 23% of the world's population, with more than 70% rural residents. Although international trade is controlled by the government, China is a large player in international agricultural markets. China recently (1993) accounts for 14% of the world wheat imports, 5% of world rice exports, and 3% of world livestock trade. China is currently negotiating with GATT to obtain membership. One condition for re-entry is elimination of government interventions in international trade. China's GATT membership is expected to lead to greater integration in international markets.

These changes have important implications for U.S. agriculture. Major U.S. commodities (including coarse grains, wheat, and rice) have experienced sharp declines in export shares. China also trades these commodities in international markets. Increased U.S. exports may come from income and population growth in the developing and newly industrialized countries in East Asia. Income growth will bring dramatic changes in economic structure and consumption patterns. These changes will, in turn, affect trade patterns (Fan, Wailes, and Cramer). As per-capita income in China continues to increase, consumption patterns will change. China is expected to increase either meat imports or feed grain imports in order to increase animal production. If China joins GATT, trade barriers will need to be eliminated, and market access will increase. Therefore, accurate estimates of demand elasticities for trade impact analysis are needed.

Recent studies on Chinese household consumption (including rural households) have been either undertaken or supported by the World Bank. Linear expenditure systems were used to estimate consumption patterns for rural households in Hubei province and urban households in Beijing for 1981 and 1982 (Van der Gaag). Lewis and Andrews also employed a linear expenditure system to estimate urban and rural household demand. The small number of observations available for these studies limits the applicability of the results. This study differs from previous studies in that we use provincial aggregate time-series data from rural household surveys for a longer time period, 1982 to 1990. These data come from the General Organization for Rural Household Survey

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The authors thank the State Statistical Bureau of China and Mr Tian Weiming for providing part of the data for this study. They are also grateful to Vernon Ruttan, Philip Pardy, Xiaoming Gao, Shangnan Shui, and Ken Young for their valuable comments on an earlier draft version of this paper.

[1] For more details on production and productivity effects of the Chinese rural reforms, see Lin and Fan. For information on Chinese rural food consumption, see Fan, Cramer, and Wailes.

Amer. J. Agr. Econ. 77 (February 1995): 54–62

of the State Statistical Bureau. Also, we use a two-stage budgeting system to estimate demand for food, clothing, housing, fuel, and other commodities in the first stage, and to estimate demand by individual commodities within the food group in the second stage. This second stage analysis is important because food accounts for more than 50% of total expenses by rural households

Economic Reforms and Changes of Consumption Patterns

Rural reforms, such as the introduction of the household production responsibility system and declining government grain procurement, have resulted in substantial income and price changes. Consequently, consumption patterns may have changed.

Income Growth

Prior to 1979, production and distribution of almost all of China's agricultural commodities were governed by rigid central planning: all production and marketing decisions were made by the collectives under the commune system. Compulsory delivery quotas for most agricultural products were set at prices well below market. Production incentives were low, thus constraining agricultural productivity. The average per-capita income growth in real terms was only 2.4% per annum from 1957 to 1978. However, since the household production responsibility was adopted in 1978, decision making has shifted to the individual farm household, agricultural production has increased significantly (farmers have more incentives to work), and resources have been allocated more efficiently in response to market demand. The rural sector has changed from a subsistence to a more market-oriented economy. As a result, rural incomes have increased rapidly. From 1978 to 1990, real per-capita income grew at 7.1% per annum. The reforms brought substantial increases in living standards and dramatic changes in consumption patterns for the rural population.

Price Changes

Consumer prices have also changed significantly in response to the reform. Prior to the reform, prices were set by the government, and free market transactions were limited. Since the reform, the government has gradually removed barriers to markets and prices, and has relied more on markets to determine prices. Thus, prices are more competitively determined. Since the reforms began, food prices have increased most rapidly among all consumption goods at an annual rate of 8.1%, while clothing prices have increased least at 3.3% per year. Fuel and other commodity prices have increased 5.5% and 3.9% per annum, respectively.

Consumption Patterns

The proportion of food expenditures to total expenditures declined from 65.9% in 1957 to 54.9% in 1990 (table 1). There was only a small decline during the prereform period (1957–79); after the reform, the food expenditure share declined sharply, almost 7% during the 1980s. This pattern of a smaller proportion of expenditures for food as income increases is consistent with Engel's law. The proportion of clothing expenditures to total expenditures also declined from 13.4% to 8.4% during this same period. Although it declined only 1% during the prereform period, this proportion dropped almost 4% in the last decade. Fuel expenditures declined from 10% in 1957 to 4.5% in 1990. The most drastic change in the consumption pattern of rural households was the increase in housing expenditures. In 1990, Chinese farmers spent almost 13% of total expenditures on construction of new houses, or improvement of existing living conditions, compared to only 2% in 1957. Other expenditures (see note to table 1) also increased from 8.6% of total expenditures in 1957 to 11.9% in 1990.

Fine grain consumption in rural China increased marginally from 1957 to 1978 (table 2).[2] Consumption increased significantly from 1978 to 1982, but consumption growth slowed after 1983. Coarse grain consumption increased slightly from 1957 to 1978, but it declined substantially from 1978 to 1985, and thereafter became stable.[3] Among fine grain products, rice changed very little, while wheat consumption increased more than 20 kilograms per person. Over the period 1978 to 1990, per-capita meat consumption almost doubled, vegetable consumption changed very little, and alcohol con-

[2] Fine grains include rice and wheat

[3] Coarse grains include corn, sorghum, millet, sweet potatoes, oats, soybeans, and other miscellaneous beans

Table 1. Annual Per Capita Income and Expenditures: China's Rural Households

Year	Total Income	Total Expenditures	Food	Clothing	Fuel	Housing	Other
	Yuan	Yuan	Yuan	Yuan	Yuan	Yuan	Yuan
1957	72.95	70.86	46.70	9.50	7.09	1.49	6.09
1965	n.a.	95.11	65.15	9.99	7 89	2.66	9.42
1978	133.57	116.06	78.57	14 74	8 24	3.71	10.79
1980	191.33	162.21	100.19	19.99	9.66	12.80	19 57
1985	397.60	317.42	183.33	30 70	18.16	38.66	46.57
1990	629.79	538.05	295.16	45.06	24.37	69.23	104.23
			Proportion of Expenditures (%)				
1957		100.00	65.90	13.40	10.00	2.10	8.60
1965		100.00	68.50	10.50	8.30	2.80	9.90
1978		100.00	67 70	12.70	7.10	3.20	9.30
1980		100.00	61.77	12.32	5.96	7.89	12.06
1985		100.00	57.76	9.67	5.72	12.18	14.67
1990		100.00	54.86	8.37	4.53	12.87	19.32

Sources. State Statistical Bureau, *China's Statistical Yearbooks* (various issues), and Editorial Committee of China's Agricultural Yearbook, *China's Agricultural Yearbooks* (various issues)
Note Total income and expenditures are reported in nominal terms The consumer price index (1957 = 100) in 1990 is 232 6 Other expenses include expenditures on daily used articles (soaps, detergent, etc), consumer durable goods (bicycles, washing machines, sewing machines, watches, clocks, electrical fans, refrigerators, motorcycles, sofas, dressers, and desks) and culturally related goods (radios, TV sets, recorders, cameras, newspapers, etc)

Table 2. Annual Per-Capita Food Consumption in Rural China

Year	Total Grain kg	Fine Grain kg	Rice kg	Wheat kg	Coarse Grains kg	Meat kg	Vegetables kg	Alcohol kg	Tobacco packs
1957	227.00	110.06	-	-	116.94	-	-	-	-
1965	226.50	113.00	-	-	113.50	-	-	-	-
1978	248.00	122.50	-	-	125 50	5.76	141.50	1.22	-
1980	257.00	163.00	-	-	94.00	7.75	127.00	1.89	-
1982	260.00	191.84	132.82	59 02	68.16	9.06	132.04	2.73	18.87
1985	257.00	209.00	135.67	73 16	48.00	10.97	131.13	4.37	23.72
1990	262 00	215.00	134.99	80.03	47.00	11.34	134.00	6.14	27.98

Source *China's Statistical Yearbooks* (various issues), *China's Agricultural Yearbooks* (various issues)
Note Rice is measured in paddy-rice terms

sumption increased four-fold. From 1982 to 1990 tobacco purchases increased 50%.

A Two-Stage LES-AIDS Model

When estimating a complete system of demand equations, a common problem is that there are too many variables relative to the number of observations available for estimation. One solution to this problem is the two-stage budgeting procedure. This procedure assumes that the consumer's utility maximization decision can be decomposed into two separate steps. In the first stage, total expenditure is allocated over broad groups of goods. In the second stage, group expenditures are allocated over individual commodities.

Weak separability of the direct utility function over broad groups of goods is both a necessary and sufficient condition for estimating the second stage of the two-stage budgeting procedure. Given a weakly separable utility function in a partition of commodities into N groups ($N > 2$), price aggregation is possible if and only if the direct utility function is strongly separable into generalized Gorman polar forms, homothetically separable forms, or a combina-

tion of the two forms (Gorman). Homothetically separable utility functions are generally considered undesirable for empirical demand analysis (Deaton). Hence, we choose a strongly separable function of indirect utility functions, with each group function corresponding to a specific group of commodities, and with each group function taking the generalized Gorman polar form.

The functional form chosen for the first stage is a linear expenditures system (LES). The advantage of the LES is that it is simple and it provides an intuitive economic interpretation, despite its strong separability assumption. The separability assumption is not overly restrictive for such commodities as food, housing, or clothing (Timmer and Alderman). The LES functional form is

$$(1) \quad P_I Q_I = P_I R_I + B_I(E - \sum_J P_J R_J)$$

where $P_I Q_I$ (P_I and Q_I are aggregated price and quantity indices for commodities within group I) is expenditure allocated to group I, E is household total expenditure, and R_I and B_I are parameters to be estimated. This expenditure function can be interpreted as follows. First, the consumer purchases the minimum required quantities of each commodity group, R_I, costing $P_I R_I$. The consumer then distributes the remaining expenditures ($E - \sum P_I R_I$) over all commodities in fixed proportions, B_I (the marginal budget share of commodity group I). Hence, $P_I R_I$ and ($E - \sum P_J R_J$) can be interpreted as subsistence and supernumerary expenditures, respectively.

The uncompensated own- and cross-price elasticities associated with equation (1) are

$$(2) \quad \eta_{II} = (1 - B_I)P_I R_I/(P_I Q_I) - 1$$

and

$$(3) \quad \eta_{IJ} = -B_I(P_J R_J)/(P_I Q_I).$$

The expenditure elasticities are

$$(4) \quad \varepsilon_I = B_I E/(P_I Q_I).$$

The Almost Ideal Demand System (AIDS), developed by Deaton and Muellbauer, is used for second-stage demand estimation. The AIDS model satisfies the axioms of choice exactly, allows consistent aggregation of individual demands to market demands, and does not impose additive preferences. The model has been applied to both aggregate- and micro-level data. The share equation for the AIDS model is

$$(5) \quad w_{i,I} = \alpha_{i,I} + \sum_{j,I} \gamma_{ij,I} \log p_{j,I} + \beta_{i,I} \log \frac{E_I}{P_I}$$

where $w_{i,I}$ is the budget share of good i in commodity group I, $p_{j,I}$ is the price of commodity j in group I, E_I is the ith group's total expenditure, and P_I is the Ith group price index

$$(6) \quad \log P_I = \alpha_{0,I} + \sum_{i,I} \alpha_{i,I} \log p_{i,I} + 1/2 \sum_{i,I} \sum_{j,I} \gamma_{ij,I} \log p_{i,I} \log p_{j,I}$$

with the following restrictions:

$$(7) \quad \sum_{i,I} \alpha_{i,I} = 1, \sum_{i,I} \beta_{i,I} = 0, \quad \sum_{i,I} \gamma_{ij,I} = 0 \text{ (adding up)}$$

$$(8) \quad \sum_{i,I} \gamma_{ij,I} = 0 \text{ (homogeneity)}; \quad \gamma_{ij,I} = \gamma_{ji,I} \text{ (symmetry)}.$$

Following Blanciforti, Green, and King, conditional uncompensated price elasticity of commodity i with respect to commodity j's price, in the same group for the AIDS model, is

$$(9) \quad \eta_{ij,I} = \delta_{ij,I} + \frac{\gamma_{ij,I}}{w_{i,I}} - \frac{\beta_{i,I}\alpha_{i,I}}{w_{i,I}} - \frac{\beta_{i,I}}{w_{i,I}} \sum_{j,I} \gamma_{ij,I} \ln p_{j,I}$$

where $\delta_{ij,I} = -1$ if $i = j$, and $\delta_{ij,I} = 0$ otherwise. The conditional expenditure elasticity is

$$(10) \quad \varepsilon_{i,I} = 1 + \frac{\beta_{i,I}}{w_{i,I}}.$$

Unconditional price elasticities within the same group and unconditional expenditure elasticities can be calculated as

$$(11) \quad \eta_{ij} = \eta_{ij,I} + \varepsilon_{i,I} w_{j,I}(1 + \eta_{II})$$

and

$$(12) \quad \varepsilon_i = \varepsilon_{i,I}\varepsilon_I$$

Derivation of the unconditional elasticities is provided in the appendix.

Data Sources and Explanations

Income, expenditure, and consumption data come from rural household sample surveys conducted by the General Organization for Rural Household Surveys of the State Statistical Bureau. The surveys were started in 1955, but were suspended during the Cultural Revolution; they were continued in 1978. In 1982, China began to publish provincial aggregate per-capita data based on these surveys. Since then, the number of rural households surveyed has increased each year; the 1990 sample includes 66,960 households. Twenty-eight provinces (autonomous regions or municipalities) were included in the analysis. However, two provinces (autonomous regions), Tibet and Hainan, were excluded due to unavailable data.

The analysis uses pooled time-series and cross-section data (provincial cell means) for rural China, covering the period 1982 to 1990. Ideally, the analysis should include years before 1982; however, as a practical matter, beginning the analysis with 1982 is acceptable because most rural price and marketing reforms were undertaken after 1982. In fact, the production responsibility system was not fully implemented until 1983. The percentage of production teams adopting the household responsibility system was 14% in 1980, 45% in 1981, 80% in 1982, and 98% in 1983 (Lin). Effects of the system were not fully realized until 1984. According to Fan, production efficiency effects of the reforms occurred over a six-year period (0.753 in 1980, 0.768 in 1982, 0.791 in 1983, 0.831 in 1984, and 0.843 in 1985). Not until after 1984 and 1985 were efficiency gains significant.

Expenditure data for commodity groups (food, clothing, housing, and fuel) come from rural household survey data collected by province from 1982 to 1990. Provincial price indices for these groups come from *China's Commodity Price Statistical Yearbooks* from 1986 to 1990. The provincial data were not available before 1986; therefore, national price indices for clothing, fuel, housing, and other commodity groups were used for each province. This was not expected to cause serious problems because state-controlled prices did not vary much across regions before 1986.[4]

Provincial food group price indexes before 1986 were calculated by the authors. Food consumption data (including items produced by the household) were available for individual items including rice, wheat, coarse grains, meat (including pork, beef, and mutton), vegetables, fruits, tea, sugar, alcohol, fish, cooking oil, and tobacco. Price data, collected from rural markets and trade posts in various provinces, came from various issues of *China's Commodity Price Statistical Yearbooks* (State Statistical Bureau) and *China's Price Yearbooks* (Ministry of Commerce). Expenditures on these items were derived from the consumption and price data.

For this analysis, aggregated cell means of the provincial households were used rather than individual household observations. Aggregation bias can occur with group data. However, for China, regional differences in tastes are larger than differences in household preferences within the same region. For example, people consume more rice in the southern provinces, while people consume more wheat in the north. Subsistence quantities of the LES [R_I, equation (1)] account for effects of social and demographic characteristics (Pollak and Wales), while the intercepts of the AIDS model [$\alpha_{i,I}$, equation (5)] account for these characteristics (Ray). Demographic effects on consumption are not the focus of this study, therefore the R_I's in the first stage and $\alpha_{i,I}$'s in the second stage are modeled as fixed effects to capture regional differences in household demand.

Estimation and Calculation of Demand Elasticities

There are five commodity groups for the first stage of the demand system: food, clothing, fuel, housing, and other commodities. The second stage consists of eight commodities within the food group: rice, wheat, coarse grains, meat, vegetables, alcohol, tobacco, and other

[4] We conducted a simple test using both national aggregate price index and individual provincial price index for 1986, when both national and provincial price indices were available. We found that the switching of price index affects parameters of clothing, fuel, and housing to some extent, and food parameters very little. But, by a Chi-square test, we fail to reject at the 10% significance level, that parameters from the two models are the same.

Table 3. Estimated Parameters and Elasticities for Commodity Groups

	Parameters		Elasticities	
	B_i	R_i	Price	Expenditure
Food	0.409 (51.22)	1.324 (30.69)	−0.526	0.707
Clothing	0.070 (19.37)	0.304 (28.19)	−0.248	0.694
Fuel	0.009 (3.69)	0.110 (25.97)	−0.269	0.216
Housing	0.323 (49.24)	0.182 (6.44)	−0.611	2.170
Other	0.189[a]	0.208 (16.15)	−0.650	1.444

Note: The estimates of fixed coefficients are not reported. Numbers in parentheses are t values.
[a] This coefficient is derived from the adding-up condition of demand parameters.

Table 4. Parameter Estimates of Food Items

	Parameters							
Commodity i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	β_i
Rice	0.052							−0.071
	(2.73)							(−2.02)
Wheat	−0.025	0.073						0.019
	(−2.11)	(5.09)						(1.74)
Coarse grains	0.024	−0.001	0.084					−0.081
	(1.32)	(−0.73)	(3.23)					(−2.20)
Meat	−0.010	−0.010	−0.062	0.079				0.034
	(−2.19)	(−1.26)	(−5.85)	(7.10)				(1.95)
Vegetables	−0.025	−0.008	−0.042	0.002	0.074			−0.007
	(3.93)	(−1.21)	(−4.80)	(0.17)	(7.97)			(−1.48)
Alcohol	−0.010	−0.019	0.012	0.001	−0.000	0.026		0.027
	(2.33)	(4.41)	(1.81)	(1.26)	(0.33)	(3.670)		(3.03)
Tobacco	−0.006	−0.011	−0.015	−0.000	0.000	−0.010	0.041	0.016
	(−1.84)	(3.09)	(−2.82)	(−0.16)	(0.77)	(−1.89)	(8.48)	(2.12)

Note: Fixed effects are not reported. Numbers in parentheses are t values.

food items. In estimation of the first-stage demands, the linear expenditure system is estimated in shares because this specification is less likely to involve heteroskedasticity than expenditures (Pollak and Wales). Use of a fixed effects model also helps to mitigate the effects of heteroskedasticity. The linear expenditure system, equation (1), was estimated by the nonlinear seemingly unrelated regression method using Shazam version 7.0. Tests for heteroskedasticity and the first-order autocorrelation were conducted using Lagrange multiplier tests, and we reject, at the 5% significance level, that these two effects are present.

The results for the first-stage commodity groups are presented in table 3. All parameters are significant at the 1% level. Own-price elasticities for food, housing, and other commodity groups are similar and range from −0.53 for the food group to −0.65 for the other commodity group. (Cross-price elasticities are not reported because the focus is on items within the food group in the second stage.) Demands are less price elastic for clothing and fuel than for the other three groups. Expenditure elasticities for food, clothing, and fuel are all less than one; therefore, these groups can be classified as necessities, while housing and other commodity groups can be classified as luxuries.

Estimated parameters for commodities within the food group are presented in table 4. A two-way fixed effects model (time effects and provincial effects) is estimated to correct for heteroskedasticity and to capture regional effects. The nonlinear second-stage system was estimated using an iterative procedure (Browning and Meghir). In the first step, the Stone price index ($\ln P_t = \sum w_{it} \log p_{it}$) was used to estimate

Table 5. Estimated Price and Expenditure Elasticities Within the Food Group

	Rice	Wheat	Coarse Grains	Meat	Vegetables	Alcohol	Tobacco
Conditional Price Elasticities							
Rice	−0.709	0.043	0.139	0.004	−0.071	−0.030	0.014
Wheat	0.121	−0.641	−0.006	0.048	−0.037	−0.094	0.052
Coarse grains	0.259	0.036	−0.263	0.048	−0.030	0.072	0.122
Meat	0 112	0 257	0.005	−0.384	0.002	−0.014	0.015
Vegetables	−0.005	0.065	−0.015	0.013	−0.409	0.002	0.004
Alcohol	−0.168	0.046	0.594	0.279	−0.005	−0.373	−0.217
Tobacco	−0.069	0.079	−0 210	0.003	0.157	−0.192	−0.019
Conditional Expenditure Elasticities							
	0.702	1.092	0.371	1.271	0.946	1.644	1.364
Unconditional Price Elasticities							
Rice	−0.629	0.166	0.181	0.148	0.036	0.156	0.168
Wheat	0.189	−0.536	0 030	0.171	0.054	0.065	0.184
Coarse grains	0.302	0.102	−0.240	0.126	0.028	0.172	0.205
Meat	0.154	0.321	0.027	−0.309	0.058	0.083	0.095
Vegetables	0.035	0.127	0.006	0.086	−0.355	0.096	0 081
Alcohol	−0.154	0.067	0.602	0.304	0.013	−0.340	−0.190
Tobacco	−0.055	0.101	−0.202	0.029	0.176	−0.158	−0.005
Unconditional Expenditure Elasticities							
	0.496	0.771	0.263	0 898	0 668	1.162	0.964

Note The elasticities of other food items are not derived because their shares are minimal They are calculated using the sample means

the parameters of equation (5) with homogeneity and symmetry restrictions imposed (the other food demand equation was dropped from the system) using the SUR technique. Next, a new price index was computed using the estimated parameters and equation (6), and the system was reestimated using the new price index. The steps were repeated until the parameters converged. Again, the null hypothesis of no heteroskedasticity and first-order autocorrelation are tested and not rejected at the 5% significance level.

Except for a few cross-price parameters, most of the price coefficients are significant at the 5% level. All expenditure parameters, except for vegetables, are significant at the 5% level. Price and expenditure elasticities for both conditional and unconditional elasticities are presented in table 5. Focusing on the unconditional demand elasticities, the own-price elasticities for grains vary from −0.63 for rice to −0.24 for coarse grains. The wheat own-price elasticity is slightly smaller than that of rice. Nonstaple foods, including meat, vegetables, and alcohol, have similar own-price elasticities in the range of −0.31 to −0.36. The own-price elasticity for tobacco is almost zero. Most of the cross-price elasticities within the food group have positive signs, implying that major food items are substitutes. Rice is a complement with tobacco and alcohol, as shown by the negative cross-price elasticities.

The estimates of expenditure elasticities for the commodities in the food group indicate that most of the commodities within the food group are necessary goods. Coarse grains have the lowest expenditure elasticities, but they are still in the normal good range. The expenditure elasticity for wheat is much larger than that for rice. Alcohol is the only luxury good among food items. Both meat and tobacco have expenditure elasticities that are near unitary.

Few studies report income (expenditure) and price elasticities for Chinese rural households. We compare our estimates to those of Lewis and Andrews. Our expenditure elasticities for

food, clothing, and other commodity groups are higher than those of Lewis and Andrews (0.69 for food, 0.61 for clothing, and 1.29 for daily articles and cultural activities); however, our expenditure elasticity for housing is lower than Lewis and Andrews' estimate of 2.95. Within the food group, our estimates for price elasticities are much higher (their estimates for grain, pork, poultry, and fish are –0.14, -0.23 –0.09, and –0.69, respectively). Our expenditure elasticity for grain is higher than their estimate of 0.22, while the expenditure elasticity of meat is lower than Lewis and Andrews' estimate of 1.02 for pork and 1.95 for poultry.

Lewis and Andrews' study only covered the period 1982 to 1985, the period when market reforms had just started. Our higher price elasticities may be partly explained since this study covers a much longer time period, and because price adjustments and marketing mechanisms have been recently improved. Farmers may have become more responsive to the price changes.

Conclusions and Policy Implications

A two-stage LES-AIDS budgeting system was used to estimate demand parameters for Chinese rural households with special emphasis on the food commodity group. For most commodity groups, demand is price inelastic. Most food items have elasticities ranging from -0.005 to –0.63. Housing and "other commodities" are luxury goods. Although it is less than one, the food expenditure elasticity is still high at 0.70.

Real income has grown at 4% per annum from 1957 to 1990, and it is projected to continue growing at even a higher rate; therefore, assuming 1.2% population growth rate per annum, total demand for food in rural China is also projected to continue growing at more than 4% a year.[5] In the last forty years, 1950–90, food production grew 3.9% per year (3.2% for grain, 6.3% for meat, and 8.6% for aquatic products). If Chinese food production continues to grow at its current rate, there will be a 0.1% gap between demand growth and supply growth. This means China will face increasing pressure to import food.

Based on our parameter estimates, total grain demand will continue to grow at a rate of 3.3% per year.[6] The estimated rice income elasticity is relatively low, while the wheat income elasticity is relatively high. Even with adjustments in production patterns, China is likely to continue to import wheat and export rice to take advantage of international markets. Food consumption of coarse grains, with an income elasticity of 0.26, will continue to decline; however, these grains will be used increasingly as feed grain. With the meat expenditure elasticity at 0.9, China's demand for meat will increase at a high rate (perhaps as high as 4.8% per annum); consequently, the demand for feed grains will also rise. Given limited arable land, China can be expected to import increased quantities of feed grains from international markets, while using its relatively cheap labor for developing its livestock industry.

[Received May 1993; final revision received August 1994.]

References

Alderman, H. "The Effects of Food Price and Income Changes on the Acquisition of Food by Low-Income Households." Washington DC: International Food Policy Research Institute, 1986.

Blanciforti, L., R. Green, and G. King. "U.S. Consumer Behavior Over the Postwar Period. An Almost Ideal Demand System Analysis." University of California-Davis Giannini Foundation Monograph No. 40, August 1986.

Browning, M., and C. Meghir. "The Effects of Male and Female Labor Supply on Commodity Demands." *Econometrica* 59(July 1991):925–51.

Deaton, A.S., and J. Muellbauer. "An Almost Ideal Demand System." *Amer. Econ. Rev.* 70(June 1980):321–26.

Fan, S. "Effects of Institutional Reform and Technological Change on Production Growth in Chinese Agriculture." *Amer. J. Agr. Econ.* 73(May 1991):266–75.

Fan, S., E.J. Wailes, and G.L. Cramer. "Impact of Eliminating Government Interventions on China's Rice Sector." *Agr. Econ.*, 11(September 1994):71–81.

Fan, S., G.L. Cramer, and E.J. Wailes. "Food Demand in Rural China: Evidence from Rural

[5] This is calculated as 1.2% (population growth rate per annum) + 4% (per capita income growth per annum) * 0.70 (income elasticity).

[6] The calculation is similar to the one in footnote 5. The income elasticity of grains is a weighted average of the elasticities for rice, wheat, and coarse grains.

Household Survey." *Agr. Econ.*, 11(September 1994):61–9

Gorman, W.G. "Separable Utility and Aggregation." *Econometrica* 27(July 1958):469–88.

Lewis, P., and N. Andrews. "Household Demand in China." *Appl. Econ.* 21(June 1989):793–807.

Lin, J.Y. "The Household Responsibility System in China's Economic Reform: A Theoretical and Empirical Study." *Econ. Develop. and Cultur. Change* 36(April 1988):S199–224.

Pollak, R., and T. Wales. "Estimation of Complete Demand Systems from Household Budget Data: The Liner and Quadratic Expenditure Systems " *Amer. Econ. Rev.* 68(June 1978):348–59.

Ray, R. "The Testing and Estimation of Complete Demand Systems on Household Budget Surveys: An Application of AIDS." *Eur. Econ. Rev.* 17(March 1982):349–69.

Timmer, P., and H. Alderman. "Estimating Consumption Parameters for Food Policy Analysis." *Amer. J. Agr. Econ.* 61(December 1979):982–87

Van der Gaag, J. *Private Household Consumption in China: A Study of People's Livelihood.* Washington DC: World Bank Staff Working Paper No. 701, 1984.

Appendix

The assumption of weak separability between commodities in the different commodity groups implies that the effects of the price change in one commodity group are captured through the group expenditures.

Derivation of the Unconditional Expenditure and Price Elasticities

1. Unconditional Expenditure Elasticity

$$(A1)\quad \varepsilon_i = \frac{\partial q_i}{\partial E}\frac{E}{q_i} = \frac{\partial q_i}{\partial E_i}\frac{E_i}{q_i}\frac{\partial E_i}{\partial E}\frac{E}{E_i} = \varepsilon_{i,I}\varepsilon_I.$$

2. Unconditional Price Elasticity

Here we consider only the two commodities in the same group

$$(A2)\quad \eta_{ij} = \frac{\partial q_i^*}{\partial p_j}\frac{p_j}{q_i^*} = \frac{\partial q_i}{\partial p_j}\frac{p_j}{q_i} + \frac{\partial q_i}{\partial E_I}\frac{E_I}{q_i}\frac{\partial E_I}{\partial p_j}\frac{p_j}{E_I}$$

where q_i^* is unconditional demand for commodity i.

Since $E_I = P_I Q_I$

$$(A3)\quad \frac{\partial E_i}{\partial p_j}\frac{P_j}{E_i} = \frac{\partial P_i}{\partial p_j}\frac{p_j}{P_i} + \frac{\partial Q_i}{\partial P_i}\frac{P_i}{Q_i}\frac{\partial P_i}{\partial p_j}\frac{p_j}{P_i}.$$

The true cost-of-living index is proportional to the cost function, and since the derivative $(\partial c/\partial p)(p/c)$ equals the relevant budget share, we can write $(\partial P_I/\partial p_j)(p_j/P_I) = W_{j,I}$. Therefore

$$(A4)\quad \eta_{ij} = \eta_{ij,I} + \varepsilon_{i,I}(w_{j,I} + \eta_{II}w_{j,I}).$$