Journal of Agricultural and Resource Economics 35(1):51–71

The Impact of Changes in Income Distribution on Current and Future Food Demand in Urban China

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The impact of changes in income distribution on food demand in the urban Jiangsu province of China is estimated in this study. Findings suggest that changes in income distribution have a considerable impact on the demand for individual food commodity groups. Therefore, given that a significant change in income distribution has occurred in urban China, food demand projections should account for expected changes in future income distribution.

Key words: China food demand, income distribution, urban income inequality

Introduction

China has had one of the most rapidly growing economies in the world since the late 1970s, when its economic reforms were initiated. Per capita gross domestic product (GDP) in China has grown at an average annual rate of 9%–10% in the past two decades; consequently, the living standards of the Chinese people as a whole have improved considerably. However, this rapid economic growth has been accompanied by a significant rise in income inequality. According to the World Bank, the Gini coefficient (the most commonly used measure of income inequality) has increased in China from 0.26 in 1984 to 0.38 in 1992, and to 0.47 in 2004. These figures are substantially above those given for other Asian countries (0.32–0.37), and are approaching the very high values recorded for some Latin American countries (0.50–0.57).

Although the high Gini coefficient for China has been attributed partly to the rural-urban income gap, it is widely acknowledged that income inequality in China has been widening within both intra-rural and intra-urban households during the past two decades (Chang, 2002; Fang, Zhang, and Fan, 2002; Khan and Riskin, 2005; Meng, Gregory, and Wang, 2005; Sicular, Yue, and Gustafsson, 2007). More specifically, in terms of the distribution of disposable income among rural families, the share of the bottom 20% of households has decreased from 7.4% in 1995 to 6.3% in 2004, whereas the share of the top 20% of households has increased from 41.7% in 1995 to 43.5% in 2004 [China's National Bureau of Statistics (NBS), 1996–2005a]. A similar trend has occurred in the distribution of disposable

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Review coordinated by Gary W. Brester.

income among urban households. The share of the bottom 20% of households has declined from 12.6% in 1995 to 8.6% in 2004, the share of the top 20% of households has risen from 29.8% to 38.2%, and that of the top 10% has risen from 17.3% to 24.1% (NBS, 1996–2005b). As shown by these trends, economic growth in China has generally favored the wealthier members of society.

The increase in income inequality may jeopardize China's social stability. While a significant amount of research in China has been devoted to analyzing the trends and causes of income inequality and the relationship between economic growth and income inequality, much less attention has been paid to studying the potential impact of changes in income distribution on food demand.

In general, income elasticities of food demand tend to be inversely correlated with income levels (Pinstrup-Andersen and Caicedo, 1978). Hence, a shift in the structure of income distribution, with more rapid income growth for low (high) income strata than for high (low), would generally lead to a greater increase (decrease) in food consumption [Food and Agriculture Organization of the United Nations (FAO), 1972]. However, none of the past studies on food demand projections in China have accounted for changes in income distribution as a factor influencing demand. Studies focusing on changes in population and the level of income in China (see Fan and Agcaoili-Sombilla, 1997) have implicitly assumed a constant income distribution. While the assumption of a constant income distribution may have been appropriate in the 1980s and the early 1990s, it is no longer applicable as China has experienced significant changes in income distribution during the last decade. Therefore, food demand forecasts based on a constant income distribution over time may result in incorrect demand projections for food and agricultural commodities.

The objective of this study is to determine the relationship between food consumption and changes in income distribution. Data from the urban Jiangsu province of China are used to identify this relationship for 10 food commodity groups. To achieve this study's objective, two goals are set. The first is to estimate the response of food demand to income changes across income strata. More specifically, the goal is to provide income elasticities by income strata in order to account for changes in income distribution in urban China. The second goal is to use income elasticity estimates to project food demand under hypothetical changes in incomes and income distribution.

Jiangsu is one of China's major provinces with a population of more than 74 million in 2004, and its gross domestic product accounts for more than 9% of China's national GDP. Jiangsu's urban per capita disposable income ranked seventh among China's 31 provinces in 2004 (NBS, 2005). Similar to urban China as a whole, the income distribution in urban Jiangsu is notably skewed. In 2004, using the NBS aggregate household sample survey data, the Gini coefficient for the entirety of urban China was 0.367, whereas (based on the sample survey data used in this study) the corresponding coefficient for urban Jiangsu province was 0.357.[1] Hence, an understanding of the impact of changes in income distribution

[1] The income inequality in urban China may be less serious than in rural China, as reported by Khan and Riskin (2005). The relatively low income inequality in urban China might be attributed to the fact that income inequality in urban China is measured using annual income instead of monthly income which is used to demonstrate income inequality in other countries (Gibson, Huang, and Rozelle, 2001). Nevertheless, income inequality in urban China does exist and has actually increased rapidly since the mid-1990s when China's government introduced a set of policies on social welfare systems aimed at transferring the responsibility of education, health services, and housing from state-owned enterprises and public institutions to individuals themselves. According to NBS aggregate household survey data, income inequality in urban China has worsened over the past two decades. This is shown by the upward trend of the Gini coefficient, rising from 0.280 in 1995 to 0.351 in 2003, and to 0.367 in 2004.

on food demand in urban Jiangsu is expected to be useful to policy makers and marketing agents interested in China's future consumption needs and patterns.

The remainder of the study is organized as follows. We first provide a review of the literature. The general approach and data used for this study are then described. Next, estimation procedures and the estimated demand elasticities are presented. In the following section, estimated income elasticities are used to predict the impact of changes in income distribution on food demand. Finally, policy and marketing implications are discussed, and concluding remarks are given.

Literature Review

Most of the previous work related to the relationship between food consumption and income redistribution has been conducted prior to the 1980s. This earlier work has found that moving toward a more equitable income distribution is expected to lead to a substantial increase in consumer expenditures for food. An FAO (1972) study estimates the impact of income redistribution on projected food demand for 11 Latin American countries. The study's findings show that a "moderate" shift in the income distribution toward a more equal income distribution would generate an additional food demand in 1980 of 9%–9.5% or 13%–14% under the "drastic" hypothesis.

Saleh and Sisler (1977) estimate the impact of income inequality on the demand for mutton in urban Iran at the time when Iran was experiencing changes in income distribution resulting from a rapid rise in per capita income. They conclude that long-term projections of mutton demand based on average estimates of income elasticities would overestimate future consumption because of failing to consider future deterioration in income distribution. Their study implies that an increase in income inequality would lead to a decrease in total consumer food expenditures.

Pinstrup-Andersen and Caicedo (1978) estimate the potential impact of changes in income distribution on food demand and human nutrition for Cali, Colombia. They conclude that changes in income distribution can effectively improve human nutrition and have a large impact on the demand for individual food commodities. For instance, the demand for cassava would increase by about 0.1% if all five income classes uniformly increased their incomes by 1%. However, if all of the increase in income went to the lowest income stratum, the demand for cassava would increase by more than 1%. "This fact clearly points out the need for including changes in income distribution in demand forecasting if any such changes are expected" (Pinstrup-Andersen and Caicedo, p. 412).

The General Approach

The first goal of this study is to estimate the response of food demand to household income changes by income strata (the income elasticities of demand). This goal is accomplished in three steps. The impact of total food expenditures on the demand for each of the studied foods (food expenditure elasticities) is estimated by income class first (step 1). Then, the impact of household income changes on total studied food expenditures (income elasticities) across income strata is estimated (step 2). In step 3, income elasticities for food groups across income strata are calculated from the food expenditure elasticities for the studied food groups (step 1) and the estimated income elasticities of food expenditure on the studied food groups (step 2).

The quadratic almost ideal demand system (QUAIDS) developed by Banks, Blundell, and Lewbel (1997) is chosen for estimating food expenditure elasticities for individual food groups across income strata (step 1). In addition to having the same degree of price flexibility as the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980) and the translog demand system developed by Christensen, Jorgenson, and Lau (1975), the QUAIDS model has the flexibility to be applied to populations at different income levels. The model's leading terms are linear in logarithmic expenditure while including the empirically necessary rank 3 quadratic term, which provides a sufficiently general approximation to the Engel relationship in the raw micro-data (Banks, Blundell, and Lewbel, 1997). Thus, the QUAIDS specification permits an evaluation of higher-rank Engel curves while at the same time maintaining consistency with assumed utility-maximizing behavior as compared to simpler models such as the AIDS and translog models (Gould and Villarreal, 2006). Because of the features possessed by the QUAIDS specification, the QUAIDS model is used in this study to estimate food expenditure elasticities at different income levels.

The assumption here is that the 10 studied food groups are weakly separable from other food and nonfood items in the consumer's budget. Given this assumption, the QUAIDS model for the studied food groups is given as:

$$(1) \qquad w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j) + \beta_i \ln\left[\frac{x}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 + u_i ,$$

where subscripts i and j indicate goods and n the number of goods in the system; γ_{ij}, β_i, and λ_i are parameters to be estimated; p_j is the price of the jth good in the system; x indicates household expenditure on the goods in the system; u_i is the error term; $a(p)$ is the price index and is defined as:

$$(2) \qquad \ln\big(a(p)\big) = \alpha_0 + \sum_{j}^{n} \alpha_j \ln(p_j) + 0.5 \sum_{i}^{n} \sum_{j}^{n} \gamma_{ij} \ln(p_i) \ln(p_j);$$

$b(p)$ is the Cobb-Douglas price aggregator and is defined as:

$$(3) \qquad b(p) = \prod_{i=1}^{n} p_i^{\beta_i};$$

and

$$(4) \qquad \alpha_i = \rho_{i0} + \sum_{k=1}^{7} \rho_{ik}\, d_k ,$$

where ρ_{i0} and ρ_{ik} are parameters to be estimated, and d_k represents the demographic variables. Here, $k = 1, \ldots, 7$, representing the seven demographic variables considered in this study, including region (south vs. north), city size (towns vs. cities), household size, presence of seniors (aged 65 and above), presence of children (aged 14 and below), educational levels of household heads, and age of household heads.

The expenditure terms $\ln(x)$ and $(\ln(x))^2$ in the QUAIDS specification [equation (1)] might be endogenous (Blundell and Robin, 1999). To test and subsequently correct for the endogeneity of $\ln(x)$ and $(\ln(x))^2$, an augmented regression framework for estimation with endogenous regressors (as suggested by Blundell and Robin) is used here. This procedure involves first estimating a reduced-form equation for $\ln(x) = \mathbf{I}\boldsymbol{\psi} + v$, where $\mathbf{I} = [1, \ln(y), (\ln(y))^2, \ln(\mathbf{p}), \mathbf{d}]$ is composed of a set of explanatory variables [household income, prices of the studied goods, and demographic variables that are the same as those used in equation (4)], and $\boldsymbol{\psi}$ is a vector of parameters. The computed residuals $\hat{v}$ from the regression are then augmented into the model (1) by writing:

$$u_i = \kappa_i \hat{v} + \varepsilon_i \quad (5)$$

and assuming $E(\varepsilon_i \mid \mathbf{I}, v) = 0$.

The properties from neoclassical demand theory can be imposed on model (1) by restricting its parameters. The adding-up restriction is given by:

$$\sum_{i=1}^{n} \rho_{i0} = 1, \quad \sum_{i=1}^{n} \rho_{ik} = 0, \quad \sum_{i=1}^{n} \gamma_{ij} = 0, \quad \sum_{i=1}^{n} \beta_i = 0, \quad \sum_{i=1}^{n} \lambda_i = 0, \quad \text{and} \quad \sum_{i=1}^{n} \kappa_i = 0. \quad (6a)$$

Homogeneity is imposed as:

$$\sum_{j=1}^{n} \gamma_{ij} = 0 \quad \text{for any } j. \quad (6b)$$

Slutsky symmetry is given by:

$$\gamma_{ij} = \gamma_{ji} \quad \text{for any } i \text{ and } j. \quad (6c)$$

The price and expenditure elasticities are calculated from the estimated parameters of the QUAIDS system following Banks, Blundell, and Lewbel (1997). The uncompensated (Marshallian) price elasticities are denoted by:

$$(7) \quad e_{ij} = w_i^{-1} \left\{ \gamma_{ij} - \left(\beta_i + \frac{2\lambda_i}{b(p)} \right) \left[\ln\left(\frac{x}{a(p)} \right) \right] \left(\alpha_j + \sum_{k}^{n} \gamma_{jk} \ln(p_k) \right) - \frac{\lambda_i \beta_j}{b(p)} \left[\ln\left(\frac{x}{a(p)} \right) \right]^2 \right\} - \delta_{ij},$$

where δ_{ij} is the Kronecker delta, which is equal to 1 when $i = j$, otherwise $\delta_{ij} = 0$. The food expenditure elasticities are calculated as:

$$e_i = 1 + w_i^{-1} \left[\beta_i + \frac{2\lambda_i}{b(p)} \ln\left(\frac{x}{a(p)} \right) \right]. \quad (8)$$

Consistent with the QUAIDS estimation (step 1), a quadratic double-log Engel function is specified to estimate the response of food expenditures on the studied food groups to changes in household income across income classes (step 2). As is the case for the QUAIDS specification, the quadratic double-log Engel function can provide income elasticities at various income levels. The Engel function used in this study is represented by:

$$\ln(x) = a_0 + a_1 \ln(y) + a_2 \left[\ln(y) \right]^2. \quad (9)$$

From this function, the income elasticity with respect to food expenditure on the studied food groups is given as:

$$e_y = a_1 + 2a_2 \ln(y). \quad (10)$$

The impact of household incomes on food demand (step 3) is then calculated as the product of the expenditure elasticities of demand and the income elasticity of food expenditure, i.e.:

$$E_{y,i} = e_i e_y , \tag{11}$$

where $E_{y,i}$ denotes income elasticity of demand for the ith food group, e_i is the food expenditure elasticity of demand for the ith food group (calculated from step 1, above), and e_y represents income elasticity of demand for food expenditure on the studied food groups (calculated from step 2, above). This approach for calculating income elasticities has been commonly used in the literature (Park et al., 1996). Note that income elasticities across income strata in this study are computed with equations (8), (10), and (11).

The second goal of this study is to use the calculated income elasticities from equation (11) to project the demand for individual food groups resulting from hypothetical changes in incomes and income distribution. Several assumptions are made to perform these projections. First, preferences are assumed to be constant for each of the income strata. Second, relative prices are held constant for each income stratum. Third, population size is assumed to be unchanged. Specifically, the effects associated with population migration from rural to urban areas on the demand for food in China are not accounted for. Finally, market development effects on food consumption in China are not considered.[2] Therefore, changes in the quantity consumed of each of the studied food groups are virtually assumed to be brought about only by changes in incomes and income distribution. As a result, the change in total quantity consumed of food group i in income stratum m, due to income changes in that stratum at constant prices, is given by:

$$\Delta Q_{i(m)} = \left(\frac{\Delta y}{y}\right)_m E_{y,i(m)} q^0_{i(m)} N_m , \tag{12}$$

where $\Delta Q_{i(m)}$ denotes the change in total quantity consumed of food group i for households in stratum m due to changes in incomes in that stratum; $(\Delta y/y)_m$ is the change in income in stratum m; $E_{y,i(m)}$ is the income elasticity of demand for food group i in stratum m; $q^0_{i(m)}$ is the current average quantity consumed of food group i for each household in stratum m; and N_m is the total number of households in stratum m.

Source of Data

The data set used for this study was collected by China's National Bureau of Statistics for Jiangsu province in 2004. The NBS conducts a nationwide urban household survey annually. As an official statistical activity, the urban household survey collects extensive socioeconomic information on income, consumption, employment, housing, demographics, education, and asset ownership. Since 2002, the survey sample has included households registered in an urban area and those who have lived there for at least six months but are registered elsewhere, which means the survey includes both permanent urban households and migrants from rural areas. This change in survey population inclusion makes the current survey data more representative of all income classes than those collected prior to 2002. The survey data are compiled from diaries of incomes and expenditures kept by the participating households over the course of a 12-month period. Thus, the data set used for this study reflects actual consumption patterns of the surveyed households during an entire year.

[2] The changes in tastes and lifestyles generated by urban living are likely to have significant effects on food consumption. Thus, migration of population from rural to urban areas in China is expected to have a considerable impact on the demand for food (Huang and Bouis, 2001). Similarly, market development associated with changes in marketing systems and economic development in China is also expected to influence the demand for food (Huang and Rozelle, 1998). However, since this study is a sensitivity analysis of the impacts of income redistribution on food demand, it is not necessary to account for these effects on food demand projections.

The Jiangsu province survey includes 4,600 households in 28 cities and towns. However, this study uses only 3,002 households drawn systematically from the 4,600 sampled households. After deleting 105 households with prices (i.e., unit values) exceeding five standard deviations above the means and 11 households with missing observations for four or more food items, a data set comprised of 2,886 households is actually used for this study.[3] The food groups analyzed consist of 10 broad food categories: grains, oils and fats, meats, poultry, eggs, aquatic products, dairy products, vegetables, fruits, and other foods (including starches and tubers and cakes). On a per capita basis, the average total expenditures for the above food groups account for 79.2% of total expenditures for food consumed at home and 68.7% of total food expenditures of the 2,886 surveyed households.

Households report their food expenditures and physical quantities associated with their food consumption in a survey diary. The prices paid by households are calculated by dividing consumer expenditures on a food category by corresponding quantities consumed. However, the calculated price is not an exogenous market price of a particular food group that can be readily used in a demand analysis. The price calculated in this way reflects more than spatial variation caused by supply shocks (transportation costs, seasonal variation, etc.). The calculated price, on the other hand, reflects household food quality choices as well as price variations (Gao, Wailes, and Cramer, 1994). Therefore, adjusting prices for quality differences is important when the studied commodities have large quality and price variations. Considering that substantial quality variation exists for the food groups in this study, a quality-price adjustment is needed. Assuming quality effects are due largely to heterogeneity of composite commodities, quality and price adjustments in this study are done by estimating a hedonic price equation independently from the demand function using information on purchasing households. The quality-adjusted price is defined as the difference between the calculated price and the quality price, given the commodity's specific quality characteristics.

Following the procedures employed by Cox and Wohlgenant (1986) and Gao, Wailes, and Cramer (1994), a hedonic price equation is specified as follows:

$$V_i = b_0 + \sum_{k=1}^{s} b_k d_k + \mu_i , \tag{13}$$

where V_i is the calculated price for food category i; b_0 and b_k are parameters to be estimated; d_k denotes variables influencing the consumer's choice of quality, such as income and household characteristics, as proxies for household preferences for unobservable quality characteristics; k represents the s variables used in the estimation; and μ_i is the regression residual. The mean price of a food group is represented by the intercept b_0. Hence, the quality-adjusted price (p_i) is defined as $p_i = \hat{b}_0 + \mu_i$.[4]

[3] Following the previous studies in demand analysis which have used cross-sectional data (Prais and Houthakker, 1955; Cox and Wohlgenant, 1986; Yen, Fang, and Su, 2002; Yen, Lin, and Smallwood, 2003), in this study, those households with unit values exceeding five standard deviations above the mean are deleted to avoid the negative effect from outliers and to simultaneously help optimization in the nonlinear estimation. While the criteria used here for deleting observations may seem ad hoc, we believe that results using the rule of two or three standard deviations are similar to those with the rule of five standard deviations because the observations deleted using any of the approaches account for only a small share in the total observations used in this study.

[4] As an anonymous reviewer points out, despite adjusting for quality differences, price elasticities estimated from cross-section data still might be biased upward. Nevertheless, the issue of "large" price elasticity estimates is not that critical to our analysis as we do not actually use them. We are simply controlling for prices when estimating income elasticities. Certainly, biased prices might lead to biased income elasticities, which are critical to our analysis. While the income elasticity estimates perhaps may be biased upward, the differences among the income elasticity estimates of food demand by income strata are expected to be similar when using "unbiased" versus "biased" income elasticity estimates.

The data used for this study included some missing observations. Specifically, no data are available from the NBS household survey data for oils and fats, meats, poultry, eggs, aquatic products, dairy products, and fruits for 5.65%, 0.03%, 0.52%, 0.35%, 0.14%, 10.74%, and 0.24% of households, respectively. The nonpurchases could be due to no preference for the commodity or survey errors because the data are from a household's diary for food consumption/expenditures over an entire year. The missing prices for meats, poultry, eggs, aquatic products, and fruits are replaced by $\hat{b}_0$ for that food group. For oils and fats and dairy products that have a large percentage of missing values, Heckman's (1979) sample selection procedure is employed to correct for sample selection bias. More specifically, an inverse Mills ratio is computed for each household in the first-step probit model, and then the computed Mills ratio is used as an instrument incorporated in the second-step hedonic price equation [equation (13)] (Greene, 2003). The resulting relationship is used to generate corresponding quality-adjusted prices for oils and fats and dairy products.

In this study, the surveyed households are equally divided into five income strata based on per capita disposable incomes. The five income strata (I, II, III, IV, and V) represent income groups from the low (stratum I) to the high (stratum V) in terms of per capita income. This income grouping follows NBS's classification standards for urban households.

Tables 1 and 2 report summary statistics related to the surveyed households in urban Jiangsu province. First, income disparity among the five income classes is substantial. Per capita disposable income for the highest-income households (stratum V) is six times as much as the lowest-income families (stratum I), although per capita total expenditures on the studied foods of households in stratum V are only twice as much as those in stratum I. This finding is expected because of subsistence requirements and partial food expenditures considered in this study. Second, with the exception of grains and oils and fats which are similar in per capita quantity consumed among the five income strata, the remaining food groups present an upward trend from low- to high-income strata. In particular, per capita quantities consumed of meats, poultry, aquatic products, dairy products, and fruits are considerably smaller for the lowest-income stratum (stratum I) than for the highest-income stratum (stratum V), suggesting a substantial growth in the demand for these food groups for low-income households. Third, a larger percentage of high-income households live in the south and in cities relative to the north and in towns. This is consistent with the fact that the south of Jiangsu province is more economically developed than the north and that cities are more economically developed than towns. Fourth, compared to high-income households, a higher percentage of low-income households have a larger family size, consisting of more children but fewer older members. Finally, the educational levels as well as the age of household heads are consistently higher in the high-income strata as compared to those in the low-income strata.

Estimation Procedures, Statistical Tests, and Demand Elasticities

Estimation Procedures

As noted earlier, no expenditures are reported by households for some of the studied foods. In other words, not all surveyed households consumed all of the studied food groups during the study period. To account for zero expenditure shares, we use the consistent two-step (CTS) estimation procedure for systems of equations with limited dependent variables (as proposed by Shonkwiler and Yen, 1999). Since the percentage of zero observations in the data set used

Table 1. Quantities Consumed at Home, Quality-Adjusted Prices, and Income and Food Expenditures, Urban Jiangsu Province, China (2004)

	Income Strata					
	I	**II**	**III**	**IV**	**V**	**All**
Food Group	Mean / (S.D.)	Mean / (S.D.)	Mean / (S.D.)	Mean / (S.D.)	Mean / (S.D.)	Mean / (S.D.)
Per Capita Quantities Consumed at Home:						
Grains	79.11	78.31	84.94	80.44	80.03	80.57
	(49.04)	(50.72)	(58.71)	(58.79)	(56.10)	(54.83)
Oils and Fats	8.94	10.47	10.52	10.52	9.96	10.08
	(5.57)	(7.19)	(9.57)	(10.34)	(9.26)	(8.58)
Meats	20.10	26.19	29.65	30.65	33.06	27.93
	(10.82)	(13.49)	(17.27)	(19.33)	(21.21)	(17.44)
Poultry	7.29	11.20	12.42	14.23	15.90	12.21
	(5.98)	(7.59)	(8.74)	(10.58)	(12.83)	(9.89)
Eggs	10.73	12.09	13.43	13.94	15.10	13.06
	(6.21)	(7.62)	(9.22)	(9.85)	(12.17)	(9.36)
Aquatic Products	14.11	17.84	21.21	22.85	27.19	20.64
	(8.97)	(11.74)	(13.86)	(15.85)	(21.41)	(15.61)
Dairy Products	8.74	15.89	23.19	30.44	35.89	22.83
	(13.26)	(17.32)	(22.92)	(27.42)	(32.81)	(25.69)
Vegetables	105.33	113.43	127.02	131.03	145.12	124.39
	(52.39)	(56.39)	(71.34)	(81.08)	(87.08)	(72.25)
Fruits	34.71	50.87	62.18	73.33	83.72	60.96
	(25.92)	(32.36)	(36.19)	(44.74)	(52.84)	(43.07)
Other Foods	12.42	13.30	14.96	15.68	16.95	14.66
	(9.15)	(9.47)	(9.69)	(10.96)	(11.43)	(10.30)
Quality-Adjusted Prices:						
Grains	3.52	3.69	3.72	3.73	3.70	3.67
	(0.59)	(0.73)	(0.73)	(0.69)	(0.85)	(0.73)
Oils and Fats	7.08	7.03	7.39	7.63	7.32	7.29
	(1.92)	(1.65)	(2.77)	(3.22)	(3.11)	(2.62)
Meats	14.96	15.29	15.48	15.67	15.35	15.35
	(1.65)	(1.72)	(1.85)	(2.11)	(2.16)	(1.92)
Poultry	12.65	13.07	13.54	13.50	13.23	13.20
	(2.45)	(2.32)	(2.41)	(2.57)	(2.70)	(2.51)
Eggs	6.04	6.18	6.19	6.22	6.19	6.16
	(0.67)	(0.75)	(0.81)	(0.83)	(0.92)	(0.80)
Aquatic Products	7.71	9.03	9.41	9.80	9.35	9.06
	(2.65)	(3.59)	(3.79)	(4.23)	(4.85)	(3.95)
Dairy Products	5.21	5.49	5.10	5.01	5.52	5.27
	(4.37)	(4.47)	(3.85)	(3.00)	(4.20)	(4.02)
Vegetables	1.93	2.10	2.18	2.22	2.14	2.11
	(0.44)	(0.51)	(0.52)	(0.57)	(0.60)	(0.54)
Fruits	2.28	2.34	2.44	2.46	2.45	2.39
	(1.11)	(1.04)	(1.01)	(1.06)	(1.14)	(1.07)
Other Foods	5.95	6.66	6.96	7.05	7.20	6.77
	(2.84)	(2.94)	(3.43)	(3.96)	(5.67)	(3.93)
Per Capita Income and Expenditures:						
Income	3,646.90	6,184.20	8,646.80	11,980.80	22,906.60	10,672.40
	(950.30)	(651.30)	(809.80)	(1,287.40)	(11,032.50)	(8,368.30)
Expenditures [a]	1,249.70	1,697.80	2,035.70	2,284.00	2,624.00	1,978.30
	(476.40)	(654.90)	(908.30)	(1,095.40)	(1,304.60)	(1,048.80)

Note: Estimated using the 2004 NBS urban household survey data.

[a] Expenditures here refer to total expenditures on the studied foods.

Table 2. Demographic Variables, Urban Jiangsu Province, China (2004)

	Income Strata					
Variable	I	II	III	IV	V	All
South (1/0)	0.23	0.33	0.40	0.49	0.56	0.40
Town (1/0)	0.38	0.33	0.25	0.23	0.19	0.28
Household Size	3.30	3.21	2.93	2.83	2.51	2.96
Presence of Seniors (1/0)	0.19	0.20	0.28	0.25	0.30	0.25
Presence of Children (1/0)	0.44	0.41	0.33	0.31	0.20	0.34
Age of Household Head	47.75	49.44	52.14	52.08	54.05	51.09
Educational Levels [a]	4.25	4.68	4.85	5.34	6.02	5.03

Note: Estimated using the 2004 NBS urban household survey data.

[a] *Educational Levels* here refers to the educational levels of household heads. The "4," "5," and "6" scales denote junior middle schooling (9 years), senior middle schooling (12 years), and professional schooling (12 years), respectively.

in this study for meats, poultry, eggs, aquatic products, and fruits is quite low, the CTS is used only for the remaining food groups with zero observations. The latter include oils and fats and dairy products.

The first step of the CTS consists of probit regressions which are estimated separately for oils and fats and dairy products using the maximum-likelihood method to obtain the univariate standard normal probability density functions (pdfs) and the univariate standard normal cumulative distribution functions (cdfs). The explanatory variables included in the estimations are logarithm of household income, logarithms of prices of the 10 studied food groups, and the demographic variables that are the same as those in equation (4). In the CTS second step, the QUAIDS model is estimated for nine food groups encompassing grains, oils and fats, meats, poultry, eggs, aquatic products, dairy products, vegetables, and fruits using the full information maximum-likelihood (FIML) estimation method, with homogeneity and symmetry imposed. For the equations for oils and fats and dairy products, the estimated cdfs and pdfs from the first-step probit estimations are applied [see Yen, Kan, and Su (2002) for a detailed explanation]. Own-price and expenditure elasticities for the "other foods" category are calculated using the adding-up restriction, specified as:

(14) $$\sum_{i=1}^{n} w_i e_{ij} = -w_j, \quad \sum_{i=1}^{n} w_i e_i = 1, \quad \text{and} \quad \sum_{j=1}^{n} e_{ij} + e_i = 0.$$ [5]

The quadratic double-log Engel function [equation (9)], which measures the impact of household income on the expenditures on the studied foods, is estimated using OLS. It is important to note that the coefficients of logarithmic income $\ln(y)$ and square of logarithmic income $(\ln(y))^2$ are statistically different from zero at the 1% significance level, supporting the use of the quadratic term in the logarithmic income in the Engel function.

[5] The demand system in the second step of the CTS is specified as $s_i = \Phi_i w_i + \varphi_i \phi_i$, where s_i represents the observed budget share, w_i denotes the deterministic component of equation (1), Φ_i and ϕ_i are the univariate standard normal pdf and cdf, and φ_i is the error covariance between the error term in the first-step probit model and the u_i in equation (1). Hence, the adding-up property does not hold in the second-step demand system (Shonkwiler and Yen, 1999; Yen, Kan, and Su, 2002). To account for the adding-up restrictions, we follow Yen, Lin, and Smallwood (2003) and estimate the first $(n-1)$ equations in the n-good system along with an identity as

$$s_n = 1 - \sum_{i=1}^{n-1} s_i,$$

where s_n is defined as the budget share of good n as a residual share. For this study, the last food category (other foods) is chosen as the residual good category.

Statistical Tests

The AIDS model is nested within the QUAIDS through the joint hypothesis that $\lambda_i = 0 \; \forall \; i$. As shown in appendix table A1, the estimated values of λ_i are statistically different from zero for all studied food groups with the exception of dairy products. This suggests nonlinear Engel curves with respect to the logarithm of total food expenditures for these eight food groups. When imposing the AIDS restriction described above on the QUAIDS specification, a likelihood-ratio statistic of 232 is obtained for the AIDS versus the QUAIDS models. Thus, the null hypothesis that the AIDS and QUAIDS models are the same is rejected at the 1% significance level. Hence, the statistical test results indicate that the QUAIDS model is superior to the AIDS specification in this particular application.[6]

Since the significance level of the coefficient of $\hat{v}$ is an indication for the exogeneity of ln(x) and $(\ln(x))^2$ (Blundell and Robin, 1999), the *t*-statistic of $\hat{v}$ is used to indicate the results of the test for exogeneity of the expenditure terms. The tests for exogeneity show that the null hypothesis of exogeneity of the expenditure terms in the QUAIDS framework is rejected for grains, oils and fats, poultry, aquatic products, dairy products, vegetables, and fruits at the 5% significance level, justifying the use of the instrumental procedure that corrects for endogeneity of the expenditure variables.

Own-Price, Food Expenditure, and Income Elasticities

Own-price, food expenditure, and income elasticities for food groups across income strata are reported in table 3.[7] All elasticities are evaluated on the basis of parameter estimates and sample means of explanatory variables. Because the focus of this study is food expenditure responses among income categories, cross-price elasticities are not provided here to conserve space. In view of food expenditure elasticities across income strata, elasticity reversal occurs for several food groups, which may reflect a change in the consumer preferences or perception of needs at different income levels. For example, for the grains category, there is a more elastic expenditure response for low-income strata than for high-income strata. However, elasticity variations across income classes for most of the studied foods are small. The homogeneous elasticities across income strata may reflect more equally distributed food expenditures across

[6] This study also conducted an out-of-sample comparison of the QUAIDS and AIDS models. Specifically, the observations are randomly and equidistantly split into four groups. The demand model is estimated using the observations composed of three groups (75% of whole observations). The resulting parameter estimates and the average values of exogenous variables for the group omitted are used to predict expenditure shares of each food group studied. This procedure is then iteratively repeated by reestimating the demand model with another 75% of observations and subsequently predicting the upcoming group. The root mean squared errors (RMSEs) are then calculated using the shares predicted and the actual average shares for the four groups omitted. Results show that the AIDS model does a better job of forecasting expenditure shares as compared to the QUAIDS specification. However, as noted by Kastens and Brester (1996), when model-derived, mean-based elasticities are used to evaluate model forecast accuracy, the superiority of the AIDS model over the QUAIDS model might be substantially dissipated. Because of the complex process involved, this study did not conduct out-of-sample testing using the mean-based constant-elasticity approach. Furthermore, the QUAIDS specification is able to generate expenditure elasticities at different income levels, which is the main result this study seeks to achieve. Thus, the out-of-sample test results only serve as a reference in the comparison of the QUAIDS and AIDS models.

[7] In the CTS procedure used in this study, the formulae for calculating elasticities for oils and fats and dairy products are adjusted as follows:

$$e_{ij} = w_i^{-1}\left\{\gamma_{ij} - \left(\beta_i + \frac{2\lambda_i}{b(p)}\right)\left[\ln\left(\frac{x}{a(p)}\right)\right]\left(\alpha_j + \sum_k^n \gamma_{jk}\ln(p_k)\right) - \frac{\lambda_i\beta_j}{b(p)}\left[\ln\left(\frac{x}{a(p)}\right)\right]^2\right\} \times \Phi_i + \phi_i\tau_{ij}(w_i - \varphi_i)/w_i - \delta_{ij},$$

$$\text{and} \quad e_i = 1 + w_i^{-1}\left[\beta_i + \frac{2\lambda_i}{b(p)}\ln\left(\frac{m}{a(p)}\right)\right] \times \Phi_i,$$

where τ_{ij} denotes the parameter of the logarithm of price used in the first-step probit estimation.

Table 3. Marshallian Own-Price, Food Expenditure, and Income Elasticities, Urban Jiangsu Province, China (2004)

	Income Strata					
Food Group	I	II	III	IV	V	All
Own-Price Elasticity:						
Grains	−1.075**[bb]	−1.085**	−1.090**	−1.098**	−1.107**	−1.089**
Oils and Fats	−1.129**[bb]	−1.135**[bb]	−1.160**[bb]	−1.171**[bb]	−1.194**[bb]	−1.154**[bb]
Meats	−1.085**[bb]	−1.079**[bb]	−1.081**[bb]	−1.084**[bb]	−1.090**[bb]	−1.084**[bb]
Poultry	−0.684**	−0.747**	−0.742**	−0.753**	−0.747**	−0.737**
Eggs	−0.925**	−0.903**	−0.890**	−0.881**	−0.874**	−0.897**
Aquatic Products	−0.524**	−0.578**	−0.614**	−0.637**	−0.668**	−0.611**
Dairy Products	−1.238**[b]	−1.168**[b]	−1.146**[b]	−1.126**[b]	−1.118**[b]	−1.149**[b]
Vegetables	−0.648**	−0.583**	−0.583**	−0.564**	−0.565**	−0.589**
Fruits	−0.881**	−0.883**	−0.893**	−0.901**	−0.908**	−0.895**
Other Foods	−0.241**	−0.278**	−0.318**	−0.327**	−0.397**	−0.316**
Food Expenditure Elasticity:						
Grains	0.581**[c]	0.433**[c]	0.375*[c]	0.275[c]	0.205[c]	0.401**[c]
Oils and Fats	0.523**[c]	0.507**[c]	0.417**[c]	0.378*[c]	0.293[c]	0.440**[c]
Meats	1.144**	1.133**	1.136**	1.140**	1.150**	1.141**
Poultry	1.385**	1.322**	1.331**	1.321**	1.328**	1.336**
Eggs	0.877**	0.818**	0.789**	0.766**	0.751**	0.806**
Aquatic Products	1.440**	1.414**	1.383**	1.366**	1.335**	1.383**
Dairy Products	1.628**	1.444**	1.387**	1.333**	1.311**	1.395**
Vegetables	0.813**[c]	0.756**[c]	0.751**[c]	0.734**[c]	0.734**[c]	0.759**[c]
Fruits	1.069**	1.108**	1.105**	1.104**	1.097**	1.098**
Other Foods	0.982	1.034	1.033	1.033	1.030	1.033
Income Elasticity:						
Grains	0.294**[c]	0.166**[c]	0.123*[c]	0.071[c]	0.031[c]	0.131*[c]
Oils and Fats	0.264**[c]	0.194**[c]	0.137**[c]	0.098*[c]	0.044[c]	0.143**[c]
Meats	0.578**[c]	0.433**[c]	0.373**[c]	0.296**[c]	0.174**[c]	0.371**[c]
Poultry	0.700**[c]	0.505**[c]	0.437**[c]	0.343**[c]	0.201**[c]	0.435**[c]
Eggs	0.443**[c]	0.313**[c]	0.259**[c]	0.199**[c]	0.114*[c]	0.262**[c]
Aquatic Products	0.728**[c]	0.541**[c]	0.454**[c]	0.355**[c]	0.202**[c]	0.450**[c]
Dairy Products	0.823**[c]	0.552**[c]	0.455**[c]	0.346**[c]	0.199**[c]	0.454**[c]
Vegetables	0.411**[c]	0.289**[c]	0.247**[c]	0.191**[c]	0.111**[c]	0.247**[c]
Fruits	0.540**[c]	0.424**[c]	0.363**[c]	0.287**[c]	0.166**[c]	0.357**[c]
Other Foods	0.496	0.395[cc]	0.339[cc]	0.268[c]	0.156[c]	0.336[c]

Notes: Estimated using the 2004 NBS urban household survey data. Single and double asterisks (*,**) denote elasticities are significantly different from zero at the 10% and 5% levels, respectively; [b(bb)] denotes own-price elasticities significantly greater than −1.0 at the 5% (10%) level; [c(cc)] denotes food expenditure and income elasticities significantly different from 1.0 at the 5% (10%) level. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures.

various income classes as compared to the income distribution itself. For own-price elasticities across income strata, no obvious variations are found for these studied foods.

Estimated income elasticities with respect to food expenditures are 0.5055 for income stratum I, 0.3823 for stratum II, 0.3284 for stratum III, 0.2597 for stratum IV, 0.1516 for stratum V, and 0.3255 for the entire sample. Wald tests reject the null hypothesis that the five elasticities are equal at the 5% significance level. These values therefore suggest food demand in urban Jiangsu province is consistent with Engel's law. In other words, the results of this study support the assertion that the income elasticity for food decreases with increases in the general level of income (Houthakker, 1957).

Unlike food expenditure and own-price elasticities that show small differences across income classes, the estimated income elasticities are substantially different at different income levels and consistently larger for low-income strata for all the studied goods. Hence, larger income growth for low-income strata relative to high-income strata would lead to a greater increase in food demand in urban Jiangsu than that occurring if income growth were uniform across strata. Moreover, the estimated income elasticities are consistent with prior expectations. Animal origin foods such as meats, poultry, aquatic products, and dairy products tend to have higher income elasticities than other food groups for a stratum; and income elasticities for grains and oils and fats for the highest-income stratum (stratum V) are close to zero, suggesting the highest-income households in urban Jiangsu are approaching a saturation level of quantity consumed of these food groups.

A Krinsky-Robb (1986) bootstrapping evaluation of own-price, food expenditure, and income elasticities was carried out. This procedure is employed to measure whether each elasticity estimate differed from 0, as well as if each own-price, food expenditure, and income elasticity was statistically different from −1.0 and 1.0, respectively [see Tonsor and Marsh (2007) for a more detailed introduction to this method]. As shown in table 3, most of the elasticity estimates are significantly different from 0; only a few of the own-price and food expenditure elasticity estimates are significantly different from −1.0 and 1.0, respectively; and almost all the estimated income elasticities are significantly different from 1.0.

Projection Results

Scenarios for Food Demand Projections

To achieve the second goal of this study, four scenarios are considered. Each scenario involves hypothetically changing incomes and income distribution patterns from existing levels and estimating the impacts on food demand. More specifically, scenario A involves increasing the incomes of all five income strata at the same rate while keeping constant the current population income distribution pattern. Scenarios B and C involve increasing each of the incomes of the low- and the high-income strata, respectively, while maintaining constant the incomes of the remaining strata. Finally, scenario D involves redistributing current incomes from high-income strata to low-income strata in such a way that total population incomes remain constant.

Based on the work of Pinstrup-Andersen and Caicedo (1978), an arbitrarily selected 1% of total incomes of all the surveyed households is used as the amount of change in the four scenarios. Because the relationships considered here are linear, the impact of the income redistribution of magnitudes different from 1% of total incomes may be estimated by simple

Table 4. Estimated Distribution of Households, Population, and Incomes by Income Strata, Urban Jiangsu Province, China (2004)

	Income Strata				
Item	I	II	III	IV	V
Households	20.00	20.00	20.00	20.00	20.00
Population	22.00	22.00	20.00	19.00	17.00
Incomes	8.06	13.33	17.06	22.89	38.67
Scenario B:					
Increase in Stratum I	8.97	13.19	16.89	22.66	38.28
Increase in Stratum II	7.98	14.18	16.89	22.66	38.28
Scenario C:					
Increase in Stratum IV	7.98	13.19	16.89	23.65	38.28
Increase in Stratum V	7.98	13.19	16.89	22.66	39.27
Scenario D:					
Transfer V to I	9.06	13.33	17.06	22.89	37.67
Transfer V to II	8.06	14.33	17.06	21.89	38.67

Note: Estimated using the 2004 NBS urban household survey data.

extrapolation. A 1% change in total population incomes translates into a change of 12.40%, 7.50%, 4.37%, and 2.59% for income strata I, II, IV, and V, respectively.

Table 4 presents the current income distribution pattern as well as the hypothetical income distribution patterns under the simulated scenarios. In general, the new income distribution patterns under scenarios B through D change little compared to the current pattern of income distribution. For example, regarding scenario D, if an amount of 1% of the total population income for the sampled households is transferred from the highest-income stratum (V) to the lowest-income stratum (I), the shares of total incomes by the lowest- and highest-income strata change only by +1 and −1 percentage point, respectively, as compared to the current income distribution pattern (table 4, row 8); the shares of total incomes by the other income strata remain unchanged. However, since the objective of this study is to examine the responsiveness of food demand to alternative income distribution patterns, small changes in income distribution patterns may be large enough to have a notable impact on food demand. These changes are discussed in the next section.

Impacts of Changes in Income Distribution on Food Demand

The impact of changes in income distribution on the demand for each of the 10 studied food groups is estimated based on equation (12). Table 5 reports the changes in total quantity consumed of individual food groups resulting from the hypothetical changes in incomes and income distribution under the four considered scenarios. Note that the percentage change in total quantity consumed of individual food groups due to a uniform 1% increase in total incomes of all the surveyed households is given by the average income elasticities. The findings are summarized below.

First, a move toward a more equal distribution of income would lead to a considerably large increase in the demand for individual food groups in urban Jiangsu. Specifically, the increase in the demand for each of the studied food groups would be considerably larger if the total

Table 5. Estimated Increase in Food Demand Under Various Household Income and Income Distribution Scenarios, Urban Jiangsu Province, China (2004)

		Estimated Demand Increase (%)						
Food Group	Current Consumption (kg)	Unchanged Distribution	All to I	All to II	All to IV	All to V	Transfer V to I (% incrs.)	Transfer V to II (% incrs.)
Grains	206,060	0.13	0.84	0.27	0.06	0.01	0.82	0.25
Oils and Fats	26,213	0.14	0.68	0.33	0.08	0.02	0.66	0.32
Meats	71,694	0.37	1.21	0.68	0.26	0.09	1.12	0.59
Poultry	31,548	0.43	1.20	0.79	0.33	0.11	1.09	0.68
Eggs	32,865	0.26	1.05	0.48	0.17	0.06	0.99	0.43
Aquatic Products	53,462	0.45	1.45	0.78	0.32	0.12	1.33	0.67
Dairy Products	57,517	0.45	0.93	0.67	0.39	0.14	0.79	0.53
Vegetables	313,488	0.25	1.01	0.45	0.16	0.06	0.95	0.39
Fruits	150,406	0.36	0.90	0.61	0.29	0.10	0.79	0.50
Other Foods	18,433	0.34	1.23	0.59	0.23	0.08	1.15	0.51

Note: Estimated using the 2004 NBS urban household survey data.

income increase was received by income stratum I rather than a uniform percentage distribution of the additional income across the five income strata. For example, compared with current consumption levels, the percentage increases in the demand for individual food groups range from 0.68 to 1.45 if the total income increase was received by the lowest-income stratum. Alternatively, they range from 0.13 to 0.45 if all five income strata uniformly increased their incomes by 1% (table 5, column "All to I" vs. "Unchanged Distribution"). Moreover, income growth that favors the second lowest income stratum would also lead to a considerable rise in food demand compared to a uniform percentage distribution of the additional income across the five income strata (table 5, column "All to II" vs. "Unchanged Distribution").

Second, a distribution-neutral income growth (a uniform increase in household incomes, holding constant the current income distribution) would lead to an increase in food demand by a larger amount than if the income growth was entirely received by high-income strata. Compared to income growth favoring the second highest stratum (i.e., IV), the increase in demand for individual food groups would be from 0.06 to 0.13 times higher if all five income strata uniformly increased their incomes by 1% (table 5, column "Unchanged Distribution" vs. "All to IV"). In particular, the demand growth resulting from the distribution-neutral income growth would be 0.12 to 0.32 times higher than the demand growth resulting from an income growth that was skewed in favor of the highest-income stratum (table 5, column "All to V" vs. "Unchanged Distribution").

Third, redistribution of income would increase consumption of food groups even if there was no increase in average per capita income. As shown in table 5 (column "Transfer V to I"), the transfer of an amount of income equal to 1% of total household incomes from the highest-income stratum to the lowest-income stratum, maintaining constant total household incomes, would increase the demand for meats, poultry, aquatic products, and other foods by more than 1.0%; eggs and vegetables by more than 0.9%; grains, dairy products, and fruits by about 0.7%; and oils and fats by more than 0.6%, as compared to the current consumption level. In fact, the income transfer from the highest- to lowest-income households would increase demand for each of the 10 studied food groups by a larger amount than did a uniform percentage distribution of the additional 1% of income across the five income strata (table 5, column "Transfer V to I" vs. "Unchanged Distribution").

These findings could be explained by the current food consumption pattern in urban Jiangsu and the associated marginal propensities to consume.[8] This study finds that income elasticities for each of the studied food groups are consistently higher for the low-income strata than the high-income strata (table 3). Given that the proportion of consumer food spending to household income is expected to decrease with a rise in the level of income, higher income elasticities here are expected to translate into corresponding higher marginal propensities to consume. As each increment of income transferred is expected to increase the demand in low-income strata (I and II) by a greater amount than it would reduce demand in high-income strata (IV and V), a change in income distribution that favors low-income strata is expected to increase total demand for individual food groups (FAO, 1972). Similarly, a change in income distribution that is skewed in favor of the high income groups is expected to decrease total demand for these food groups. Thus, the greater the difference between the marginal propensities to consume among the five income strata, the greater the changes in demand caused by income redistribution are expected to be.

Discussion

The results of this study show different food demand patterns resulting from hypothetical changes in income levels and income distributions. Several implications related to public policy and food marketing are discussed below.

Suggestions for Future Research on Food Demand Projections

This study presents income elasticities for five income strata in urban Jiangsu province. The results indicate that a change in the distribution of consumer incomes is expected to have a considerable effect on the demand for individual food groups. Given that China's socioeconomic structure has been changing due to rapid economic growth and changes in socioeconomic systems, changes in income distribution patterns are likely to continue in China. Consequently, any food demand projection based on unchanged distribution of incomes may overestimate future food demand, if income distribution becomes more unequal in the future. In contrast, food demand projections based on constant income distribution may underestimate future food demand, in the case of a more equal distribution of income in the future.[9]

[8] Marginal propensity to consume (MPC) refers to the increase in personal consumer spending that occurs with an increase in disposable income. Mathematically, the MPC function is expressed as the derivative of the consumption (C) function with respect to disposable income (Y), i.e., $MPC = \partial C / \partial Y = E_{y,i} * (C/Y)$, where $E_{y,i}$ is income elasticity of demand for food group i. Because $E_{y,i}$ and C/Y for each of the studied food groups are higher for low-income strata in this study, the calculated MPCs for individual food groups are consistently higher for low-income strata.

[9] We also have compared demand projections based on provincial average, which is derived from an unchanged distribution of income, with the sum of separate demand projections for the five income strata on the assumption of alternative hypothetical changes in the distribution of income. With the average annual growth rate of 10% between 2004 and 2014, we find that food demand projections based on unchanged income distribution would overestimate the demand for the studied food groups by 0.39%–0.67% if the future income distribution continues to follow the 1995 to 2004 trends for urban China (i.e., with the corresponding annual growth rates for income strata I, II, III, IV, and V being 5.5%, 7.5%, 9.3%, 10.8%, and 12.8%, respectively). However, food demand projections based on unchanged income distribution would underestimate the demand for the studied food groups by 0.48%–1.04% if the future income distribution moves from the 2004 pattern for urban China to the 1995 pattern (i.e., with the corresponding annual growth rates for income strata I, II, III, IV, and V being 16.0%, 12.7%, 11.9%, 9.2%, and 8.6%, respectively).

It is therefore recommended that food demand projections in both urban Jiangsu and urban China take into account any expected changes in the future income distribution.

An Examination of Food Demand in Urban China During the Past Five Years

From the results of this study, it may be concluded that the increase in income inequality in urban China may have led to a slow growth in food demand over the past five years, particularly the demand for meats, poultry, and fish. The NBS recent survey data (NBS, 2000–2007) indicate urban at-home per capita consumption of meats, poultry, and fish stagnated during the last five years (2002–2006) while the real per capita incomes of urban residents have grown at an average rate of 9% during the same period. Considering that the demand for meats, poultry, and fish in urban China is lower than for neighboring Asian developed countries and regions such as Japan, South Korea, Taiwan, and Hong Kong, one would expect the demand for animal protein in urban China still would have room for growth. While the increase in food-away-from-home expenditures has been partly responsible for the slow growth in the at-home consumption of meats, poultry, and fish, the increase in income inequality might be the main factor underlying the current food consumption levels in urban China.

Implications for Future Food Demand in Urban China

Food and feed demand in China is expected to increase considerably as China approaches the more advanced stages of industrialization. According to the findings of this study, income growth in favor of low-income strata would result in a rather significant increase in demand for individual food groups. Even in the absence of changes in the distribution of population income, an overall distribution-neutral growth in income is expected to bring a significant increase in food demand in urban Jiangsu. Thus, the potential growth in food demand in urban China is substantial.

Kuznets (1955) argues that an inverted U-shaped relationship exists between income inequality and the level of economic development. According to Kuznets, an increase in inequality during the initial move to a modern economy is likely to give way to more equality as a nation approaches the more advanced stages of industrialization. In view of Kuznets' finding and the fact that China's present policies aim at improving the existing income inequality patterns, food demand in urban China is expected to increase considerably in the future as rapid income growth in urban China is expected to continue.

The prospect for future food demand in urban China has an important implication for China's agriculture. As food consumption patterns for urban consumers change due to income growth and improvements in the current income distribution in urban China, total demand for foods with animal origin (pork, beef, mutton, poultry, eggs, milk, and fish), vegetables, and fruits is expected to rise considerably in the future. In response to the increase in demand for these food commodities, agricultural land allocated to food grain production is expected to be transferred to feed grains, vegetables, and fruits. Consequently, more farmers are likely to be engaged in feeding livestock, poultry, and fish, as well as the production of fruits and vegetables. These changes in agricultural production are anticipated to lead to increases in employment and incomes in the agricultural sector, since the production of livestock, fish, and horticultural crops is likely to be more labor-intensive and more profitable as compared to the current agricultural structure. Therefore, for a long-term sustainable improvement in income distribution, it would be advisable for policy makers to focus on improving the current income distribution in China.

The prospect for future food demand in urban China also has important implications for global food markets. China encompasses about 10% of the world's arable land and about 21% of its people. The land constraint makes it difficult for China to feed its large population if they have more livestock products, fish, vegetables, and fruits in their diets. Thus, the expectation is that the growing demand for foods of animal origin, vegetables, and fruits will cause China to resort to imported feed grains in order to increase its livestock inventory in the future (Hayes, 1999; Zheng and Henneberry, 2009).

Poverty Reduction Issues

Income transfer from higher to lower income strata might be an effective way to improve nutrition and the standard of living of the poor. The results from this study—indicating that an income transfer from high- to low-income households has a rather significant impact on the demand for individual food groups—suggest an income redistribution strategy in favor of the low-income population may be an effective government policy instrument to improve the standard of living and nutrition of the poor. Because income elasticities for foods are less than one, only a part of the income transfer from high- to low-income strata would be spent on food. Hence, in addition to increased food demand, such transfer is expected to improve the relative purchasing power for other goods by low-income consumers (Pinstrup-Andersen and Caicedo, 1978). An income transfer scheme through taxing the income or property of the high-income population and imposing taxes on luxury items may be an effective approach for helping the poor.

Concluding Remarks

This study examines the impact of changes in income distribution on food demand in urban Jiangsu province of China. To accomplish this objective, the response of food demand to household income changes is estimated. The estimated income elasticities are then used to project food demand changes resulting from the changes in incomes and income distribution under several scenarios. Our major findings regarding the impact of income redistribution on demand for foods that are consumed at home are:

- A move toward a more equal income distribution is expected to considerably increase the demand for individual food groups.
- A distribution-neutral income growth pattern is expected to increase food demand by a larger amount than would an income growth which is skewed in favor of high-income households.
- An income transfer from high- to low-income households is also expected to significantly increase food consumption even if there is no increase in average per capita income.

A change in income distribution is a normal phenomenon in the process of economic advancement in developing countries like China. Determining the stage where China's economy currently stands in the light of Kuznets' (1955) finding is beyond the scope of our investigation. However, this study simulates food demand patterns for different income distribution scenarios. From this perspective, our analysis provides insight as to how China's food demand could evolve in the future.

[*Received April 2009; final revision received December 2009.*]

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Table A1. Summary of Estimated Coefficients and Equation R^2s

	Coefficients of								
Explanatory Variable	Grains	Oils and Fats	Meats	Poultry	Eggs	Aquatic Products	Dairy Products	Vegetables	Fruits
Constant	0.2072**	0.4847**	−0.0753	0.0350	−0.0901**	0.1946**	−0.1222**	−0.0838	0.4319**
South (1/0)	−0.0159**	−0.0067**	−0.0250**	0.0226**	−0.0100**	0.0040	0.0017	0.0238**	0.0092**
Town (1/0)	−0.0193**	−0.0076**	0.0152**	0.0158**	0.0022**	0.0155**	−0.0149**	−0.0038*	−0.0044*
Household Size	0.0180**	0.0038**	0.0000	−0.0034**	0.0020**	−0.0100**	−0.0085**	0.0038**	−0.0061**
Presence of Seniors (1/0)	−0.0026	0.0002	0.0062	−0.0003	−0.0008	0.0017	−0.0005	0.0044	−0.0089**
Presence of Children (1/0)	−0.0068**	−0.0016	−0.0089**	−0.0035	−0.0006	−0.0094**	0.0313**	−0.0071**	0.0044*
Educational Levels	−0.0037**	−0.0020**	−0.0075**	−0.0020**	−0.0001	−0.0010	0.0099**	−0.0002	0.0061**
Age of Household Head	0.0014**	0.0001	−0.0010**	−0.0004**	0.0002**	−0.0001	−0.0005**	0.0005**	−0.0002
ln (*p-Grains*)	−0.0473**								
ln (*p-Oils and Fats*)	0.0024	−0.0490**							
ln (*p-Meats*)	0.0433**	0.0488**	−0.0501**						
ln (*p-Poultry*)	0.0064	−0.0039	−0.0115	0.0213**					
ln (*p-Eggs*)	0.0047	0.0211**	−0.0052	−0.0011	−0.0022				
ln (*p-Aquatic Products*)	−0.0035	−0.0253**	−0.0016	−0.0144**	0.0048	0.0343**			
ln (*p-Dairy Products*)	0.0118**	0.0134**	−0.0128**	0.0003	−0.0048**	0.0044	−0.0163**		
ln (*p-Vegetables*)	−0.0186**	0.0386**	−0.0386**	0.0074	−0.0264**	0.0207**	−0.0083**	0.0095	
ln (*p-Fruits*)	0.0058	−0.0401**	0.0318**	−0.0071	0.0114**	−0.0132**	0.0057*	0.0350**	−0.0352**
ln (*p-Other Foods*)	−0.0051**	−0.0060*	−0.0042	0.0025	−0.0022	−0.0063**	0.0065**	−0.0195**	0.0057*
ln (x)	0.0144	−0.1006**	0.0964**	−0.0072	0.0394**	−0.0564**	0.0247**	0.0993**	−0.1098**
$\ln(x)^2$	−0.0068**	0.0054**	−0.0047**	0.0026**	−0.0035**	0.0077**	0.0002	−0.0097**	0.0087**
$\hat{v}$	0.0607**	0.0235**	−0.0016	−0.0116**	0.0028	−0.0195**	−0.0347**	0.0298**	−0.0360**
φ		−0.0623**					0.0623**		
Adjusted R^2	0.2210	0.1240	0.0835	0.1238	0.1765	0.2513	0.1636	0.2293	0.2028

Note: Single and double asterisks (*,**) denote statistical significance at the 10% and 5% levels, respectively.