Food, Agriculture, and the Environment Discussion Paper 11

Structural Changes in the Demand for Food in Asia

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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March 1996

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Foreword

Many Asian countries are expected to undergo structural transformations in their economies and rapid urbanization over the next 25 years. The changes in tastes and lifestyles engendered by urban living are likely to have significant influences on food demand—influences perhaps as strong as the well-documented influences of household incomes and food prices. Changes in marketing systems and occupational changes, closely linked with increasing GNP per capita, also may influence the demand for food.

In this paper, estimates presented for Taiwan and China demonstrate that structural changes in food demand (as distinguished from changes due to income and price effects) have been significant factors driving the rapid changes in dietary patterns seen in East Asia over the past three decades. Because most previous demand studies have ignored the possible influence of structural shifts, which are highly correlated with increases in per capita income over time, the effects of income on food demand have been overestimated. Relatively little is known about the specific reasons underlying these structural shifts. Thus, it is difficult to form judgments as to the points at which, in the process of economywide structural adjustment, these structural changes in food demand will begin, accelerate, slow down, and perhaps stop.

The crucial question for demand projections in higher-income countries of Asia is the determination of when these structural shifts will decelerate, at which point the upwardly biased estimates of income elasticities for meat, fish, and dairy products will begin to overestimate future demand. In lower-income countries, such as India and Indonesia, where meat consumption is presently quite low because structural transformation is in an early stage, time series data for meat consumption will not reflect a possible impending upward structural shift in demand. Thus, existing income elasticities will underestimate the demand for meat if these structural changes in food demand do indeed materialize.

This report establishes that structural changes can have large influences on food demand patterns and so points toward the need for further research to understand the underlying factors that account for these demand shifts.

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Director General, IFPRI

Acknowledgments

The authors gratefully acknowledge the help of Wen Chern and Hwang-Jaw Lee in making the Taiwan data available to us. We also thank Julian Alston and Scott Rozelle for helpful comments.

On the whole, direct per capita consumption of cereal as food has declined over the past three decades in the rapidly growing economies of Japan, Korea, and Taiwan, while meat, fish, and dairy consumption has increased dramatically. Typically, economists have explained such changes in Asian food consumption patterns primarily as resulting from increases in disposable income and changes in food prices (for example, Ito, Peterson, and Grant 1989; Capps et al. 1994).

There is no doubt that household income and food prices strongly influence food consumption patterns. This fact is perhaps as well substantiated empirically as any relationship in the economics literature. Nevertheless, in projecting food demand patterns over the long run, particularly in economies undergoing the rapid structural transformation and urbanization expected to occur in many countries in Asia over the next 25 years, changes in tastes and lifestyles also may be important influences on food demand.

Unfortunately, methodologies for measuring the effects of such changes in tastes and lifestyles have not been as well developed as those for measuring income and price effects. Moreover, because these changes in tastes and lifestyles are strongly correlated with increasing gross national product (GNP) per capita, it is difficult to separate the two effects empirically in time-series estimations.

A case in point is consumption of rice in Japan, which has declined from 131 kilograms to 74 kilograms per capita between 1962 and 1992 (FAO 1994). There is no denying the negative correlation between rice consumption and the rapid increase in Japanese disposable income that occurred during this period. The question raised here is whether this correlation also implies causality, so that projected future increases in income are a good indicator of future shifts in demand. That is, as Japanese incomes continue to increase, will Japanese rice consumption continue to decline to 60 kilograms, and then to 50 kilograms per capita, and so on, before leveling off? At what point will per capita consumption of rice stabilize?

There are a number of reasons to think that there may be structural shifts (as distinguished from income and price effects) in food demand patterns as populations move from rural to urban areas:

1. There may be a wider choice of foods available in urban markets.[1]
2. Urban residents are more likely to be exposed to the rich variety of dietary patterns of foreign cultures.
3. Urban lifestyles may place a premium on foods that require less time to prepare, for example, if employment opportunities for women improve and the opportunity cost of their time increases.[2]
4. Urban occupations tend to be more sedentary than rural ones. Persons engaged in more sedentary occupations require fewer calories to maintain a given body weight.
5. Urban residents typically do not grow their own food. Thus, their consumption choices are not constrained by the potentially high-cost alternative of selling one food at farm-gate prices (say, rice) to buy another food

[1]Some evidence of this phenomenon for China is provided in Huang and Rozelle 1995.

[2]Some evidence of this for Sri Lanka is provided in Sahn and Alderman 1988.

(say, bread) at retail prices (a choice faced by semisubsistence producers).[3]

While changes in food demand patterns that cannot be attributed to increases in household incomes and changes in food prices may first be noticed in urban areas, as structural transformation proceeds to a more advanced level, these same changes in food demand patterns eventually may occur in rural areas as well. At some point, market availability and lifestyles in urban and rural areas become virtually indistinguishable.

Because structural shifts in food demand patterns have been ignored for the most part in previous Asian food demand studies,[4] the primary objective of this paper is simply to establish their importance empirically, using data from Taiwan and China. It is left to subsequent studies to attribute such shifts to the several explanatory factors (and perhaps others) outlined above.

After providing a more rigorous definition of an hypothesized shift in food preference patterns as societies urbanize and agriculture commercializes, household survey data for Taiwan for two years, 1981 and 1991, are analyzed. These data permit comparison of food consumption patterns in farm and nonfarm households after differences in family income are controlled, as well as comparison of food consumption in rural areas, towns, and cities. An analysis of provincial-level data for China, disaggregated by rural areas, small cities, and large cities, is then presented and conclusions are drawn.

A Disaggregated Model of National Food Demand

In this section a framework is developed for understanding the effects on national aggregate demand for food staples brought about by the shifts described in (4) and (5) above. Then the effects of lifestyle changes described in (1), (2), and (3) are incorporated into this framework in the context of demand for nonstaple foods.

Demand for Food Staples

As semisubsistence producers move into production of commercial crops and into nonagricultural occupations, decisions governing household-level supply of and demand for food become less closely linked. Observed reactions to changes in market prices and income may change substantially because of *how* income is earned, even though underlying preference functions may remain unaltered.

To see this, assume that price and income elasticities of demand are to be estimated using time series data for aggregate national per capita consumption of a particular food staple, for a country where semisubsistence production of that food staple is common. For simplicity, assume two production technologies for this staple, a large-scale, commercial technology and a small-scale, semisubsistence technology.[5]

All households are classified into one of four types, with θ denoting the share of total population, where

θ_{subsis} = small-scale, semisubsistence producers of the staple food,

θ_{commer} = large-scale, commercial producers of the staple food (both small- and large-scale producers of the staple food may produce other agricultural products as well),

[3]Thus, one can expect that semisubsistence rice farmers will eat above-average amounts of rice, and corn farmers will eat above-average amounts of corn, and so on, whereas it is impossible to make a priori judgments about the staple food preferences of urban residents relative to national norms.

Often there are urban-rural differences in the *retail* prices of foods that also will account for a part of the difference in the levels of consumption of specific foods between urban and rural areas. However, the effects of such price differentials (perhaps due to transportation costs) on food demand already are taken into account in the existing food demand literature, using economic models that do not include structural shifts in demand.

[4]Bouis (1991) and Huang and David (1993) are exceptions.

[5]Individual farm sizes and the share of total production marketed by individual farms, of course, will range between these two extremes.

θ_{othrur} = other households in rural areas that are not engaged in production of the staple food,[6] and

θ_{urban} = urban residents.

Letting Q denote aggregate national per capita consumption, and q denote per capita consumption of the pertinent household group, in any particular year,

$$Q = \theta_{subsis}\, q_{subsis} + \theta_{commer}\, q_{commer} + \theta_{othrur}\, q_{othrur} + \theta_{urban}\, q_{urban}. \qquad (1)$$

Certainly, in general, q_{subsis}, q_{commer}, q_{othrur}, and q_{urban} will not be equal, both because income levels will differ among these groups and because rural retail food prices may be lower than urban retail food prices. Standard time-series estimation recognizes such differences. Aggregate national prices and incomes are weighted averages for various population groups. An often implicit assumption, however, is that the demand functions across household groups are similar, that is,

$$q_{subsis} = f_1(y, p, z), \qquad (2a)$$

$$q_{commer} = f_2(y, p, z), \qquad (2b)$$

$$q_{othrur} = f_3(y, p, z), \qquad (2c)$$

$$q_{urban} = f_4(y, p, z), \qquad (2d)$$

where y is per capita income, p is the retail price of the staple food, and z is a vector of other relevant variables.

However, household economics theory suggests that *how* income is earned influences the entire vector of group-specific demand parameters (although not necessarily the food preference functions themselves), implying that f_1, f_2, f_3, and f_4 may be quite dissimilar. For example, for specific urban occupations, y might reasonably be treated as exogenous in equation (2d), but certainly y is endogenous in equation (2a). One implication is that a semisubsistence farm household's consumption of a specific food staple may be dramatically reduced, for example, by a decision to migrate to an urban area, apart from differences in retail prices between urban and rural areas and earning power. At least two reasons could account for such a reduction.

First, semisubsistence producers of a food staple avoid retailing and other marketing costs when they consume out of own production. Apart from greater risks associated with growing nonfood crops, such a cost saving may be an important additional incentive for semisubsistence farmers to continue growing staples, and to resist commercialization and specialization. In effect, a decision to migrate to an urban area, or even to reduce staple production below household "requirements," is at the same time a decision to pay a substantially higher price for that staple at the margin, thus affecting consumption.

Second, assume that two persons with the same demand preferences and levels of income and facing the same prices differ only in the activity levels necessary for earning that income. Energy requirements will be greater for the person engaged in the more active occupation.

Under a reasonable set of assumptions, more active persons will spend more for food than less active persons; more important, diets of those who are more active will be proportionately more staple-based, since staples are relatively inexpensive sources of calories (Bouis forthcoming). If rural occupations require a greater energy expenditure than urban occupations, one would expect that rural populations would consume more calories and more food staples, controlling for prices and income (some empirical evidence of this is provided in Bouis 1991 and Ravallion 1990). Again, how income is earned affects demand.[7]

[6]Landless agricultural laborers are included in this group, although, to the extent that they receive in-kind wages in the form of the staple food, they may behave like semisubsistence producers. In many countries, members of producer households will also earn income as agricultural laborers. Again, such categorizations are simplifications and are intended to make a point without loss of generality.

[7]Other plausible but empirically less tractable reasons can be given for arguing that producers of a food will eat more of that food. Aside from the intrinsic satisfaction of eating what they have grown themselves, farmers know the quality of their own produce and are familiar with ways to prepare it. Even though alternative foods may become available, habits change slowly.

It is possible that, controlling income and any observed differences in retail prices across geographical regions,[8]

$$q_{subsis} > q_{commer} > q_{othrur} > q_{urban}. \qquad (3)$$

Over time, as aggregate per capita income increases in developing countries and as their economies undergo structural transformation, θ_{subsis} and θ_{othrur} will decline (they are negatively correlated with income) and q_{commer} and θ_{urban} will increase (they are positively correlated with income).[9] One would expect, then, to observe a negative correlation between Q and Y over time, as structural transformation takes place. This correlation is independent of the influence of income per se on demand, and it measures the effect of changes in the way that income is earned. This, in turn, leads to an upwardly biased (in absolute value) estimate of the income elasticity.[10] Although, for a time, this biased estimate may provide accurate predictions of aggregate demand as structural transformation proceeds, at some point this transformation process runs its course, and food consumption patterns will diverge from those predicted using time-series income elasticity estimates.

Demand for Nonstaple Foods

The result just discussed for equation (3) provides a plausible explanation for declining rice consumption throughout Asia, in addition to possible income and price influences. Incorporating effects (1), (2), and (3), outlined in the introduction, simply reinforces this result, implying increased consumption of wheat, meat, fish, and fruits.

Typically, baked wheat products are more readily available in urban markets than in rural areas. They provide some variety in staple food consumption and are less labor-intensive to prepare for meals.

In addition, a greater variety of meat, fish, dairy products, and fruits will be available in urban markets than in rural areas, encouraging habitual consumption of these foods. Adults who have recently migrated from rural to urban areas may resist significant changes in accustomed dietary patterns, but their children may be less resistant. Because adult energy requirements may be lower in urban areas (due to less strenuous occupations), hunger in urban areas may be more easily satiated (for a given total expenditure on food). Therefore, a higher percentage of calories may be derived from higher-cost nonstaple foods.

This section has provided several arguments for expecting structural shifts in food demand patterns in Asia. The next two sections will attempt to measure their importance empirically, using data sets from Taiwan and China.

Taiwan Household Expenditure Surveys

An Overview of Changing Food Consumption Patterns in Taiwan

First, average diets may change rapidly in countries experiencing rapid economic growth and structural transformation. In the 30 years between 1959–61 and 1989–91, per capita rice consumption in Taiwan declined by one-half (Table 1). Consumption of meat (including pork, chicken, and beef) quadrupled. Fruit consumption increased five times and fish consumption doubled. Thus, substitution of calories obtained from nonstaple food sources for staple food sources has been substantial.

Table 2 shows indexes of real per capita income and food price levels for these food groups for 1971, 1981, and 1991 (1981=100), using the consumer price index as a deflator. Incomes have increased substantially; prices of wheat and meat have fallen

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[8]That $q_{commer} > q_{othrur}$ assumes that the price effect due to the ability to "buy" own production at favorable prices is stronger than the energy expenditure effect. Commercial producers presumably are using mechanized technologies or hiring in labor. Their activity levels may not be substantially different from those of urban residents. Such an assumption is not crucial to the arguments being made.

[9]At some later stage of development, especially as rural population densities decline, θ_{commer} may also decline.

[10]Aggregate domestic production may increase or decrease, depending on the profitability of commercial production of the staple relative to other commercial crops. Related to this, staple food prices could increase, decrease, or remain constant, depending on government trade and buffer stock polices.

Table 1—Per capita annual food consumption, Taiwan, 1940–92

Period	Rice	Wheat	Sweet Potato	Meat	Fish	Fruit
			(kilograms/capita/year)			
1940–44	109	0	91	11	10	27
1949–51	133	7	66	13	12	16
1959–61	137	22	62	16	23	20
1969–71	136	25	24	25	33	43
1979–81	105	24	4	40	38	72
1989–91	68	29	2	62	45	108
1992	64	29	2	66	42	100

Source: Taiwan, Council for Agricultural Planning and Development, various years.

Table 2—Indexes of real income, expenditure, and real food price levels for food groups, 1971, 1981, and 1991

	Per Capita		Real Food Price				
Year	Income	Expenditure	Rice	Wheat	Meat	Fish	Fruit
			(1981 = 100)				
1971	41	58	n.a.	n.a.	n.a.	n.a.	n.a.
1981	100	100	100	100	100	100	100
1991	213	192	99	79	77	149	134

Sources: Taiwan, Department of Agriculture and Forestry 1981, 1991; Taiwan, Department of Budget, Accounting and Statistics 1992.

Note: N.a. means not available.

by one-fifth, while fish and fruit prices have risen by one-third to one-half. To what extent do increases in income and declining food prices explain the dramatic transformation of Taiwanese diets shown in Table 1, as compared with changing tastes and lifestyles? Conventional wisdom, of course, holds that rising incomes and declining food prices explain most of the change.

An ideal data set for measuring structural shifts in food demand patterns would record foods consumed, prices, income by source, and standard demographic information for a large number of families before and after these families migrated from rural to urban areas. Such a longitudinal data set would record this information across two or more generations. To the best of the authors' knowledge, such complete data are unavailable, however.

A next best alternative (not involving observations for the same households over time) would be two national cross-sectional household surveys taken several years apart. Cross-sectional survey data are available for Taiwan for 1981 and 1991, consisting of 11,886 observations in 1981 and 12,734 observations in 1991. These surveys contain household-level information on (1) age and gender of family members, (2) total expenditures on specific food and nonfood items, (3) income earned and occupations of various household members, and (4) geographic location, among other variables.

A major shortcoming of the data set for this analysis was absence of data on food quantities or prices. Prices for specific food items were obtained from published sources (Taiwan Department of Agriculture and Forestry 1981, 1991), which provided county- and region-specific variation in prices. As outlined later in the paper, the dependent variables in the regression estimations are budget shares for various foods, so that food quantity data are not required for these estimations. Prices for rice, wheat flour, chicken, eggs, and fruit are available at the county level. Prices for other foods are available at the regional level for Taipei, Taichung, Tainan, and Kaohsiung. Weighted average prices for major meat products (pork, beef, mutton, and chicken), six major fish products (sea bream, marlin and sailfish, tuna, cuttlefish, striped prawn, and shrimps), and three major fruits (banana, pineapple, and citrus) were used as the prices of meat, fish, and fruit, respectively, in the regression analysis. County and provincial-level food budget shares for these disaggregate, individual foods for 1981 were used as weights in computing both the 1981 and 1991 prices for the aggregate food groups.[11]

Tables 3 and 4 give per capita food consumption levels for 1981 and 1991, respectively, disaggregated by villages, towns, and cities (that is, moving from the least to the most urbanized settings) and income quintile. Table 5 provides similar information disaggregated by farming and nonfarming occupations for 1981 and 1991. In constructing these

[11]Household-level food quantity data are required for construction of Tables 4, 5, 6, 10, 11, 12, 13, and 14. These were obtained by dividing average household expenditures for a specific food (from the household surveys) by national per capita availability (from published food balance sheets) to obtain an average national-level price for each food. The household-level expenditure data for individual foods were divided by national prices to obtain a household-level estimate of quantity consumed.

Table 3—Annual per capita food consumption, by region and expenditure group, Taiwan, 1981

Region/Income[a]	Rice	Wheat	Meat	Fish	Fruit
	(kilograms/capita/year)				
City	86.9	28.6	46.8	42.9	105.5
1	83.3	16.9	29.2	25.9	55.2
2	86.5	24.3	41.6	37.8	89.0
3	87.7	31.7	51.1	46.4	115.2
4	88.9	37.4	59.0	55.1	144.9
5	90.6	47.4	71.5	68.4	182.4
Town	100.6	21.9	39.6	34.0	75.9
1	96.9	15.5	28.8	23.0	46.7
2	101.5	21.9	40.0	34.2	76.1
3	103.6	28.2	48.0	43.7	97.4
4	104.0	32.6	57.6	50.3	127.0
5	105.9	34.0	65.3	61.9	162.6
Village	114.4	17.9	32.0	28.3	52.7
1	107.3	12.8	26.2	23.3	36.3
2	121.9	21.1	35.5	31.5	63.0
3	126.0	32.9	43.9	40.9	92.2
4	132.8	34.0	57.6	47.7	112.7
5	142.8	42.1	78.1	50.1	162.2
Average	99.4	23.4	40.1	35.8	80.5
1	100.0	14.3	27.4	23.7	42.6
2	100.5	22.7	39.4	35.0	78.2
3	97.5	30.9	49.2	44.9	107.1
4	97.7	35.9	58.6	53.1	137.0
5	97.7	44.5	70.9	65.7	177.1

Source: Taiwan Household Expenditure Surveys 1981.
Note: To compute food consumption levels of various groups, an implicit aggregate price for each commodity is estimated, based on food expenditure and food balance data. This price is used to deflate the food expenditure to derive food consumption by income group and region.
[a]The ranges of per capita expenditure in Taiwanese dollars (NT$ in real 1981 prices) for five groups of households are: 1: < 30,000; 2: 30,000–45,000; 3: 45,000–60,000; 4: 60,000–90,000; and 5: > 90,000.

Table 4—Annual per capita food consumption, by region and expenditure group, Taiwan, 1991

Region/Income[a]	Rice	Wheat	Meat	Fish	Fruit
	(kilograms/capita/year)				
City	61.1	35.4	70.0	45.5	122.3
1	57.4	9.8	33.6	21.1	36.5
2	64.3	18.9	48.4	29.3	61.8
3	61.6	23.8	59.0	37.1	87.3
4	61.7	31.7	68.8	44.6	112.2
5	59.8	46.4	79.2	52.3	156.5
Town	68.3	27.7	60.3	37.5	98.3
1	64.3	10.7	39.2	22.3	38.0
2	69.3	16.4	49.4	29.2	66.5
3	69.1	21.8	55.4	34.2	81.4
4	68.3	28.7	63.1	39.2	102.8
5	66.9	41.8	70.2	45.0	136.2
Village	79.0	18.4	56.2	35.6	92.5
1	69.0	9.1	39.1	22.6	46.0
2	73.0	13.4	47.5	29.2	64.5
3	78.1	16.6	55.6	35.0	83.9
4	83.4	21.2	63.1	40.0	109.5
5	88.8	31.7	68.0	46.4	156.9
Average	67.6	28.9	63.5	40.4	107.2
1	66.3	9.7	38.7	22.4	42.4
2	70.0	15.5	48.4	29.2	64.8
3	69.4	21.0	56.5	35.3	83.9
4	67.7	28.9	65.7	41.8	108.3
5	64.6	43.6	75.5	49.6	150.5

Source: Taiwan Household Expenditure Surveys 1991.
Note: To compute food consumption levels of various groups, an implicit aggregate price for each commodity is estimated, based on food expenditure and food balance data. This price is used to deflate the food expenditure to derive food consumption by income group and region.
[a]The ranges of per capita expenditure in Taiwanese dollars (NT$ in real 1981 prices) for five groups of households are: 1: < 30,000; 2: 30,000–45,000; 3: 45,000–60,000; 4: 60,000–90,000; and 5: > 90,000.

tables, all households were placed in one of five income quintiles, based on real income, with 1981 used as the base.

In comparing food consumption between villages, towns, and cities, or between farming and nonfarming occupations, within identical income groups (say income quintile 3) for a specific year, note that rice consumption is lower in more urbanized areas and occupations, while wheat, meat, fish, and fruit consumption is somewhat higher (egg consumption is about equal between urban and rural areas and therefore is not shown in the tables). These differences presumably are due to structural differences in tastes and lifestyles between geographic locations and occupations.[12]

When food consumption is compared across income quintiles for a given year and geographic location or occupation, income elasticities appear to be high for all foods except rice. Table 6 shows the difference in consumption levels between 1981 and 1991 for income quintile 3 by geographic location and by occupation. These differences in food consumption are due to some combination of price effects and structural changes *within* geographic loca-

[12]Urban-rural *retail* price differentials may explain some of the difference in consumption levels between urban and rural areas. However, rural consumption is lower for several foods for which the rural price can be expected to be lower than the urban price.

Table 5—Annual per capita food consumption, by year, occupation, and expenditure group, Taiwan

Region/Income[a]	Rice	Wheat	Meat	Fish	Fruit
	(kilograms/capita/year)				
1981					
Nonfarming	93.2	25.5	42.6	38.5	90.3
1	92.0	15.6	28.4	24.6	48.7
2	93.2	23.2	40.2	36.0	82.1
3	93.4	31.3	49.9	45.5	109.7
4	94.7	36.5	58.4	53.9	139.3
5	96.0	45.2	69.9	66.4	178.7
Farming	120.9	16.2	31.3	26.5	46.8
1	112.0	12.3	26.1	22.4	33.7
2	133.6	20.6	35.9	30.8	60.2
3	139.4	27.4	42.3	38.6	81.2
4	142.3	27.9	60.8	41.2	102.7
5	146.8	23.2	99.3	44.0	128.8
1991					
Nonfarming	65.3	30.7	64.5	41.0	110.1
1	64.6	10.0	39.2	22.6	40.6
2	67.9	16.5	48.4	28.9	64.8
3	66.9	22.0	56.6	35.0	84.3
4	65.4	29.7	65.9	41.9	108.1
5	62.8	44.5	75.9	49.7	151.8
Farming	84.2	16.6	55.8	36.1	86.3
1	69.0	9.3	37.8	22.1	45.1
2	76.3	12.7	48.4	30.0	64.7
3.	81.3	15.8	55.8	36.6	81.8
4	90.7	20.2	63.5	40.8	110.3
5	107.6	24.3	65.6	46.7	120.9

Source: Taiwan Household Expenditure Surveys 1981, 1991.
Note: To compute food consumption levels of various groups, an implicit aggregate price for each commodity is estimated, based on food expenditure and food balance data. This price is used to deflate the food expenditure to derive food consumption by income group and region.
[a]The ranges of per capita expenditure in Taiwanese dollars (NT$ in real 1981 prices) for five groups of households are: 1: < 30,000; 2: 30,000–45,000; 3: 45,000–60,000; 4: 60,000–90,000; and 5: > 90,000.

Table 6—Change in per capita food consumption between 1981 and 1991, for income quintile 3 and the national average, Taiwan

Location/Occupation	Rice	Wheat	Meat	Fish	Fruit
	(kilograms/capita/year)				
Income quintile 3					
City	−26.1	−7.9	+7.9	−9.3	−27.9
Town	−34.5	−6.4	+7.4	−9.5	−16.0
Village	−47.9	−16.3	+11.7	−5.9	−8.3
Nonfarming	−26.5	−9.3	+6.7	−10.5	−25.4
Farming	−58.9	−11.6	+13.5	−2.0	+0.6
National	−28.1	−9.9	+7.3	−9.6	−23.2
National average (all income groups)	−30.8	+5.5	+23.4	+4.6	+26.7

Source: Tables 3, 4, and 5.

tion or occupation between 1981 and 1991, roughly controlling for differences in real income. Note that rice consumption declines substantially between 1981 and 1991, even though the rice price changed little. The decline is much higher for farming than for nonfarming populations. This suggests a considerable structural shift in demand.

Meat prices declined between 1981 and 1991, while fish and fruit prices increased. Thus, the positive changes for meat and the negative changes for fish and fruit in Table 6 are to be expected. Price effects and the hypothesized positive structural shifts when income is controlled reinforce one another for meat. Price effects outweigh the hypothesized positive structural shifts for fish and fruit. Nevertheless, note that fruit consumption increased among those in farming occupations, despite a substantial increase in price. Apparently, structural shifts for this group outweighed price effects.

Having provided an intuitive overview of possible structural influences that have caused food consumption patterns to change in Taiwan between 1981 and 1991, these influences are documented and measured econometrically.

Model Specification

An almost ideal demand system (AIDS) is used as the basic modeling framework (Deaton and Muellbauer 1980). The AIDS model in the budget share form is expressed as

$$w_i = A_i + B_i \log(X/P) + \Sigma r_{ij} \log(p_j), \quad (4)$$

for $i, j = 1, \ldots n$, where w_i is the budget share of the i^{th} commodity, X is total consumption expenditure, p is commodity price, P is a price index defined by

$$\log(P) = a_0 + \Sigma_k A_k \log(p_k) + 1/2\ \Sigma_k \Sigma_j r_{kj} \log(p_k) \log(p_j), \quad (5)$$

and a_0, A_i, B_i, and r_{ij} are parameters to be estimated.

The effects of nonincome and nonprice factors (structural shifts) on food consumption can be introduced into the AIDS equations by allowing any subset of parameters (designated here as vector Z) to depend on these structural variables.

To incorporate the effects of the Z variables into the AIDS, it is assumed that the parameters A_i and B_i

(but not the parameters r_{ij}) of the demand system in equations (4) and (5) depend linearly on the z_j's:

$$A_i = a_i + \Sigma_s a_{is} z_s, \qquad (6)$$

and

$$B_i = b_i + \Sigma_s b_{is} z_s, \qquad (7)$$

where $Z = (z_1, \ldots, z_m)$, a_i, a_{is}, b_i, and b_{is} are parameters to be estimated.

The adding-up restrictions for the demand system, equations (4)–(7), require

$$\Sigma_i a_i = 1, \qquad (8a)$$

$$\Sigma_i a_{is} = \Sigma_i b_{is} = 0, \text{ for } s = 1, \ldots, m, \qquad (8b)$$

$$\Sigma_i b_s = 0, \qquad (8c)$$

and

$$\Sigma_j r_{ij} = 0. \qquad (8d)$$

The homogeneity restriction is

$$\Sigma_j r_{ij} = 0, \qquad (9)$$

and the cross-equation symmetry restrictions can be imposed as

$$r_{ij} = r_{ji} \text{ for } i \neq j. \qquad (10)$$

To specify a stochastic structure for equations (4)–(7), using h to index household-level information, the error term, ε_{ih}, may be added to equation (4).

The demand model presented above is a nonlinear system. Assuming that ε_{ih} follows a multivariate normal distribution, this nonlinear system of equations can be estimated by the full information, maximum likelihood method (FIML) (Amemiya 1977), with the imposition of the homogeneity and symmetry restrictions in equations (9) and (10).

The commodities included in the system are rice, wheat, meat, fish, fruit, other foods, and all nonfoods, which are aggregated.

In applying the model to the data for Taiwan, Z is a vector with nine elements: four dummies (town, city, occupation, and $d_{91} \times$ *village*, the last representing "urbanization" and other structural changes over the period 1981–91 *within* rural areas; $d_{91} = 1$ for 1991 survey data and $d_{91} = 0$ for 1981 survey data), and five demographic variables (family size and various age composition variables). Since, the dependent variables are in budget shares and the error-covariance matrix is singular, one of the shares is dropped during estimation.

The expenditure (e_{iy}), uncompensated price (e_{ij}), and compensated price (ce_{ij}) elasticities are derived as follows:

$$e_{iy} = 1 + (b_i + \Sigma_s b_{is} z_s) / w_i, \qquad (11)$$

$$e_{ij} = -\delta_{ij} + r_{ij} / w_i - (b_i + \Sigma_s b_{is} z_s) [a_i + \Sigma_s a_{is} z_s + \Sigma_k r_{kj} \log(p_k)] / w_i, \qquad (12)$$

and

$$ce_{ij} = e_{ij} + w_j e_{iy}, \qquad (13)$$

where δ_{ij} is the Kronecker delta.

In equations (11)–(13), expenditure and price elasticities of demand vary as the level of urbanization, occupation, family structure, and the other factors change to the extent that coefficients associated with the z_i variables are statistically significant from zero.

Mathematically, the impact of each structural factor z_i on the commodity demand can be derived as follows.[13] First, differentiate equation (4) with respect to the m^{th} z_i, holding all other variables constant, which gives

$$dw_i = a_{im}\, dz_m - (b_i + \Sigma_{s \neq m} b_{is} z_s) [\Sigma_j a_{js} \log(p_j)] dz_m - [b_{im} \Sigma_j a_{js} \log(p_j)]\, dz_m 2 + b_{im}$$

[13]The effects of various structural variables on demand for specific commodities can be evaluated, first, by taking the first-order derivatives of equations (11) through (13) with respect to z_i (and after appropriate manipulations, calculating "elasticities of elasticities of demand") or, second, by calculating the total differentiation of equation (4), given that equations (5) through (10) hold with respect to each z_i, keeping income and price constant (for example, at the sample means).

$$[\log X - a_0 - \Sigma_j(a_j + \Sigma_{s\neq m}a_{js}z_s)\log(p_j)$$

$$- \Sigma_i\Sigma_j r_{ij} \log(p_j)\log(p_j)]\ dz_m. \qquad (14)$$

Because equation (14) controls for the income and price changes, dividing equation (14) by w_i implies the percentage change of i^{th} commodity consumption (q_i) due to the different level of z_m. That is,

$$dw_i / w_i = dq_i / q_i$$

$$= \{a_{im}\ dz_m - (b_i + \Sigma_{s\neq m}b_{is}z_s)$$

$$[\Sigma_j a_{js}\ log(p_j)]dz_m$$

$$- [b_{im}\ \Sigma_j a_{js} \log(p_j)]dz_m 2 + b_{im}$$

$$[\log X - a_0 - \Sigma_j(a_j + \Sigma_{s\neq m}a_{js}z_s)$$

$$\log(p_j) - \Sigma_i\Sigma_j r_{ij}$$

$$\log(p_j)\log(p_j)]dz_m\} / w_i. \qquad (15)$$

Econometric Estimations

The detailed estimation results are shown in Table 7. Expenditure and own-price elasticities, calculated from the Table 7 coefficients, are presented in Tables 8 and 9, respectively. Table 7 shows that almost all of the coefficients on variables representing structural shifts are significantly different from zero for each food. The net effects of these variables on observed differences in consumption between geographic locations and observed changes in consumption over time are discussed later in this section.

Income and Price Elasticities. The expenditure elasticities themselves, for any given food group, do not vary greatly between villages, towns, and cities. The greatest variation across geographic location occurs for rice. As expected, all expenditure elasticities are positive, even for rice, for which per capita consumption declined significantly between 1981 and 1991. With the exception of rice, all expenditure elasticities fall in a range between 0.5 and 1.0. The elasticities for meat and fish, in particular, are lower than those estimated by Capps et al. (1994) using time-series data that did not take structural shifts in demand into account.

With the exception of rice and meat, own-price elasticities are above 1.0 (in absolute value). In that expenditure elasticities are relatively low, this suggests generally strong cross-price substitution effects, except for meat.[14]

Magnitudes of Structural Shifts in Demand. While measured structural shifts in demand are significantly different from zero in a statistical sense, such shifts may or may not be important from a policy perspective. As seen in Table 1, the diets of Taiwanese consumers changed substantially between 1981 and 1991. How much of this change was due to price and income effects and how much was due to structural factors? Tables 10–14 provide information on the magnitude of shifts in demand due to various structural factors calculated from the estimated regression coefficients.

Table 10 provides estimates of differences in consumption of various foods, after controlling for income, price, and demographic differences (1) between villages, towns, and cities in 1981, (2) within villages between 1981 and 1991, and (3) between farming and nonfarming occupations in 1981. In general, rice consumption declined and fruit consumption increased with greater urbanization. The percentage changes for meat, fish, wheat, and other foods are positive but lower than for fruit.

Table 11 presents demographic effects such as size of household and ages of household members, controlling urbanization and price and income effects. As families become smaller, controlling age composition effects, there is a tendency to eat somewhat less rice and more wheat and nonstaple foods.

Changes in age composition shown in Table 11 affect consumption in at least two ways. First, because young children are physically small and people over 50 years of age are likely to be less active,

[14]Real chicken prices fell substantially between 1981 and 1991, more than pork and beef prices fell, and chicken consumption increased more than consumption of pork and beef. The estimated low price response for meat in the aggregate may, to some extent, reflect shortcomings in not having household-level price data and having to use country- and provincial-level prices instead (see footnote 11). It may also be that the now wealthy consumers of Taiwan have a relatively strong desire to eat meat. They may be willing to substitute various types of meat within this aggregate group in response to changing prices.

Table 7—Nonlinear FIML parameter estimates of a dynamic AIDS model, Taiwan

	Commodity (i)					
Parameters	**Rice**	**Wheat**	**Meat**	**Fish**	**Fruit**	**Other Foods**
			(kilograms/capita/year)			
a_i (base)	−0.2996	0.0275	−0.1332	0.1924	0.2737	0.3339
	(−17.61)	(2.85)	(−8.36)	(14.28)	(14.95)	(10.08)
a_i – (town)	0.0668	−0.0182	−0.0098	0.0240	−0.0405	−0.0799
	(17.97)	(−6.62)	(−2.31)	(5.38)	(−6.45)	(−7.23)
a_i – (city)	0.1041	−0.0197	0.0009	0.0189	−0.0455	−0.0690
	(25.46)	(−7.23)	(0.19)	(4.06)	(−7.24)	(−6.26)
a_i – (village × d91)[a]	0.1235	−0.0165	−0.0343	−0.0246	−0.0582	−0.1019
	(23.43)	(−4.85)	(−4.81)	(−3.89)	(−8.30)	(−7.47)
a_i – (occupation)	−0.0526	−0.0042	0.0123	0.0163	0.0219	0.0020
	(−15.93)	(−1.71)	(3.68)	(4.57)	(5.33)	(0.22)
a_i – (family size)	−0.0462	−0.0062	−0.0011	0.0158	−0.0051	0.0006
	(−16.60)	(−4.65)	(−0.42)	(5.97)	(−1.82)	(0.10)
a_i – (percent < 7 years)	0.0817	−0.0035	−0.0365	−0.0356	−0.0361	−0.0921
	(9.82)	(−0.83)	(−4.65)	(−4.56)	(−3.93)	(−4.10)
a_i – (18–40 years percent)	0.1053	−0.0116	−0.0140	−0.0152	−0.0357	0.1618
	(13.78)	(−2.89)	(−1.77)	(−1.98)	(−4.09)	(8.36)
a_i – (percent 41–50 years)	0.0766	−0.0231	−0.0143	0.0013	−0.0244	0.0877
	(9.92)	(−5.38)	(−1.82)	(0.17)	(−2.77)	(4.39)
a_i – (percent > 50 years)	0.0568	−0.0195	−0.0128	−0.0045	−0.0360	0.0276
	(7.68)	(−4.55)	(−1.55)	(−0.56)	(−3.91)	(1.34)
b_i (base)	−0.0512	0.0036	−0.0259	−0.0291	0.0053	−0.0304
	(−30.46)	(3.88)	(−14.66)	(−15.74)	(2.49)	(−6.92)
b_i – (town)	0.0150	−0.0035	−0.0021	0.0044	−0.0088	−0.0149
	(21.23)	(−6.65)	(−2.38)	(4.85)	(−7.43)	(−7.02)
b_i – (city)	0.0243	−0.0039	0.0005	0.0031	−0.0102	−0.0113
	(32.20)	(−7.48)	(0.48)	(3.24)	(−8.66)	(−5.27)
b_i – (village × d91)[a]	0.0259	−0.0027	−0.0088	−0.0072	−0.0135	−0.0226
	(25.47)	(−3.93)	(−5.32)	(−5.12)	(−9.83)	(−8.06)
b_i – (occupation)	−0.0118	−0.0005	0.0029	0.0039	0.0051	0.0009
	(−18.47)	(−1.12)	(4.17)	(5.37)	(6.33)	(0.48)
b_i – (family size)	−0.0105	−0.0010	−0.0003	0.0036	−0.0003	0.0003
	(−19.03)	(−3.82)	(−0.57)	(6.46)	(−0.48)	(0.22)
b_i – (percent < 7 years)	0.0184	−0.0005	−0.0053	−0.0056	−0.0065	−0.0213
	(11.17)	(−0.58)	(−3.21)	(−3.49)	(−3.55)	(−4.81)
b_i – (percent 18–40 years)	0.0223	−0.0015	−0.0001	−0.0006	−0.0057	−0.0303
	(14.53)	(−1.80)	(−0.07)	(−0.39)	(−3.23)	(7.81)
b_i – (percent 41–50 years)	0.0150	−0.0036	−0.0015	0.0019	−0.0035	0.0171
	(9.43)	(−4.17)	(−0.90)	(1.20)	(−1.96)	(4.25)
b_i – (percent > 50 years)	0.0102	−0.0031	−0.0019	−0.0007	−0.0055	0.0062
	(6.74)	(−3.61)	(−1.10)	(−0.40)	(−2.96)	(1.50)
r_{i1} (rice)	0.0208					
	(4.83)					
r_{i2} (wheat)	0.0254	−0.0058				
	(18.19)	(−5.32)				
r_{i3} (meat)	−0.0024	−0.0149	0.0523			
	(−1.28)	(−15.29)	(24.57)			
r_{i4} (fish)	−0.0010	−0.0009	−0.0123	−0.0346		
	(−0.65)	(−1.63)	(−9.70)	(−27.77)		
r_{i5} (fruit)	−0.0111	0.0050	−0.0139	−0.0147	−0.0156	
	(−7.59)	(5.51)	(−8.94)	(−15.28)	(−8.77)	
r_{i6} (other food)	−0.0239	−0.0132	−0.0231	−0.0503	0.0321	−0.0363
	(−6.86)	(−9.56)	(−7.62)	(−23.15)	(14.21)	(−5.19)
a_0	16.1333	16.1333	16.1333	16.1333	16.1333	16.1333
	(18.19)	(18.19)	(18.19)	(18.19)	(18.19)	(18.19)

Notes: Sample size: 24,233. The complete almost ideal demand system (AIDS) is estimated using nonlinear full information, maximum likelihood (FIML) measure with the imposition of the homogeneity and symmetry restrictions. The parameter estimates converge for FIML after 22 iterations, using converge = 0.001 as the convergence criteria. The numbers in parentheses are t-values.

[a]d91 is a dummy variable for 1991.

Table 8—Budget shares and expenditure elasticities evaluated at the sample mean, Taiwan, 1981–91

	Sample Mean of Budget Share				Expenditure Elasticities			
Commodity	Mean	Village	Town	City	Mean	Village	Town	City
Rice	4.2	6.4	4.0	3.0	0.173	0.285	0.065	0.129
Wheat	1.1	1.0	1.2	1.2	0.768	0.895	0.739	0.721
Meat	6.6	7.3	6.5	6.3	0.569	0.591	0.547	0.571
Fish	5.6	6.1	5.4	5.5	0.605	0.578	0.633	0.603
Fruit	3.8	3.5	3.8	3.9	0.807	0.919	0.794	0.752
Other food	14.0	15.1	14.2	1.3	0.795	0.828	0.775	0.788
Nonfoods	64.6	60.6	65.0	66.9	1.192	1.217	1.199	1.173

Source: Taiwan Household Expenditure Surveys 1981, 1991.

Table 9—Price elasticities evaluated at the sample mean, Taiwan, 1981–91

	Uncompensated Own Price Elasticity				Compensated Own Price Elasticity			
Commodity	Mean	Village	Town	City	Mean	Village	Town	City
Rice	−0.609	−0.804	−0.614	−0.390	−0.612	−0.786	−0.612	−0.386
Wheat	−1.514	−1.578	−1.503	−1.489	−1.505	−1.569	−1.492	−1.481
Meat	−0.243	−0.317	−0.230	−0.200	−0.206	−0.274	−0.194	−0.164
Fish	−1.638	−1.599	−1.656	−1.652	−1.604	−1.564	−1.622	−1.619
Fruit	−1.412	−1.438	−1.415	−1.397	−1.381	−1.405	−1.385	−1.367
Other food	−1.259	−1.237	−1.259	−1.276	−1.148	−1.127	−1.149	−1.172
Nonfoods	−1.641	−1.701	−1.651	−1.598	−0.870	−0.964	−0.872	−0.813

Table 10—The effects of urbanization and occupation changes on annual per capita food consumption in Taiwan between 1981 and 1991

	Structural Changes			
Commodity	Move from Village to Town in 1981	Move from Village to City in 1981	Village Difference between 1981 and 1991	Switch from Farming to Nonfarming in 1981
Percentage changes		(percent)		
Rice	−11.9	−22.8	−23.3	−13.6
Wheat	7.5	19.0	−23.9	14.1
Meat	5.0	4.5	10.7	3.2
Fish	3.2	9.9	16.9	6.0
Fruit	24.3	37.6	45.4	18.5
Other food	2.5	−1.5	10.5	1.5
Absolute changes		(kilograms)		
Rice	−13.6	−26.0	−26.6	−15.5
Wheat	1.3	3.4	−4.3	2.5
Meat	1.6	1.5	4.4	1.0
Fish	0.9	2.8	4.8	1.7
Fruit	12.8	19.8	23.9	9.8

Table 11—The effects of demographic changes on annual per capita food consumption in Taiwan between 1981 and 1991

Commodity	Hypothetical Structural Changes: Family Size Doubles	100 Percent 1–7 Years[a]	100 Percent 18–40 Years[a]	100 Percent 41–50 Years[a]	100 Percent Over 50 Years[a]
			(kilograms/capita/year)		
Percentage change					
Rice	1.1	–27.0	–5.2	6.7	9.7
Wheat	–8.9	–13.2	–22.8	–35.6	–35.8
Meat	–3.0	–23.2	–10.9	–7.0	–7.6
Fish	–5.1	–21.0	–11.8	–10.7	–4.7
Fruit	–8.3	–14.9	–11.2	–14.2	–22.8
Other food	–2.0	2.1	5.5	2.1	–3.1
Absolute change (kilograms)					
Rice	0.9	–22.4	–4.3	5.6	8.1
Wheat	–2.4	–3.5	–6.0	–9.3	–9.4
Meat	–1.5	–12.1	–5.7	–3.7	–4.0
Fish	–1.9	–8.0	–4.5	–4.1	–1.8
Fruit	–7.9	–14.1	–10.6	–13.4	–21.5

[a]Changes are calculated assuming that the entire population falls within the indicated age category.

aggregate per capita consumption of various foods is expected to decline if these age groups represent a higher percentage of the total population. Second, there may be generational differences in tastes, due either to recent secular influences (for example, media advertising) or changing tastes and nutritional requirements with age (for example, a decline in milk consumption). Older generations appear to prefer rice to wheat compared with younger generations. Younger generations prefer more fruit than older generations.

Tables 12 and 13 provide a disaggregation between villages and towns and between villages and cities, respectively, of several factors determining observed differences in consumption of food in 1981: (1) urbanization, (2) occupation, (3) family size and age structure, (4) income, and (5) prices. For rice, wheat, and fruit consumption, structural factors account for a higher percentage of the differences in consumption between geographic areas than income and price influences. For meat and fish consumption, income and price factors affect differences in consumption more than structural influences.

A disaggregation of villages in 1981 and 1991 is presented in Table 14 with a pattern similar to that in Tables 12 and 13; the structural factors strongly influence consumption of rice, wheat, and fruit, and price and income effects strongly influence meat consumption. However, the income and price effects are individually strong for most foods, but influence demand in opposite directions so that their joint influence tends to be much smaller.

Summary

Analysis of the household-level data for Taiwan for 1981 and 1991, which allows disaggregation by urban and rural areas and by occupation, for a time period during which there was rapid economic development and dramatic changes in the composition of diets in Taiwan, provides strong empirical support for the hypothesis that demand for food is substantially influenced not only by growth in family income and price changes, as might be expected, but also by differences in urban and rural lifestyles, the development of more advanced marketing systems, and occupational changes that are closely linked with increasing GNP per capita. Because urbanization is expected to proceed rapidly in a number of developing countries over the next several decades, projections of future global food supply and demand balances need to take such structural changes into account. While analysis of the Taiwan data serves a useful purpose in initial attempts to understand the magnitude and nature of such shifts, it is far more important from a global perspective to document and understand these phenomena for countries with larger populations such as China.

Table 12—Structural, income, and price factors contributing to differences in per capita food consumption between cities and villages, Taiwan, 1981

Commodity	Observed Change	Specific Structural Factors: Urbanization	Occupation	Family Size	Age Structure: Total	1–7 Years	18–40 Years	41–50 Years	Over 50 Years	Sum of Structural Factors	Income, Price, and Other Factors	Income Factors	Price and Other Factors
Percentage change							(percent)						
Rice	–24.0	–22.8	–6.6	–0.4	–2.5	–1.6	–0.3	–0.3	–0.3	–32.3	8.3	7.7	0.6
Wheat	59.8	19.0	6.5	1.7	0.7	–0.6	–1.6	1.6	1.3	27.9	31.9	43.2	–11.4
Meat	46.2	4.5	1.5	0.6	–1.2	–1.0	–0.7	0.3	0.3	5.4	40.9	34.2	6.6
Fish	51.6	9.9	2.9	1.0	–1.1	–0.9	–0.8	0.5	0.2	12.7	38.9	36.2	2.7
Fruit	100.2	37.6	8.9	1.6	0.1	–0.6	–0.8	0.6	0.8	48.2	52.0	45.1	6.9
Absolute change							(kilograms)						
Rice	–27.4	–26.0	–7.5	–0.5	–2.9	–1.8	–0.3	–0.4	–0.3	–36.8	9.4	8.8	0.6
Wheat	10.7	3.4	1.2	0.3	0.1	–0.1	–0.3	0.3	0.2	5.0	5.7	7.7	–2.1
Meat	14.8	1.5	0.5	0.2	–0.4	–0.3	–0.2	0.1	0.1	1.8	13.0	11.0	2.0
Fish	14.6	2.8	0.8	0.3	–0.3	–0.3	–0.2	0.1	0.1	3.6	11.0	10.2	0.8
Fruit	52.8	19.8	4.7	0.9	0.0	–0.3	–0.4	0.3	0.4	25.4	27.4	23.8	3.6

Table 13—Structural, income, and price factors contributing to differences in per capita food consumption between towns and villages, Taiwan, 1981

Commodity	Observed Change	Specific Structural Factors: Urbanization	Occupation	Family Size	Age Structure: Total	1–7 Years	18–40 Years	41–50 Years	Over 50 Years	Sum of Structural Factors	Income, Price, and Other Factors	Income Factors	Price and Other Factors
Percentage change							(percent)						
Rice	–12.0	–11.9	–4.5	–0.1	–2.6	–1.8	–0.2	–0.3	–0.3	–19.1	7.2	1.7	5.4
Wheat	22.3	7.5	4.5	0.6	1.0	–0.7	–1.2	1.6	1.2	13.5	8.8	19.7	–10.9
Meat	23.8	5.0	1.1	0.2	–1.1	–1.2	–0.6	0.3	0.3	5.1	18.6	14.6	4.1
Fish	20.1	3.2	2.0	0.4	–1.0	–1.0	–0.6	0.5	0.2	4.6	15.6	16.9	–1.3
Fruit	44.0	24.3	6.2	0.6	0.2	–0.7	–0.6	0.6	0.8	31.2	12.9	21.2	–8.3
Absolute change							(kilograms)						
Rice	–13.7	–13.6	–5.2	–0.1	–2.9	–2.0	–0.2	–0.4	–0.3	–21.9	8.2	2.0	6.2
Wheat	4.0	1.3	0.8	0.1	0.2	–0.1	–0.2	0.3	0.2	2.4	1.6	3.5	–1.9
Meat	7.6	1.6	0.3	0.1	–0.4	–0.4	–0.2	0.1	0.1	1.6	6.0	4.7	1.3
Fish	5.7	0.9	0.6	0.1	–0.3	–0.3	–0.2	0.1	0.0	1.3	4.4	4.8	–0.4
Fruit	23.2	12.8	3.2	0.3	0.1	–0.3	–0.3	0.3	0.4	16.4	6.8	11.1	–4.4

Table 14—Structural, income, and price factors contributing to changes in per capita food consumption in villages in Taiwin between 1981 and 1991

Commodity	Observed Change	Specific Structural Factors: Urbanization	Occupation	Family Size	Age Structure: Total	1–7 Years	18–40 Years	41–50 Years	Over 50 Years	Sum of Structural Factors	Income, Price, and Other Factors	Income Factors	Price and Other Factors
Percentage change							(percent)						
Rice	−30.9	−23.3	−1.8	−1.0	3.5	1.8	0.3	0.3	1.0	−22.6	−8.3	27.5	−35.8
Wheat	2.8	−23.8	1.8	3.7	−3.1	0.7	1.9	−1.6	−4.0	−21.4	24.2	86.3	−62.1
Meat	75.6	10.7	0.4	1.3	0.9	1.2	0.9	−0.3	−0.9	13.3	62.3	57.0	5.3
Fish	25.8	16.9	0.8	2.4	1.0	1.1	1.0	−0.5	−0.5	21.1	4.7	55.8	−51.1
Fruit	75.5	45.4	2.5	3.6	−1.6	0.6	0.9	−0.6	−2.6	49.9	25.6	88.6	−63.0
Absolute change							(kilograms)						
Rice	−35.3	−26.6	−2.1	−1.2	4.0	2.1	0.4	0.4	1.1	−25.9	−9.4	31.4	−40.8
Wheat	0.5	−4.3	0.3	0.7	−0.6	0.1	0.3	−0.3	−0.7	−3.9	4.4	15.5	−11.1
Meat	24.2	3.4	0.1	0.4	0.3	0.4	0.3	−0.1	−0.3	4.2	20.0	18.2	1.8
Fish	7.3	4.8	0.2	0.7	0.3	0.3	0.3	−0.1	−0.2	6.0	1.3	15.8	−14.5
Fruit	39.8	23.9	1.3	1.9	−0.9	0.4	0.5	−0.3	−1.4	26.2	13.6	46.7	−33.1

Provincial-level Data from China

An Overview of Food Consumption Patterns in China

For 1991, provincial-level information on quantities consumed of various foods, expenditures for these foods, and per capita income were obtained from China's State Statistical Bureau (SSB 1992). For each of 28 provinces, data are disaggregated by rural areas, small cities, and capital cities, giving 89 observations. Similar data for 1989 are available from SSB (1990), but only for urban areas; these data yield an additional 57 observations.

Average consumption levels in China are shown in Table 15. Similar to the data for Taiwan, grain consumption is higher in rural areas and consumption of various nonstaple foods is higher in urban areas. Again, the primary question to be addressed is the extent to which these differences can be explained by (1) differences in incomes and prices and (2) apparent structural shifts in demand.

In Table 16, food consumption data for income groups 5, 6, and 7 for rural areas are compared with income groups 2, 4, and 7 for urban areas. Such a comparison provides a rough control for income.

Grain consumption is 80 to 100 kilograms higher in rural areas.[15] Meat (pork, poultry, mutton, and beef) consumption is from 3 to 8 kilograms higher in urban areas. Vegetable consumption is higher in rural areas, except at very high income levels.

Table 15—Annual per capita food consumption, rural and urban, China, 1991

Food Commodity	Rural 1	Rural 2	Urban Small	Urban Capital
	(kilograms)			
Grain	199.4	196.5	138.7	118.6
Meat, fish, and their products				
Red meat	12.2	13.5	23.9	27.4
Pork	11.2	10.9	16.8	19.0
Beef and mutton	1.0	1.2	3.7	3.5
Poultry	1.3	1.4	3.4	4.9
Eggs	2.7	3.0	5.8	9.5
Milk	1.2	1.3	2.5	10.6
Fish	2.2	2.6	6.4	8.7
Edible oil	5.7	5.8	6.2	7.2
Vegetables	127.0	123.3	121.3	126.6
Fruit	6.8	7.7	32.8	38.0

Note: Figures for rural1 are weighted averages published by SSB (1993); all other figures (rural2, small city, and provincial capital city) are sample means based on provincial aggregate data (SSB 1992, 1993).

Model Specification

In specifying the demand equations to be estimated, the small sample size made it necessary to reduce the number of Z variables used for China, as compared with the analysis for Taiwan. Options were (1) to include separate intercept variables for rural/urban1/urban2 (labeled as the "intercept dummy" model in the tables; "urban1" refers to small cities and "urban2" refers to large, capital cities) or (2) to allow income elasticities to vary for rural/urban1/urban2 (labeled as the "slope dummy" model in the tables). The Wald chi-square statistics in Table 17 show that all combinations of the null hypotheses of equality between intercepts and slopes for rural/urban1/urban2 are rejected, whether homogeneity and symmetry conditions are imposed or not.

An AIDS model similar to that specified in the previous section was also applied to China's provincial-level data set. However, because of the small sample size and the high collinearity between the explanatory variables, the model either failed to converge or converged (when assigned a value for a_0, a priori), with few of the estimated parameters being statistically significant. Therefore, a linear approximation (LA) of AIDS—LA/AIDS; $\log(P)$ in equation (5) is replaced by $\Sigma_i w_i \log(p_i)$—was applied. An iterative, seemingly unrelated regressions procedure was used.

Both the intercept dummy and slope dummy models were estimated, using a two-step procedure. First, an LA/AIDS model was used to estimate demand (budget shares) for various aggregate food groups, including an aggregate "meat" group, which includes pork, beef and mutton, poultry, fish, and eggs. The results from this first-stage estimation were then used to estimate demand (budget shares) for various component foods for the aggregate meat group.

[15]It is questionable whether direct grain consumption is as high as 215 kilograms per capita in rural areas. This represents an energy intake of 2,050 calories per day before adding calories from nonstaple foods. It may be that some grain is used as livestock feed.

Table 16—Annual per capita food consumption by income group, China, 1991

Region/Income Group	Average Income	Per Capita Food Consumption Grain	Red Meat	Poultry	Fish	Edible Oil	Vegetables
	(yuan)	(kilograms)					
Weighted average							
Rural	709	199.5	12.2	1.3	2.2	5.7	127.0
1	234	179.5	7.6	n.a.	n.a.	4.0	89.1
2	550	201.5	11.6	0.7	0.6	5.4	127.7
3	693	211.4	12.7	1.6	2.6	6.1	138.7
4	890	215.0	14.5	1.4	3.3	6.5	146.8
5	1,193	215.4	15.8	2.5	5.8	7.2	150.7
6	1,703	213.5	17.5	n.a.	n.a.	7.4	146.8
7	2,721	215.2	20.1	n.a.	n.a.	8.5	146.0
Urban	1,713	127.9	22.2	4.4	8.0	6.9	135.3
1	1,007	120.1	16.5	2.7	6.1	5.6	117.2
2	1,240	122.5	18.8	3.3	6.8	6.1	119.7
3	1,439	123.4	19.8	3.7	7.2	6.3	125.3
4	1,671	126.5	21.4	4.3	7.8	6.6	129.2
5	1,951	128.9	23.0	4.8	8.1	7.0	135.6
6	2,283	138.8	24.8	5.3	8.9	7.6	144.8
7	2,957	148.7	28.3	6.4	9.0	8.5	158.9

Source: SSB 1992, 1993.
Notes: Figures for poultry and fish consumption in the rural area are computed based on aggregate provincial-level data with income levels of 546, 696, 836, and 1,202 yuan for rural income groups 2, 3, 4, and 5, respectively. n.a. means not available.

Table 17—Tests of differences in the consumption pattern between rural and urban populations, China

Hypothesis	Degrees of Freedom	Wald Chi-Square Statistics: Without Homogeneity and Symmetry	With Homogeneity and Symmetry	Critical Value (5 percent)
Unrestricted model				
Intercepts Rural = Urban1 = Urban2	14	143.18	118.44	23.68
Slope for Ln(X/P^*) Rural = Urban1 = Urban2	14	141.66	115.89	23.68
Intercept and slope Rural = Urban1 = Urban2	28	312.92	329.47	41.34
Intercept dummy model				
Rural = Urban1 = Urban2	14	166.18	208.23	23.68
Urban1 = Urban 2	7	36.77	86.61	14.07
Slope dummy model				
Rural = Urban1 = Urban2	14	164.56	205.55	23.68
Urban1 = Urban 2	7	37.91	87.17	14.07

Note: Urban1 and urban2 are small and large or capital cities, respectively.

The formula for the expenditure elasticities (e_{iy}) is the same as for the true AIDS model, but the price elasticity formula for LA/AIDS is defined as

$$e_{ij} = \delta_{ij} + r_{ij} / w_i - (b_i + \Sigma_s b_{is} z_s) [w_j + \Sigma_k w_k \log(p_k) (e_{kj} + \delta_{kj})] / w_i. \quad (16)$$

Econometric Estimations

The first-stage estimations are presented in Tables 18 and 19, and the second-stage estimations are presented in Tables 20 and 21. Income and price elasticities computed for the slope dummy model esti-

Table 18—Estimated parameters for the complete demand system, slope dummy model, China

Variable	Budget Share (W_i)						
	Grain	Meat	Edible Oil	Vegetables	Fruit	Other Foods	Beverages and Tobacco
$Ln(P_{grn})$	0.050	−0.035	−0.003	−0.052	0.010	0.007	−0.002
	(5.59)	(−2.74)	(−0.83)	(−6.48)	(1.67)	(1.10)	(−0.26)
$Ln(P_{meat\ and\ product})$	−0.035	0.198	−0.004	0.055	0.016	−0.004	−0.076
	(−2.74)	(5.73)	(−0.46)	(3.15)	(1.08)	(−0.28)	(−5.12)
$Ln(P_{oil})$	−0.003	−0.004	0.022	−0.014	−0.005	−0.005	0.004
	(−0.83)	(−0.46)	(5.47)	(−2.64)	(−0.92)	(−1.17)	(1.00)
$Ln(P_{vegetables})$	−0.052	0.055	−0.014	0.025	−0.002	−0.002	−0.016
	(−6.44)	(3.15)	(−2.64)	(1.63)	(−0.19)	(−0.19)	(−1.60)
$Ln(P_{fruit})$	0.011	0.016	−0.005	−0.002	0.010	−0.015	−0.014
	(1.67)	(1.08)	(−0.92)	(−0.19)	(0.63)	(−1.63)	(−1.72)
$Ln(P_{other\ food})$	0.007	−0.004	−0.005	−0.002	−0.015	0.041	−0.001
	(1.10)	(−0.28)	(−1.17)	(−0.19)	(−1.63)	(3.64)	(−0.18)
$Ln(P_{beverages\ and\ tobacco})$	−0.002	−0.076	0.004	−0.016	−0.014	−0.001	0.061
	(−0.26)	(−5.12)	(1.00)	(−1.60)	(−1.72)	(−0.18)	(4.92)
$Ln(P_{miscellaneous})$	0.023	−0.150	0.005	0.005	0.004	−0.020	0.044
	(2.84)	(−8.27)	(1.00)	(0.49)	(0.04)	(−2.20)	(4.45)
$Ln(X/P^*)$	−0.055	−0.031	−0.005	0.131	0.010	0.005	0.061
	(−3.58)	(−1.18)	(−0.78)	(8.22)	(0.94)	(0.40)	(3.69)
Urban1 × $Ln(X/P^*)$	−0.017	0.015	−0.003	−0.009	0.007	0.003	−0.005
	(−8.30)	(4.38)	(−3.09)	(−4.12)	(4.49)	(1.53)	(−2.34)
Urban2 × $Ln(X/P^*)$	−0.019	0.024	−0.002	−0.009	0.008	0.004	−0.010
	(−8.27)	(6.23)	(−2.32)	(−4.02)	(4.72)	(2.33)	(−4.08)
Ln(*family size*)	0.185	0.034	−0.007	0.054	−0.042	−0.086	−0.064
	(5.80)	(0.63)	(−0.55)	(1.67)	(−1.85)	(−3.35)	(−1.19)
Year dummy (1991)	−0.004	0.028	0.002	0.004	−0.001	−0.004	−0.017
	(−0.89)	(2.91)	(0.08)	(0.65)	(−0.27)	(−0.86)	(−3.27)
Constant	0.261	0.386	0.040	−0.705	0.043	0.203	−0.129
	(2.15)	(1.91)	(0.822)	(−5.52)	(0.48)	(2.07)	(−1.03)
R^2	0.926	0.783	0.608	0.700	0.759	0.627	0.456

Notes: System $R^2 = 0.999$. The model is estimated using Zellner's seemingly unrelated regression with the imposition of the homogeneity and symmetry restrictions. Regional dummies are not shown. The numbers in parentheses are t-values.

mations are reported in Table 22 (first-stage estimations) and Table 23 (second-stage estimations).

The grain expenditure elasticity in rural areas is estimated to be 0.25 and that in urban areas to be below 0.10. Except for the miscellaneous category, all other expenditure elasticities are quite high, approaching 1.0 or higher, and are similar between rural, urban1, and urban2 areas.

The aggregate meat expenditure elasticity is estimated to be about 0.9. The pork, poultry, and fish expenditure elasticities are estimated to be in the 1.0 to 1.4 range. The milk expenditure elasticity is substantially higher and the expenditure elasticities for beef and mutton and eggs are substantially lower. All own-price elasticities for individual foods have reasonable magnitudes, with the exception of that for beef and mutton.

The primary objective of this analysis, however, is not to estimate price and income effects, but to measure apparent differences in food demand patterns between urban and rural areas, after controlling for income and price effects. These results are shown in Tables 24 and 25.

Table 24 indicates that grain, edible oil, vegetable, and beverage and tobacco consumption is higher in rural areas, after differences in income and food prices are controlled. Meat, fish, dairy, and fruit consumption is higher in urban areas. Table 25 gives a disaggregation of the 5.8 and 9.3 kilogram difference in per capita intake of meat, fish, and dairy products between rural and urban1 and urban2 areas, respectively.

What are the implications of structural shifts of this size for projections of demand for meat, fish, and dairy products? A very rough calculation can be made by taking 7.5 kilograms as a midpoint for the 5.8 and 9.3 kilograms just mentioned, due to structural shifts in moving from rural areas to small cities and large cities, respectively. If the urban population were to increase from one-quarter of the population

Table 19—Estimated parameters for the complete demand system, intercept dummy model, China

	Budget Share (W_i)						
Variable	**Grain**	**Meat**	**Edible Oil**	**Vegetables**	**Fruit**	**Other Foods**	**Beverages and Tobacco**
$\text{Ln}(P_{grn})$	0.050	−0.032	−0.003	−0.054	0.012	0.008	−0.002
	(5.65)	(−2.57)	(−0.88)	(−6.69)	(1.80)	(1.15)	(−0.27)
$\text{Ln}(P_{meat\ and\ product})$	−0.032	0.200	−0.004	0.057	0.015	−0.004	−0.076
	(−2.57)	(5.60)	(−0.42)	(3.25)	(0.98)	(−0.29)	(−5.08)
$\text{Ln}(P_{oil})$	−0.003	−0.004	0.022	−0.014	−0.005	−0.006	0.004
	(−0.88)	(−0.45)	(5.49)	(−2.62)	(−0.91)	(−1.18)	(0.99)
$\text{Ln}(P_{vegetables})$	−0.054	0.057	−0.014	0.025	−0.001	−0.002	−0.016
	(−6.69)	(3.25)	(−2.62)	(1.54)	(−0.11)	(−0.22)	(−1.64)
$\text{Ln}(P_{fruit})$	0.012	0.015	−0.005	−0.001	0.010	−0.015	−0.014
	(1.80)	(0.98)	(−0.91)	(−0.12)	(0.60)	(−1.60)	(−1.70)
$\text{Ln}(P_{other\ food})$	0.008	−0.004	−0.006	−0.002	−0.015	0.041	−0.001
	(1.15)	(−0.29)	(−1.18)	(−0.22)	(−1.60)	(3.66)	(−0.18)
$\text{Ln}(P_{beverages\ and\ tobacco})$	−0.002	−0.076	0.004	−0.016	−0.014	−0.001	0.061
	(−0.27)	(−5.08)	(0.99)	(−1.64)	(−1.70)	(−0.18)	(4.93)
$\text{Ln}(P_{miscellaneous})$	0.022	−0.150	0.005	0.006	0.0004	−0.021	0.044
	(2.77)	(−8.24)	(1.00)	(0.53)	(0.04)	(−2.22)	(4.33)
$\text{Ln}(X/P^*)$	−0.065	−0.022	−0.006	0.129	0.013	0.007	0.055
	(−4.22)	(−0.83)	(−0.93)	(7.85)	(1.17)	(0.52)	(3.34)
Urban1	−0.095	0.080	−0.013	−0.041	0.034	0.013	−0.030
	(−8.78)	(4.31)	(−3.04)	(−3.59)	(4.36)	(1.50)	(−2.55)
Urban2	−0.106	0.127	−0.011	−0.044	0.040	0.023	−0.056
	(−8.72)	(6.15)	(−2.17)	(−3.48)	(4.58)	(2.29)	(−4.29)
Ln(*family size*)	0.176	0.031	−0.006	0.068	−0.044	−0.086	−0.070
	(5.61)	(0.58)	(−0.51)	(2.08)	(−1.94)	(−3.37)	(−2.10)
Year dummy (1991)	−0.004	0.026	0.0003	0.005	−0.001	−0.004	−0.017
	(−0.91)	(2.80)	(0.11)	(0.90)	(−0.32)	(−0.87)	(−3.34)
Constant	0.328	0.355	0.045	−0.727	−0.002	0.196	−0.094
	(2.67)	(1.70)	(0.88)	(−5.48)	(−0.37)	(1.94)	(−0.73)
R^2	0.929	0.783	0.607	0.692	0.757	0.626	0.460

Notes: System $R^2 = 0.999$. The model is estimated using Zellner's seemingly unrelated regression with the imposition of the homogeneity and symmetry restrictions. Regional dummies are not shown. The numbers in parentheses are t-values.

to two-thirds of the population (over a specified period), this would result in a 3-kilogram increment in demand for these products (40 percent of 7.5 kilograms, after population growth, income, and prices are controlled). Total national per capita consumption of meat, fish, and dairy products presently is about 30 kilograms per capita annually, so that this is about a 10 percent increase.[16]

Ten percent may not seem like a large additional increase. However, as the Taiwan data demonstrate, it is crucial to note that substantial structural shifts in food demand are occurring *within* rural and urban populations as well. In this section of the paper, only the difference between two moving targets has been measured. If, as can be expected, structural shifts occur within rural and urban populations, the total additional demand may be much larger than 10 percent.

Conclusions

Empirical estimates presented for Taiwan and China support an hypothesis that structural changes in food

[16]Comparing the results for demand for meat, fish, and dairy for China and Taiwan, the observed difference in consumption between rural and urban areas for 1989–91 is about 40 kilograms for China (see Table 15). Thus, 7.5 kilograms, the estimate used here for the structurally related shifts in demand for China between rural and urban areas, accounts for about 20 percent of this 40-kilogram difference. For Taiwan, the difference in meat and fish consumption (not including dairy) between villages and cities in 1981 is estimated to be just under 30 kilograms (see Table 12). Between 5 and 6 kilograms or about 20 percent of this difference is attributed to structural shifts.

Table 20—Estimated parameters for meat and the meat product demand subsystem, slope dummy model, China

	Budget Share (W_i)				
Variable	Pork	Beef and Mutton	Poultry	Fish	Eggs
$\text{Ln}(P_{pork})$	−0.224	−0.097	0.075	0.075	0.098
	(−4.07)	(−2.94)	(2.92)	(2.63)	(3.15)
$\text{Ln}(P_{beef\ and\ mutton})$	−0.097	0.120	0.006	0.028	0.027
	(−2.94)	(3.54)	(0.32)	(1.23)	(1.15)
$\text{Ln}(P_{poultry})$	0.075	0.006	−0.034	−0.032	−0.032
	(2.92)	(0.32)	(−1.45)	(−1.87)	(−1.69)
$\text{Ln}(P_{fish})$	0.075	0.028	−0.032	−0.061	−0.052
	(2.63)	(1.23)	(−1.87)	(−2.14)	(−2.22)
$\text{Ln}(P_{eggs})$	0.098	0.027	−0.032	−0.052	−0.024
	(3.15)	(1.15)	(−1.69)	(−2.22)	(−0.74)
$\text{Ln}(P_{milk})$	0.073	−0.085	0.017	0.042	−0.017
	(3.08)	(−4.97)	(1.11)	(2.62)	(−0.95)
$\text{Ln}(X_{meat}/P^*)$	0.005	−0.054	0.013	0.053	−0.046
	(0.19)	(−2.36)	(0.94)	(2.55)	(−2.11)
Urban1 × $\text{Ln}(X_{meat}/P^*)$	−0.034	0.036	0.005	0.014	−0.019
	(−3.34)	(4.10)	(1.01)	(1.79)	(−2.32)
Urban2 × $\text{Ln}(X_{meat}/P^*)$	−0.043	0.033	0.010	0.012	−0.016
	(−3.78)	(3.34)	(1.65)	(1.42)	(−1.73)
Ln(*family size*)	0.035	0.145	0.011	0.140	−0.363
	(0.36)	(1.73)	(0.21)	(1.90)	(−4.65)
Year dummy (1991)	−0.004	0.028	0.015	−0.008	0.004
	(−3.11)	(2.52)	(2.04)	(−0.81)	(0.40)
Constant	0.752	−0.164	0.022	−0.246	0.790
	(3.93)	(−1.00)	(0.21)	(−1.69)	(5.12)
R^2	0.750	0.734	0.666	0.611	0.506

Notes: System R^2=0.990. The model is estimated using Zellner's seemingly unrelated regression with the imposition of the homogeneity and symmetry restrictions. Regional dummies are not shown. The numbers in parentheses are t-values.

demand can be quite significant factors, driving the rapid changes in dietary patterns seen in East Asia over the past three decades. Because most previous studies have tried to explain these dramatic changes in diets primarily in terms of rising incomes and changing food prices, relatively little is known about the specific reasons causing these structural shifts. Thus, it is difficult to form judgments as to the points at which, in the process of economywide structural adjustment, these structural changes in food demand will begin, accelerate, then slow down, and perhaps stop.

How this lack of information will affect policy is perhaps most easily understood for rice. Almost all cross-sectional evidence on demand for rice indicates that the income elasticity is either close to zero or positive as it substitutes for less-preferred food staples with rising incomes. Yet per capita consumption of rice has declined dramatically over time in a few countries, including Japan and Taiwan. These two empirical observations could be reconciled if rice prices had risen dramatically compared with substitute foods, but that has not occurred. Therefore, significant downward structural shifts in demand likely explain a substantial portion of the observed decline.

Assuming continued sustained economic growth, at what level of income or structural transformation or both will per capita rice consumption begin to decline in China, India, and Indonesia (to name three countries with large populations that account for a high proportion of world rice consumption)? Once the decline begins, will rice consumption eventually fall by as much as 50 percent, as has happened in Japan and Taiwan, or perhaps more? Might such a decline not occur? It is interesting to note that rice consumption in Korea did not fall much between 1973 and 1992, declining from 140 kilograms to 126 kilograms per capita (FAO 1994).

Two very different future scenarios are possible for demand for rice in Asia to the year 2020, one in which per capita consumption of rice declines dramatically and another in which per capita consumption falls marginally. Existing estimates of income elasticities for rice provide little insight into which scenario might occur.

Table 21—Estimated parameters for meat and the meat product demand subsystem, intercept dummy model, China

	Budget Share (W_i)				
Variable	Pork	Beef and Mutton	Poultry	Fish	Eggs
$\text{Ln}(P_{pork})$	−0.239	−0.095	0.076	0.079	0.103
	(−4.39)	(−2.93)	(2.94)	(2.82)	(3.31)
$\text{Ln}(P_{beef\ and\ mutton})$	−0.095	0.128	0.008	0.027	0.018
	(−2.93)	(3.83)	(0.45)	(1.19)	(0.78)
$\text{Ln}(P_{poultry})$	0.076	0.008	−0.034	−0.033	−0.034
	(2.94)	(0.45)	(−1.44)	(−1.93)	(−1.79)
$\text{Ln}(P_{fish})$	0.079	0.027	−0.033	−0.064	−0.051
	(2.82)	(1.19)	(−1.93)	(−2.21)	(−2.19)
$\text{Ln}(P_{eggs})$	0.103	0.018	−0.034	−0.051	−0.020
	(3.31)	(0.78)	(−1.79)	(−2.19)	(−0.60)
$\text{Ln}(P_{milk})$	0.076	−0.087	0.017	0.041	−0.016
	(3.26)	(−5.09)	(1.11)	(2.54)	(−0.90)
$\text{Ln}(X_{meat}/P^*)$	−0.008	−0.046	0.016	0.054	−0.046
	(−0.32)	(−2.21)	(1.20)	(2.82)	(−2.29)
Urban1	−0.117	0.146	0.018	0.055	−0.091
	(−3.38)	(4.92)	(0.97)	(2.08)	(−3.21)
Urban2	−0.157	0.143	0.035	0.055	−0.086
	(−3.81)	(4.04)	(1.65)	(1.72)	(−2.57)
Ln(*family size*)	0.030	0.194	0.011	0.156	−0.418
	(0.31)	(2.33)	(0.22)	(2.11)	(−5.32)
Year dummy (1991)	−0.045	0.034	0.015	−0.005	−0.001
	(−3.36)	(3.03)	(2.07)	(−0.52)	(−0.07)
Constant	0.810	−0.282	0.012	−0.284	0.891
	(4.10)	(−1.69)	(0.11)	(−1.89)	(5.60)
R^2	0.750	0.748	0.666	0.613	0.514

Notes: System R^2=0.991. The model is estimated using Zellner's seemingly unrelated regression with the imposition of the homogeneity and symmetry restrictions. Regional dummies are not shown. Numbers in parentheses are t-values.

Table 22—Expenditure and own price elasticities of demand for the commodity group evaluated at the overall sample mean, China

		Expenditure Elasticity				Uncompensated Own Price Elasticity			
Commodity	Budget Share	Mean	Rural	Urban1	Urban2	Mean	Rural	Urban1	Urban2
Grain	0.106	0.134	0.246	0.092	0.073	−0.437	−0.448	−0.432	−0.430
Meat	0.280	0.914	0.841	0.928	0.967	−0.279	−0.268	−0.281	−0.288
Edible oil	0.032	0.733	0.786	0.700	0.719	−0.306	−0.310	−0.304	−0.305
Vegetables	0.130	2.315	2.460	2.253	2.242	−1.103	−1.136	−1.089	−1.087
Fruit	0.066	1.311	1.225	1.340	1.360	−0.864	−0.859	−0.866	−0.867
Other food	0.079	1.124	1.089	1.125	1.153	−0.486	−0.484	−0.486	−0.487
Beverages and tobacco	0.105	1.721	1.833	1.701	1.639	−0.527	−0.543	−0.524	−0.520
Miscellaneous	0.202	0.241	0.162	0.291	0.262	−0.388	−0.373	−0.399	−0.393

Note: The elasticities are computed based on the model presented in Table 18.

An analagous dilemma presents itself in projecting demand for meat, fish, and dairy products. It would seem clear that income elasticities for these products are substantially above zero. However, existing income elasticity estimates from time-series data may be upwardly biased for countries such as Japan and Taiwan, measuring both the positive effect of income on demand for these products *and* structural shifts in demand, structural shifts that are positively correlated with increases in per capita gross domestic product.

Again, the crucial question for demand projections in these economically more advanced countries is at what point these structural shifts will slow down and perhaps stop, at which point the upwardly biased estimates of income elasticities for meat, fish, and

Table 23—Meat expenditure and own price elasticities of demand for the commodity group evaluated at the sample mean, China

Commodity	Budget Share	Expenditure Elasticity				Uncompensated Own Price Elasticity			
		Mean	Rural	Urban1	Urban2	Mean	Rural	Urban1	Urban2
Pork	0.471	0.954	1.011	0.936	0.916	−1.462	−1.480	−1.456	−1.449
Beef and mutton	0.103	0.689	0.453	0.824	0.788	0.239	0.296	0.206	0.214
Poultry	0.107	1.176	1.129	1.179	1.222	−1.329	−1.325	−1.329	−1.333
Fish	0.141	1.454	1.391	1.489	1.482	−1.478	−1.472	−1.481	−1.480
Eggs	0.149	0.595	0.676	0.545	0.564	−1.089	−1.104	−1.080	−1.084
Milk	0.029	2.071	2.057	1.960	2.196	−2.086	−2.085	−2.079	−2.095

Note: The elasticities are computed based on the model presented in Table 20.

Table 24—The effects of urbanization on per capita annual food consumption in China

Commodity	Intercept Dummy Model		Slope Dummy Model	
	Rural to Urban1	Rural to Urban2	Rural to Urban1	Rural to Urban2
	(kilograms/capita/year)			
Grain	−63.2	−70.1	−58.3	−64.2
Meat, fish, and their products	5.8	9.3	5.7	8.9
Edible oil	−1.4	−1.2	−1.4	−1.1
Vegetables	−21.2	−22.9	−23.0	−24.9
Fruit	8.3	9.8	8.2	9.6
Other food	1.8	3.1	1.8	3.0
Beverages and tobacco	−5.0	−9.3	−4.4	−8.5

Notes: The effects of urbanization on food consumption are measured as the consumption differences between rural and urban consumers after controlling for the income and price effects. In the above analysis, consumption changes are computed based on a hypothesis of moving a consumer from a rural to an urban area, holding his total expenditure (X) and prices constant at the levels that he or she faced in the rural area.

dairy products will begin to overestate future demand. Interestingly, in countries such as India and Indonesia, where meat consumption is presently quite low because structural transformation is in an early stage, time-series data for meat consumption will not reflect a possible impending structural shift in demand. Thus, existing income elasticities will give underestimates of demand for meat, if these structural changes in food demand do indeed materialize.

Table 25—The effects of urbanization on per capita annual consumption of meat, fish, and their products in China

Commodity	Intercept Dummy Model: Rural to Urban1	Intercept Dummy Model: Rural to Urban2	Slope Dummy Model: Rural to Urban1	Slope Dummy Model: Rural to Urban2
	(kilograms/capita/year)			
Neutral effect				
Pork	3.1	4.9	3.0	4.8
Beef and mutton	0.3	0.6	0.3	0.5
Poultry	0.4	0.6	0.4	0.6
Fish	0.7	1.2	0.7	1.1
Eggs	0.9	1.4	0.8	1.3
Milk	0.4	0.6	0.4	0.6
Total	5.8	9.3	5.7	8.9
Biased effect				
Pork	−1.5	−2.5	−1.2	−2.0
Beef and mutton	2.2	2.1	1.5	1.3
Poultry	0.3	0.5	0.2	0.3
Fish	1.1	1.0	0.8	0.6
Eggs	−1.7	−1.7	−1.0	−0.9
Milk	−0.3	0.7	−0.3	0.7
Net effect				
Pork	1.7	2.5	1.8	2.7
Beef and mutton	2.5	2.6	1.8	1.8
Poultry	0.7	1.1	0.6	0.9
Fish	1.8	2.2	1.5	1.7
Eggs	−0.9	−0.3	0.2	0.4
Milk	0.1	1.2	0.1	1.3
Total	5.8	9.3	5.7	8.9

Notes: The impact of urbanization on individual meat consumption is measured as the difference between rural and urban consumption, with income and price effects controlled. In the table, consumption differences are separated into two components: a "neutral" impact and a "biased" impact. The former assumes that the impact of urbanization is equal for all component foods in the aggregate meat, fish, and their products group (the first-stage estimations), while the latter reflects the adjustments (substitutions) among component foods due to urbanization (the second-stage estimations). The net impact is the sum of these two effects.

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