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ESTIMATING THE WHOLESALE DEMAND FOR FOOD IN BEIJING

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With the removal of significant government intervention, the changing structure of the Chinese food markets has led to the evolution of different types of markets, and particularly the growth of wholesale markets. This paper analyzes food consumption patterns for the largest wholesale food market in Beijing. An AIDS model is applied to monthly data for the period 1991 to 1994 to estimate expenditure and price elasticities for vegetables, grains, fruit, meat and aquatic products. The magnitude and direction of these elasticities are then examined to explore the policy implications of the analysis.

Keywords: food demand, AIDS model, China

I. INTRODUCTION

China's food industry, the largest in the world, has undergone substantial reforms since 1978. Chinese consumers now have much greater freedom with many alternative markets from which to purchase. The most notable growth has been in wholesale markets where demand and supply forces play the major role in determining prices. To our knowledge, no empirical research on China's food consumption patterns in the open wholesale markets has been reported in the literature.

The purpose of this paper is to assess consumption patterns in one of China's largest wholesale food markets. Utilising an AIDS model, expenditure and price elasticities are estimated for vegetables, grains, fruits, meat and aquatic products from monthly wholesale data. A review of the changing role and structure of food markets in China is provided first, prior to a brief review of previous studies of Chinese food consumption. The model, data and estimation procedures are then outlined after which the results are reported and interpreted. A comparison of the results with those of previous studies is then undertaken. Implications of the analysis are presented prior to concluding comments.

II. CHINA'S FOOD ECONOMY

Prior to the reforms of 1978, the Chinese food economy was characterised by an underlying philosophy of self-sufficiency. The purchasing and marketing of farm products was basically monopolised by the state as farmers were required to sell products to the state for fixed prices

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(Ling 1990, p229). The rural supply and marketing co-operatives played the key role in purchasing rural products and distributing them, and they were all owned and controlled by the state (Wan et al 1988, p73). The state's food distribution system was characterised by rationing and involved subsidies for the urban population. Market prices in all the food industries were determined by the government leaving no role for free market demand and supply forces.

From 1978 significant economic reforms were introduced for the agricultural sector. These reforms have been aimed at increasing productivity and the role of market forces, leading to a vastly different market structure of the food industries. This increased role of the free markets is highlighted by the major food industries in China including grains, meat, fruits and vegetables.

The reforms have led to a much more diversified structure of the grains industry. At present consumers can purchase grains from the government, through the wholesale markets or through free markets on the side of the road. There have been occasions where the government has set ceiling prices for grain (World Bank 1992, p102), but as the market develops, it is likely that the government's tendency to intervene will decline. Although the government still sets procurement and distribution prices for certain quantities of grain, rather than control supply the government acts as a participant in the market through buying and selling and uses the market to influence supply.

The meat industry is similarly characterised by free markets and some government intervention. Within the meat industry the pig market is by far the most important. There are two main types of traders in the pig market, private market agents and state run ones. While there are a couple of co-operatives, their share of the market is small (Bingsheng 1992, p92). A much greater quantity of meat is now being sold through wholesale markets. Similarly, a larger amount of aquatic products are now sold through wholesale markets.

Relatively speaking, the fruits and vegetables industry is probably the most open of all the food markets with demand and supply forces effectively determining prices. Farmers sell fruits and vegetables either directly to consumers, through the free market or through the wholesale markets. Due to the numerous participants in these wholesale markets, they are very competitive, while the individual wholesale markets compete with one another to attract sellers through their administration charges.

Concurrent with the reforms and growth of various types of food markets in China, there has been a general trend in food consumption patterns, shifting consumption from staple foods of grains and vegetables toward non-staple foods such as meat, poultry, fish and processed foods.

This trend has coincided with substantial income growth in China, which over the ten years up to 1992 averaged 13 per cent per annum (State Statistical Bureau of China 1994, T2.13). Over this decade, per capita consumption of the staple grain increased by 2 per cent, while per capita consumption of the non-staples of meat and poultry increased by 55 per cent. In the case of aquatic products the growth was even greater at 82 per cent (State Statistical Bureau of China 1994, T8.6). These figures indicate that the budget shares of meat, poultry and fish are increasing, while that of grain is decreasing. This shifting pattern of food consumption habits in China is consistent with those in other developing countries that have experienced similar income growth such as Taiwan (see Garnaut and Ma 1992). The degree of this change has important implications for the producers and traders in the competing food markets.

III. PREVIOUS STUDIES

A number of previous studies have analysed the demand for food in China. These include Tang and Stone (1980), Van der Gaag (1984), Yang (1985), Carter and Zhong (1988), Lewis and Andrews (1989), Halbrendt and Gempesaw (1990), Peterson et al (1991), Huang and David (1993), Chang (1994), Chern and Wang (1994), Fan et al (1994a), Fan et al (1994b), Halbrendt et al (1994), Samuel (1994), and Wu et al (1995).

The earlier studies of Tang and Stone (1980), Van der Gaag (1984), Yang (1985) and Carter and Zhong (1988) are rather limited. Tang and Stone (1980) estimated grain consumption by a method of moving averages, with the underlying assumption that the total consumption was determined by the government. Van der Gaag (1984) made improvements on Tang and Stone's model by placing greater emphasis on the impact of income on demand, providing projections of consumption based on Engel curve analysis. Similarly, Yang (1985) based the individual's determination of consumption on income. Carter and Zhong (1988) specified per capita consumption levels for grain as a function of income and established consumption habits, providing estimates for both the rural and urban sector. These studies are very specific, dealing mostly with the grains sector, based on extremely aggregated data and involve highly simplified models of consumption. These limitations, along with the outdated data used, hamper the relevance of their findings.

Lewis and Andrews (1989) and Chern and Wang (1994) applied the Linear Expenditure System (LES), or adaptations of it, to data from Chinese government sample surveys for the years 1982 to 1985 and 1990, respectively. Both studies found the demand for food to be inelastic with respect to income. The study of Chern and Wang (1994) found urban consumers extremely price inelastic with respect to grain and oil, but more price elastic for meat and fruits.

However, these studies are limited as LES models rely on a specific form of utility function and do not allow complements or inferior goods to exist (Powell 1974, p38).

Studies by Fan et al (1994a), Halbrendt et al (1994) and Wu et al (1995) all utilised the AIDS model. The first two studies analysed rural consumption, utilising pooled provincial level data from 1982 to 1990, and consumption expenditure survey data for 1990, respectively, having been obtained from Chinese government agency surveys. They report similar findings of very low expenditure elasticities for grains but higher for the remaining foods, particularly meat. The price elasticities are found to be low for all foods, particularly in the study of Halbrendt et al (1994). The study of Wu et al (1995), based on a 1990 survey for a cross section of 33 urban Chinese cities, finds similar expenditure elasticities, although its own price elasticity estimates tend to be higher than the previous two studies implying that the urban consumers is more price responsive than the rural consumers.

Although providing useful information, none of the above studies is based on market level data over a reasonable time period. More specifically, all the previous studies except Wu et al (1995), are based on Chinese government collected data which tend to be very aggregated. Further, the studies of Halbrendt et al (1994) and Wu et al (1995) are based on a data sample for only one year. These constraints limit the confidence in the findings and may have reduced the precision of the results. Further, the most recent analysis is based on 1990 data, yet there has since been substantial development and growth of wholesale markets since then which may reduce the usefulness of these studies.

IV. MODEL

The AIDS model developed by Deaton and Muellbauer (1980) is utilised in this study. An advantage of this model is that it allows the underlying utility function to have flexible properties. The model is derived by maximising total expenditure subject to a given level of utility and prices. The model implicitly assumes that the commodity group under investigation is weakly separable from all other commodity groups. In the case of this study it means that the consumers expenditure on food is separable from the rest of their expenditure. The general form of the model is

$$(1) \quad w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log y / p_i$$

where w_i = budget share of the i th commodity

p_j = is the price of the j th commodity

y = expenditure or income within the system

p = price index

p , the price index, is defined by

$$(2) \quad \log P = \alpha_p + \sum_i \alpha_i \log P_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \log P_i \log P_j$$

where γ_{ij} measures the change in the i th budget share following a 1 per cent change in p_j , with real income held constant.

The AIDS model can be turned into the linear approximation AIDS (LVAIDS) model by approximating the price index to be Stones geometric price index, that is

$$(3) \quad \log P = \sum_i w_i \log P_i$$

The use of the stone price index implies that the model is linear in its parameters and that estimation can be carried out equation by equation (Deaton and Muellbauer 1980, p316).

For the model to be consistent with the theory of demand, the following restrictions need to hold. The adding up restrictions (or Engel conditions) are

$$(4) \quad \sum_{i=1}^k \alpha_i = 1, \sum_{i=1}^k \gamma_{ij} = 0, \sum_{i=1}^k \beta_i = 0 \text{ and ensure that } \sum_{i=1}^k w_i = 1$$

The homogeneity condition is satisfied if

$$(5) \quad \sum_{i=1}^k \gamma_{ij} = 0 \text{ for } i = 1, 2, \dots, k$$

The symmetry condition is satisfied if

$$(6) \quad \gamma_{ij} = \gamma_{ji}$$

These conditions imply that the consumers rank commodity bundles in an ordinal and rational fashion being driven by utility maximisation.

V. DATA AND ESTIMATION PROCEDURES

The data for this study cover the period 1991 to 1994, from the Dazhongsi wholesale food market in Beijing. This market was established in 1986, following the government's relaxation

of price controls for many foods in 1985 and the "open door to Beijing" policy to welcome sellers from across the whole country (Dazhongsi Wholesale Market 1994). These policies attracted more and more sellers from other provinces to sell their agricultural goods in Beijing. The participants in the market, which include state, collective and private enterprises, now come from over 600 counties across 28 provinces (Dazhongsi Wholesale Market 1994). The sellers compete side by side in the market, creating a very competitive atmosphere.

The market has grown substantially from year to year. Initially, sales were minor but they grew to an average value of 27.9 million Yuan (US\$5.34 million) per month in 1991. Substantial growth over the next three years saw average sales per month in 1994 reach a value of 113 million Yuan (US\$13.36 million). Being now the largest wholesale market in Beijing, its vegetable sales alone are able to satisfy a third of Beijing's vegetable demand (Quan, Personal Communication 1994). Vegetables account for the majority of sales in the Dazhongsi market, sometimes accounting for 65 per cent of the turnover in the market, while fish, fruits, meat and poultry are the next most important followed by grains and edible oil. Sellers in the market are required to pay a trading fee, which given government regulation, can be up to a value of two per cent of their turnover. However, the Dazhongsi market often charges lower rates to encourage new sellers (Dazhongsi Wholesale Market 1994). This is the main avenue for attracting participants from other markets.

The monthly data, which are derived from the daily price and quantity figures, are obtained by the administrators of the wholesale market which collect a percentage fee of each seller's trade. The data were aggregated into the categories of vegetables, grains, fruits, meat and poultry, and aquatic products. Analysis of the raw data indicated that the majority of foods followed a seasonal pattern. The data were, therefore, seasonally adjusted through the use of a centred 12 month moving average (see Kenkel 1989). Prices were adjusted to real prices using the overall price index for China, with 1991 as the base year (State Statistical Bureau of China 1994). Estimation was carried out via a systems model which required the parameters for the aquatic products model to be calculated from the Engel conditions rather than directly estimated. The homogeneity and symmetry conditions were found not to hold, via the likelihood ratio test, and were subsequently imposed.

From the estimated parameters, the elasticities from the LA/AIDS are given by (Cashin 1991, p265)

$$(7) \quad \eta_i = 1 + \frac{\beta_i}{W_i} \quad \text{expenditure elasticity of demand}$$

$$(8) \quad \epsilon_{ii} = -1 + \frac{\gamma_{ii}}{W_i} - \beta_i \quad \text{Marshallian own price elasticity of demand}$$

$$(9) \quad \epsilon_{ij} = \frac{\gamma_{ij}}{W_j} - \beta_i \frac{W_j}{W_i}$$

Marshallian cross price elasticity of demand

The data quality for this study is superior to that used in most previous studies, being monthly data over a period of four years. However, the food groups represent commodity aggregation of, for instance, the individual vegetables or grains that are sold. This could impinge upon the accuracy of the elasticities estimated. Further, as the elasticities are actually calculated from equations (7), (8) and (9), their level of significance or standard deviation is not directly available.

VI. RESULTS

The regression results are presented in Table 1. The values of the parameters of the LA/AIDS model can be interpreted as the change in the budget share allocated to a product resulting from either a one Yuan per kilo increase in the price of a product or a one Yuan increase in the expenditure variable. The *t* statistics are reported in parentheses below the coefficients. The *R*² value for the system of 0.87 is reasonably high and the majority of the coefficients are statistically significant at the five per cent level and even at the more stringent one per cent level of significance. In particular, all the own price coefficients are significant at the five per cent level, with the only own price coefficient not to be significant at the one per cent level being that for grain. The expenditure coefficients are also significant except in the case of grain and fruit. For the cross price coefficients, the most significant variables are for vegetables, which can be explained by their significant role in the Chinese diet. That is, in addition to grains, vegetables form the main component of the Chinese diet, being used in just about all dishes whether they be grain, meat or seafood based.

The estimated price and expenditure elasticities are reported in Table 2. All the own price elasticities are inelastic, a common observation for foods. The majority of the own price elasticities are negative, as expected; however, there are positive own price elasticities for grain and aquatic products. The lack of a negative price elasticity in the case of grain, as well as its being a necessity, may reflect the fact that grain is a commodity that has experienced the greatest level of intervention from the government. For most Chinese consumers, aquatic products do not constitute a major part of their diet, but rather consumed on special occasions. In some cases, aquatic products may be used to influence guests and in such cases the positive price elasticity may reflect the snob effect, where, even though the price of aquatic products has risen, the individuals wish to give the impression that they can still afford it. The remaining price elasticities all have negative coefficients. The most elastic responses are for fruits and

meat and poultry, while grain and vegetables are much less sensitive to price changes, reflecting their necessity nature.

Analysis of the cross price elasticities indicates that, on average, the cross price elasticities are smaller than the own price elasticities, particularly for fruits. However, in the case of vegetables, there are some very high negative cross price elasticities indicating strong complementarity. That is, as vegetable prices fall, not only are more vegetables purchased, but also more grain, meat and poultry and aquatic products are purchased. For instance, the cross price elasticity for meat and poultry indicates a two and a quarter percentage increase in the quantity of meat and poultry consumed given a one per cent decrease in the price of vegetables. The reason why these cross price elasticities are so high may reflect the fact that vegetables make up such a large share of the consumers budget, in which case a fall in vegetable prices provides the consumer with a significant increase in income. Rather than spend this increased income on the base diet of vegetables, they prefer to complement the vegetables through grain, meat and poultry and fish. More specifically, grain, meat and poultry and aquatic products represent smaller budget shares than vegetables and thus a 2 or 3 per cent increase on their expenditure is much smaller than a 2 or 3 per cent increase on vegetable expenditure. The remaining cross price elasticities are all much lower, and in general, their signs are as expected. For instance, meat and poultry as well as aquatic products are complements for vegetables and fruits, while they are substitutes for each other.

The estimated expenditure elasticities are positive for all foods suggesting that as expenditure on the food group investigated in total increases, expenditure on all the foods in this group will increase. They indicate that grains and vegetables are very much necessities within the group. Fruits, meat and poultry and aquatic products all have expenditure elasticities above one, indicating that, as expenditure on the whole group of foods increases, a greater percentage will be spent on fruits, meat and poultry and aquatic products. As total expenditure increases, expenditure on vegetables and grain will also rise but at a much lower rate, implying that the budget shares of fruits, meat and poultry and aquatic products will rise, while that of vegetables and grain will fall. By far the largest expenditure elasticity is for meat and poultry implying that this food group is considered the most luxurious and receives the greatest increase in demand as income and expenditure rise.

VII. COMPARISON OF RESULTS WITH PREVIOUS FINDINGS

Table 3 presents estimated own price elasticities reported here and those of previous studies. Prior to drawing comparisons, it is important to note that the studies of Lewis and Andrews (1989) and Fan et al (1994b) are based on 1982 to 1985 and 1982 to 1990 data sets.

respectively, while the remaining studies are based on 1990 data. Further, the findings of Lewis and Andrews (1989) and Chen and Wang (1994) are not based on AIDS models, while the results of Fan et al (1994b) and Lewis and Andrews (1989) are for the rural sector only. Most importantly, the findings of this study are the only ones to be based on wholesale market data and, apart from Wu et al (1995), represent a much more disaggregated database.

The majority of estimated own price elasticities from this study lie within the range of estimates from previous studies. In the case of grain, Chen and Wang (1994) also found a positive own price elasticity, while the positive elasticity for aquatic products has not been found previously. The higher price elasticities for fruits and meat and poultry in this study are consistent with the findings of previous studies as is the more inelastic response for vegetables. This continues to support the hypothesis that grains and vegetables are necessities, while fruits, meat and poultry are more price responsive, reflecting their more luxurious nature within the food group.

Estimated expenditure elasticities for this and previous studies are found in Table 4. The results of this study are consistent with previous findings, as the estimates for all the foods lie within the range of those previously estimated. There are, however, some noteworthy differences among the various sets of estimates. The expenditure elasticity for vegetables is lower than three of the four previous estimates, while the estimate for meat and poultry is higher than all but one of the previous estimates. Given that the current study is based on much more recent data, this indicates that a lower proportion of increased expenditure is now being allocated to vegetables, while a larger proportion is being allocated to meat and poultry.

VIII. IMPLICATIONS

The findings of this study suggest that the demand for individual food groups in China appears to be price inelastic, which implies that there is little benefit to lowering prices. However, the finding that Chinese consumers are most responsive to price changes for fruits and meat and poultry suggests that the suppliers and marketers of these commodities need to be more flexible on the pricing of these commodities.

For expenditure elasticities, the positive values for all foods indicates that the demand for all these foods will increase as income and thus expenditure rises. However, the findings indicate that the rate of expenditure on the different food groups will vary. Specifically, a greater proportion of expenditure will be on fruits, meat and poultry and aquatic products. This finding supports the earlier discussion that Chinese consumption habits are continuing to change toward the more traditionally non-staple foods.

Further, the results indicate that the growth areas in Chinese food consumption will be in fruits, meat and poultry and fish. In particular, the very large expenditure elasticity found for meat and poultry implies that meat and poultry will experience a substantial growth in demand as income rises in China. Future production or import levels of meat and poultry will, therefore, need to rise. This may create opportunities for exporters of some of these foods to China. Additionally, it will create opportunities for joint venture interests in the meat and poultry industries. The continued reduction in the government's intervention in the meat and poultry industry is likely to create even greater opportunities.

Although the major growth areas in Chinese food markets appear to be in fruits, meat and poultry and fish, the expenditure elasticities for both grains and vegetables, of 0.85 and 0.77 respectively, are still reasonably high. Given the high levels of consumption of these products already, a 0.85 or 0.77 per cent increase in expenditure, with respect to a one per cent increase in expenditure on the whole food group, represents a substantial increase in the consumption of grains or vegetables. Therefore, the production or supply of these commodities will need to rise. However, in the case of grain there does not appear to be much capacity for domestic suppliers to meet the increasing demand, as the scope for any further increases in productivity for grain appears limited (Garnaut and Ma 192, p105), while rural industrialisation is limiting the land available for grain production. Further, there will be an associated increased demand for feed grains derived from the increased demand for meat and poultry products. Therefore, the prospects for increased grain exports to China appear promising. There may also be similar opportunities in the case of vegetables, however, the heterogeneous nature of the vegetables group implies that a much more disaggregated analysis is required to suggest specific individual export opportunities.

On the whole, there appear to be opportunities in a number of the Chinese food industries. The degree of these opportunities for any participant in the industry or any exporter will still depend on Chinese government policies pertaining to that particular industry and import regulations. Market forces, however, appear to play an increasingly significant role in shaping Chinese food markets.

IX. CONCLUDING COMMENTS

The findings of this study, most likely the first based on wholesale market data, provide useful information on the demand structure of one of the growing wholesale food markets of China. Given the likely continued growth and development of these markets further studies investigating the wholesale markets across the whole of China are warranted to test the consistency of the results of the current study, or any divergences from them. In addition, a

more disaggregated analysis of the individual vegetables, grains, fruits and meats in the wholesale markets may provide more plausible empirical knowledge on food demand responsiveness. Finally, any studies that could be undertaken at the retail level would also be likely to provide still more robust estimates of food consumer behaviour in China.

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TABLE 1
 Estimated Parameters of Wholesale Demand for Food in Beijing
 1991 to 1994

	Share	Constant	Vegetables	Grain	Fruits	Meat and Poultry	Aquatic Products	Expenditure	R ²	Durbin Watson
Vegetables	0.62	3.90 (3.59)	0.43 (10.05)	-0.05 (-4.65)	0.02 (1.13)	0.12 (5.51)	-0.28 (-7.43)	-0.15 (-2.36)	0.65	0.69
Grain	0.02	0.03 (0.09)	-0.05 (-4.65)	0.02 (2.08)	0.01 (1.52)	0.02 (1.78)	-0.01 (-0.10)	-0.01 (-0.15)	0.17	1.92
Fruit	0.10	0.02 (0.03)	0.02 (1.13)	0.01 (1.52)	0.06 (3.43)	-0.06 (-3.92)	-0.04 (-2.24)	0.01 (0.46)	0.27	1.02
Meat and Poultry	0.09	-2.47 (-4.51)	-0.12 (-5.51)	0.02 (1.78)	-0.06 (-3.92)	0.08 (3.63)	0.08 (4.35)	0.13 (4.30)	0.60	1.08
Aquatic Products	0.17									

TABLE 2
 Calculated Elasticities of Wholesale Demand for Food in Beijing
 1991 to 1994

	Vegetables	Grain	Fruits	Meat and Poultry	Aquatic Products	Expenditure Elasticity
Vegetables	-0.15	-3.22	0.14	-2.25	-1.61	0.77
Grain	-0.08	0.39	0.14	0.17	-0.01	0.85
Fruit	0.06	0.05	-0.36	-0.77	-0.24	1.14
Meat and Poultry	-0.17	0.05	-0.60	-0.28	0.46	2.48
Fish	-0.42	0.04	-0.46	0.65	0.39	1.01

TABLE 3
Comparison of Own Price Elasticities of Demand for Food in China

	Vegetables	Grain	Fruits	Meat and Poultry	Aquatic Products
This study	-0.15	0.39	-0.36	-0.28	0.39
Wu et al (1995)	-0.88	-0.70 ^a	-1.14	-0.65 ^b	-1.40
Halbrendt et al (1994)	-0.10	-0.23	-0.32	0.09 to -0.66 ^c	
Fan et al (1994)	-0.47	-0.46 to -0.55 ^d		-0.60	
Chen and Wang (1994)	-0.52 to -0.59	0.04 to 0.05	-0.95 to -1.10	-0.05 to -1.84 ^e	
Lewis and Andrews (1989)		-0.14		-0.09 to -0.23 ^f	-0.69

a this figure is for rice only
b this figure is for pork only
c 0.09 is for poultry and -0.66 for meat
d -0.46 is for wheat and -0.55 for rice
e -0.05 is for beef and -1.84 for poultry
f -0.09 is for poultry and -0.23 for pork

TABLE 4
Comparison of Expenditure Elasticities of Demand for Food in China

	Vegetables	Grain	Fruits	Meat and Poultry	Aquatic Products
This study	0.77	0.85	1.14	2.48	1.01
Wu et al (1995)	1.19	0.98 ^a	1.45	1.17 ^b	0.20
Halbrendt et al (1994)	0.91	0.58	1.84	1.09 to 1.27 ^c	
Fan et al (1994)	1.20	0.31 to 0.59 ^d		1.78	
Chen and Wang (1994)	0.22 to 0.47	-0.06	0.88 to 1.58	0.50 to 3.01 ^e	
Lewis and Andrews (1989)		0.22		1.02 to 1.95 ^f	3.65

a this figure is for rice only
b this figure is for pork only
c 1.09 is for meat and 1.27 for poultry
d 0.31 is for rice and 0.59 for wheat
e 0.50 is for beef and 3.01 for poultry
f 1.02 is for pork and 1.95 for poultry