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Dynamic Food Demand in Urban China

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Dynamic Food Demand in Urban China

Abstract:

Purpose – The purpose of this paper is to investigate dynamic food demand in urban China, with use of a complete dynamic demand system - DLES-LA/DAIDS, which pushes forward the techniques of demand analysis.

Design/methodology/approach – We employ a transitionary demand process and develop a new approach of complete demand system with a two-stage dynamic budgeting: an additively separable dynamic linear expenditure system (DLES) in the first stage and a linear approximate dynamic almost ideal demand system (LA/DAIDS). Employing provincial aggregate data (1995-2010) from the China urban household surveys (UHS), we estimated the demand elasticities for primary food products in urban China.

Findings – Our results indicate that most primary food products are necessities and price-inelastic for urban households in China. We also found that the dynamic model tends to yield relatively smaller expenditure elasticities in magnitude than the static models do due to dynamic adjusting costs, such as habit formation, switching costs, and learning process. .

Practical implications – The research contributes to the demand analysis methodologically, and can be used for better projections in policy simulation models.

Originality/value – This paper methodologically releases the restrictive assumption of instant adjustment in static models and allows consumers to make a dynamic decision in food consumption. Empirically, we introduce a new complete dynamic demand model and carry out a case study with the use of urban household data in China.

Keywords: two-stage budgeting, food, demand model, DLES-LA/DAIDS, China

JEL code: D21

1. INTRODUCTION

The allocation of expenditure between goods and services is of continuing interest for researchers both from a theoretical and from an empirical perspective. Quite a few econometric models have been developed during the past decades, such as the Linear Expenditure System (LES) (Stone, 1954), the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980a), the Generalized Almost Ideal and Translog Demand Systems (GAITL) (Bollino and Violi, 1990), the Quadratic AIDS (Banks et al., 1997), and the Quadratic Generalized Lewbel Demand Systems (QAITL) (Moro, 2003). These models are widely used in food demand analysis, particularly in emerging economies. The emerging countries are experiencing a rapid structural change in food consumption, which provide good case studies in a short period. Households tend to shift from traditional dietary dominated by fiber food to high-value and quality food in company of rapid economic growth (Yu and Abler, 2009; Gao et al., 1996; Obayelu et al. 2009; Tian and Yu 2013; Yu, Gao and Zeng 2014). China is no exception. After three decades of remarkable economic growth, the dietary structure changes dramatically in China and a large volume of literature has been devoted to this topic (e.g. Lewis and Andrews, 1989; Fan et al., 1994; Fan et al., 1995; Gao et al., 1996; Ma et al., 2004; Yen et al., 2004; Wan, 2005; Jiang and Davis, 2007; Zheng and Henneberry, 2009; Abler, 2010; Tian and Yu 2013).

However, most of the previous studies on food demand in China use static models. Deaton (1986) argues that static models, for the stake of simplicity, adopt a restrictive assumption that the food demand within one period only depends on the expenditure and prices in that period. It implies that consumers are assumed to fully adjust to price and income changes instantaneously. However, many studies indicate that consumers do not simultaneously make the adjustment to income or price changes and get a balance in the transitionary process (Brown, 1952; Pollak, 1970; Kesavan et al., 1993; Anderson and Blundell, 1983; Blundell, 1988; Yu and Abler, 2010). Actually, the demand for food is a dynamic process rather than a static one due to the habit formation, switching costs, learning process etc. in the transition process (Nevo, 2010). Thus, static models might lead to misspecifications of demand function and risk the accuracy and credibility of the estimated elasticities (Shukur, 2002). Zheng and Henneberry (2009, 2010, and 2011) find that that demand elasticities are different for different income groups in a study of food demand in urban China, which evidences the dynamic behavior. This ad hoc estimation of dynamic behavior is somehow contradictory to the assumption of behavior homogeneity within an income group. It confirms the methodological limitations of static demand models. There is a call for dynamic demand models.

To better understand the structural changes in food consumption in China with rapid income growth, this paper attempts to make a step forward and proposes a complete two-stage dynamic demand model: a dynamic linear expenditure system (DLES) in the first stage to estimate the allocation of total expenditure between the food and other commodities and services, and a linear approximated dynamic almost ideal demand system (LA/DAIDS) model in the second stage to allocate food expenditure between different food items. With use of the data over 1995-2010 from China urban household surveys (UHS), an empirical evidence is provided.

The rest of the paper is organized as follows. Section 2 presents a discussion of general forms of dynamic adjustments, followed by an introduction of the new two-stage DLES-LA/DAIDS model. Section 3 introduces the dataset used in this study and specifies an empirical two-stage DLES-LA/DAIDS model, followed by the results and discussions in section 4. Finally, we conclude the paper in section 5.

2. THEORETICAL FRAMEWORK

Generally, there are two main approaches to model the dynamic demand behavior. One is to take theory to play most of its role in the steady state solution such as habit persistence model, the other is vector time series specification that explicitly incorporates both the anticipated and unanticipated behavior (Blundell, 1988, Blanciforti et al., 1986). The habit persistence model is more interpretive as it is derived directly from the economic theory, but the economic restrictions only hold locally sometimes (Blanciforti et al., 1986). The vector time series model is generated within a dynamic framework, which allows for a nonhomogeneous and nonsymmetrical short-run behavior and a homogeneous and symmetrical long-run behavior. There is evidence that time series model empirically tends to hold homogeneity and symmetry by data in general case (Anderson and Blundell, 1982, Anderson and Blundell, 1983, Marcus J, 1990). Thus, the present paper adopts the vector time series approach to model the dynamic food demand.

A complete demand system is proposed empirically to plausibly replicate the consumption decision process with assumption of weakly separable utility. The utility tree approach, in which multi-stage budget occurs when consumers allocate their total expenditure in sequential stages, is usually used to circumvent the large number of variables in a complete demand model (Gorman, 1959b, Edgerton, 1997, Gorman, 1959a, Goldman and Uzawa, 1964, Deaton, 1986). Following this strategy, this paper develops a two-stage dynamic complete demand system.

In two-stage dynamic budgeting process, the broad group allocation depends on the prices and expenditure both in the past and current periods. Rational consumers need to maximize their total utility in the time horizon. The solution is given by the following maximization problem.

$$\begin{aligned} &\text{Max. } V = f\{v_1[B_1(L)E_1, C_1(L)p_1], \cdots, v_G[B_G(L)E_G, C_G(L)p_G]\},\ G \in N \\ &s.t. \quad \sum_1^N E_{Gt}(u_{Gt}, p_{Gt}) = E_t \end{aligned} \qquad \textbf{(1)}$$

where V is the total (indirect) utility. $B(L)$ and $C(L)$ are the lag polynomials. E and p denote expenditure and price, respectively. There are N groups of goods, and the indirect utility function for subgroup G is given by $v_G[B_G(L)E_G, C_G(L)p_G]$.

When the indirect utility for subgroup G is given, the expenditure allocation for a subgroup in the following second stage, becomes a problem of minimization of subgroup expenditure subject to a given utility level as follow,

$$\begin{aligned} &Min.\ E_G(u_G, p_G) = \sum_G D_G(L)p_k \cdot H_G(L)q_k, \quad k \in G \\ &s.t. \quad u_G = v_G[B_G(L)E_G, C_G(L)p_G] \end{aligned} \qquad \textbf{(2)}$$

where $D_G(L)$, and $H_G(L)$ are the lag operations for price and quantity respectively within subgroup G . For the stake of simplicity, it is very helpful to assume that there are no interrelations between expenditures and prices in different periods and prices are exogenous all over the time.

Theoretically, price information for all periods is needed for solving this multi-stage dynamic system. However, it is usually impossible in practice. To handle the price aggregation in a two-stage budgeting process, Gorman (1959b) suggests to use an additively separable utility function, which implies the homothetic preferences for commodities in the same group (Fan et al., 1995, Gao et al., 1996, Edgerton, 1997, Deaton and Muellbauer, 1980b). Hence, an additive separability utility function and a linear expenditure functional form are chosen in the first stage to allocate the total expenditure. Although this assumption is very strong, it is not overly restrictive for such broad groups (Fan et al., 1995), and the use of the DLES is more practicable. A general dynamic Almost Ideal Demand System is used as weak separability of its utility function is both a necessary and sufficient condition for estimating the second stage (Deaton and Muellbauer, 1980b).

On the basis of linear expenditure system (Stone, 1954), the dynamic demand function is the sum of the partial derivatives of the indirect utility function with respect to prices and expenditures up to the present with the use of Roy's identity.

$$A'(L)E_{gt} = B'(L)(E_t, p_t) + u_t \tag{3}$$

The direct introduction of lagged demand leads to estimations of only short run parameters (Bewley and Fiebig, 1990, Kesavan et al., 1993). The standard estimators of the long run responses involve ratios of regression coefficients, they typically do not possess finite sample moments and it is awkward to generate the asymptotic standard error (Bewley and Fiebig, 1990). To get an alternative convenient framework allowing for directly estimating short run and long run coefficients and their standard errors, we adopt Bewley's structural transformation and get the general DLES which can directly estimate both short run and long run coefficients and standard errors as follows (more details are provided in appendix):

$$E_{gt} = C'(L)\Delta E_{gt} + \beta_g(E_t, p_t) + D'(L)\Delta(E_t, p_t) + v_t \tag{4}$$

Where $C'(L)$ and $D'(L)$ are lag polynomials. v_t is the error term and Δ is difference operator. (E_t, p_t) is the vector of total expenditure and prices at time t.

On the basis of the price-independent generalized logarithmic (PIGLOG) expenditure function, similarly, we can get the general LA/DAIDS for the second stage as follows:

$$w_{it} = \kappa(L)\Delta w_{it} + \phi_i(p_t, E_t', P_t^*) + \omega(L)\Delta(p_t, E_t', P_t^*) + \mu_t \tag{5}$$

where w_i is the budget share of food i within that group, $\kappa(L)$ and $\omega(L)$ are lag polynomials. (p_t, E_t', P_t^*) is the vector of price, group expenditure and Stone price index variables within that group, $logP_t^* = \sum_i w_{it} logp_{it}$. ϕ is the vector of steady-state condition parameters.

In dynamic demand systems, we could estimate both short-run and long-run elasticities. We have to point out that the short-run elasticities may not satisfy the demand properties, such as symmetry and homogeneity, due to transitionary effects; while these properties could be imposed for long-run parameters.

3. DATA

The data used in this paper is provincial aggregate data and it covers the urban households in 29 provinces (autonomous regions or municipalities) in China from 1995 to 2010[2]. The income, expenditure and consumption data come from the China Urban Household Surveys (UHS) conducted by the China National Bureau of Statistics (CNBS) and implemented since the early 1980s (Wang et al., 1995). UHS is a national uniform survey in China and sample households are selected by using a three-stage stratified sampling scheme (Cheng et al., 1998). The total number of surveyed households increases from 35520 households in 1995 to 65607 households in 2010. CNBS publishes the provincial aggregate data based on these surveys annually in the China Urban Living and Price Yearbook. We assume that Hicks' composite commodity theorem holds for disaggregated goods within each subgroup. The assumption behind Hicks' theorem is strong (prices of a group of goods can only vary over time in strict proportion to each other), but Lewbel (1996) derives a

[2] Two provinces, Tibet and Chongqing, are excluded due to unavailable data.

generalized composite commodity theorem under which goods can be aggregated even if this assumption does not hold exactly. Then we could use the average prices of specific commodities in big cities within a province (usually the capitals), derived from China's Price Yearbook (various issues), as the proxies for the provincial prices.

Table 1 reports the income and the structure of expenditure. From 1995 to 2010, national urban household disposable income has an average annual growth rate of 10.5%. The total expenditure consists of 10 broad groups, including food, clothes, household appliances and services, health care and medical services, transport and communication, recreation and education, residence, miscellaneous goods and services. The food expenditure annually grew at 6.9% for urban households over the same period, and it is obviously slower than the total expenditure growth rate. The food expenditure share declines from 49.9% in 1995 to 35.7% in 2010, which is consistent with the so-called Engel's law.

[Table 1]

In order to take food-away-from-home (FAFH) into consideration, we divide total food expenditure into three groups: main food, FAFH, and other food[3], which are separable from each other in the first stage. There are 9 primary food categories in the main food subgroup: namely grains, edible oils, meat, poultry, eggs, fish, vegetables, fruits and dairy products[4]. The structure of the food expenditure at national level is presented in Table 2. It is clear that households allocate large shares of food budget on meat and vegetables. The food expenditure shares on these two subgroups are 14.39% and 10.44% respectively in 2010. Grains are also an important

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[3] The main products of 'other food' group are tobacco, and drinks. This group also includes starch, bean and bean-made product, seasoning, sugar and so on.

[4] Grains consist of rice and wheat; meat consists of pork (the dominant part), beef and mutton; poultry includes chicken and duck. Fish covers all kinds of fish and the other aquatic products, fruits include the dry fruits (but not important part), and milk and its product are included in the dairy products group.

part, which accounts for 14.75% in 1995. However, the growth rate of expenditure on grains is only 2.65% over the period 1995-2010. Consequently, the expenditure share of grains decreases to 8.02% in 2010 for urban China.

[Table 2]

4. *EMPIRICAL MODELS*

A parsimonious but data coherent dynamic empirical model is needed to be specified. In a general dynamic model, one shock spreads to future periods at a depreciating rate (Yu and Abler, 2010). Moreover, the inclusion of more lags considerably causes a decrease in degree of freedom. Given the limited length of time series data on food consumption in our research, it is necessary to reparameterize the general dynamic form to get a parsimonious model, which is the first order dynamic demand model. The first order DLES in the first stage is given by

$$E_{gt} = C'_g \Delta E_{gt} + \beta_g (E_t - \sum_{h=1}^{N} \gamma'_h p_{ht}) + \gamma'_g p_{gt} + D'_g \Delta(E_t, p_t) + v_t \quad \textbf{(6)}$$

Similar with the static demand models, economic restrictions such as adding-up, homogeneity and symmetry also can be tested in the dynamic model. However, the dynamic model allows for nonhomogeneous and nonsymmetrical short-run behavior due to the transitionary characteristics of consumer behavior in the short-run. The restrictions suggested by economic theory are only imposed on the long-run structure. Accordingly, the adding up constraint implies $\sum_g \beta_g = 1$ in first order DLES. The long-run expenditure elasticity and uncompensated price elasticities can be calculated as follows

DLES long run: $\eta_g = \beta_g E / E_g$ **(7)**

DLES long run: $e_{gh} = -\beta_g \gamma'_h p_h / E_g$ **(8)**

DLES long run: $e_{gg} = (1-\beta_g)\gamma'_g p_g / E_g - 1$ **(9)**

The subscripts t for the variables and elasticities are dropped for the simplification reason.

Similarly, the first order LA/DAIDS model for the second stage budgeting is yielded as follows

$$w_{it} = \kappa_i \Delta w_t + \phi_i + \sum_{j=1}^{s} \phi_{ij} logp_{jt} + \phi_{i0} log \frac{E'_t}{P^*_t} + \omega_i \Delta(p_t, E'_t, P^*_t) + \mu_t \quad \textbf{(10)}$$

Where E'_t is the expenditure on a subgroup and i, j are the specific items within this subgroup. The adding up and homogeneity restrictions need to be imposed for the long run effects, namely $\sum_{i=1}^{s} \phi_i = 1$, $\sum_{i=1}^{s} \phi_{i0} = \sum_{j=1}^{s} \phi_{ij} = 0$. Following the suggestion of Anderson and Blundell (1983), the symmetry restrictions are also imposed on the long run parameters, namely $\phi_{ij} = \phi_{ji}, \forall_{i,j}$, leaving the short run responses to be unrestricted. The long-run elasticity formulas used in this paper are adapted from the approximations suggested by Green and Alston (1990), Green and Alston (1991). The conditional expenditure and uncompensated price elasticities in subgroup g are given as,

LA/AIDS long run: $\eta_{gi} = 1 + \phi_{i0} / w_i$ **(11)**

LA/AIDS long run: $e_{ij} = \left[\phi_{ij} - \phi_{i0} w_j \right] / w_i - \delta_{ij}$, **(12)**

where Kronecker delta $\delta_{ij} = 1$ when $i = j$, and 0 otherwise. The two-stage budgeting process implies relations between the sequential stages, such as the food expenditure has an impact on the grain consumption. Thus, in the two-stage dynamic demand model, it is plausible to take all the short run and long run effects in both stages into consideration when we estimate the unconditional income or price effect. However, the long run effects should be the dominant part and the whole system approaches to a steady state condition. Once the systematic equations are estimated, we can calculate the approximate long run total demand elasticities. Following the instruction of Edgerton (1997), the total unconditional expenditure and uncompensated price elasticities are given by

$$\eta'_{gi} = \eta_{gi}\eta_{g} \quad \textbf{(13)}$$

$$e'_{ij} = \delta_{gh}e_{ij} + \eta_{gi}w_{hj}(\delta_{gh} + e_{gh}) \quad \textbf{(14)}$$

It has long been recognized that demographic variables (such as the number of children and their ages) are the important determinants of consumer consumption patterns. However, the demographic information is not available in our aggregate dataset. In addition, we include regional dummy variables in estimation, which could capture this effect.

An iterative Seemingly Unrelated Regressions (ITSUR) procedure is employed to estimate the DLES-LA/DAIDS model. The regional dummy variables are used to capture regional differences (including demographical variables) and mitigate the effects of heteroskedasticity in food demand across different provinces in both stages. Finally, the equation of ‘other food’ group is excluded due to adding up restrictions and the structure of data when we estimate the first order DLES in the first stage. The first order LA/DAIDS in the second stage is estimated with the homogeneity and symmetry restrictions with exclusion of dairy products to fulfill the adding-up constraint according to equation (10).

5. EMPIRICAL RESULTS

All the estimated models are reasonable in terms of explanatory power. The results show that all estimated coefficients for short run responses are statistically significant, indicating that the presence of dynamic adjustments in the demand behavior. The long run expenditure elasticities and price elasticities are presented in Table 3 and Table 4.

Expenditure elasticities for main food, other food, clothing, household appliance and service and miscellaneous goods are all positive but less than 1, indicating they are necessities for the urban household in China. The long run expenditure elasticity and the compensated own price elasticity for main food are 0.66 and -0.49 respectively. While the expenditure elasticities for FAFH, health care and medical service, transport and communication, recreation and residence are greater than 1, suggesting that they are luxury goods for urban households in China.

The rapid economic growth has led to an increasing urbanization and a rapid growth in the number of supermarkets, convenience stores and outlets (Gale and Huang, 2007). It changed food consumption patterns and motivated a significant rise in FAFH since 1980s (Dong and Hu, 2010). The long run expenditure elasticity for FAFH is 1.39, much higher than the one for main food. The compensated own price elasticity for FAFH is price elastic with the value of -1.28.

[Table 3 and 4]

In the second stage, most of the primary food items, including grains, edible oils, meat, poultry and vegetables are necessities for urban households in China. In addition, the results indicate that all food items are price inelastic as the unconditional compensated own price elasticities are smaller than 1. The long run expenditure elasticity for grains is 0.15 and the compensated own price elasticity is -0.62. The estimated expenditure elasticity for edible oils is 0.59, while it has the lowest own price elasticity in magnitude (-0.35). When it comes to meat (including pork, beef, and mutton) the long run expenditure elasticity and own price elasticity are respectively 0.55 and -0.62.

The fish has a relatively higher long run expenditure elasticity and the largest compensated own price elasticity in magnitude with the value of 0.88 and -0.99 (the scale of uncompensated own price elasticity is even larger than 1). It suggests that an increase in expenditure can significantly drive the consumption of fish (aquatic food) and the demand for fish is more sensitive to prices than other kinds of food.

Fruits and dairy products, however, are luxury goods due to the long run expenditure elasticities are 1.14 and 1.69 respectively, which suggests that the expenditure on both fruits and dairy products are expected to increase by larger amounts than that on grains, edible oils, meat, poultry and vegetables when household income keeps growing(Gao, Yu and Lee 2013; Yu 2012). The own price elasticity for fruits is the second largest one in magnitude within the main food group with the value of -0.84. It indicates that the demand for fruits is quite price elastic.

Regarding eggs, the expenditure elasticity is, surprisingly, -0.11. It seems that egg is an inferior good for Chinese urban citizens. As we know, egg is an important source of protein in traditional Chinese diet, but it also contains lots of cholesterol. Medical sciences indicate that a high level of cholesterol is strongly associated with cardiovascular disease such as heart attack, stroke, and peripheral vascular disease. As income increases, Chinese consumers start to care more and more about their health, and tend to substitute egg with other healthy protein sources such as fish and meat (Tian and Yu, 2012; Yu, Gao and Zeng, 2014).

6. COMPARISONS WITH OTHER STUDIES

To compare the differences between the results of two-stage DLES-LA/DAIDS and those from static demand models in a more intuitive way, Table 5 presents the comparison of estimated expenditure elasticities and own price elasticities from this study with the main stream literature of static model on food demand in China. The comparable elasticities are mainly taken from the studies conducted in the past two decades for urban China.

[Table 5]

In general, the expenditure elasticities from our study tend to be lower than those from static ones. For instance, the expenditure elasticity for grain in our study is 0.15, which is smaller than all mentioned studies except for Huang and Bouis (1996). However, there is no clear difference for own price elasticities between our study and the current static research. It is reasonable, consumption patterns may not be able to adjust quickly with income change due to habit formation, switching costs, learning process and other adjusting costs in the dynamic process.

The assumption of simultaneous adjustments in the static demand system would lead to a more sensitive response to the changes in income than that in a dynamic model. In other words, if we take the dynamic adjusting factors, such as the habit persistence and switching cost, into account, the change in food consumption will consequently be confined, even given same changes in income. Accordingly, income effect in the dynamic system should be smaller than that in the static model. However, such an effect due to adjusting costs on own price elasticities is less clear in the dynamic model (Table 5). It is possible that consumer can make very quick adjustments to price changes in the dynamic process.

7. CONCLUSION

Consumers may not simultaneously adjust their behavior to changes in income in the short run, confined by the adjusting costs, such as habit formation, switching cost, and learning cost. Existence of adjusting costs implies that the static demand models in the current main stream might not correctly model consumer behaviors. Specifically, the income or expenditure elasticities estimated by these static models might be over-reported. It could lead to serious policy consequence if these elasticities are used for projection.

This paper develops a flexible two-stage dynamic model--an additively separable DLES in the first stage and a LA/DAIDS with the inherence of weak separability in the second stage, to explain the dynamic food demand behavior in urban China. With use of provincial aggregate data on household consumption from urban China (1995-2010), we estimated the two-stage DLES-LA/DAIDS model.

We first empirically identified statistically significant short run effects in our models. We then find that unconditional expenditure elasticities for food products are generally smaller than their counter-parts from the mainstream static models in the current literature. These evidence the existence of dynamic adjusting costs in food demand, consistent with our theoretical framework.

In addition, the results also indicate that most of the primary food products, including grains, edible oils, meat, poultry, fish and vegetables are necessities, and all primary foods are price inelastic in urban China. The research contributes to the demand analysis both empirically and methodologically, and can be used for better projections in policy simulation models.

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Table 1. Per capita income and expenditure categories at national level in urban China (1995-2010, Yuan)

Year	Disposable Income	Total Consumption	Food	Clothing	Household Appliances and Services	Health Care and Medical services	Transport and Communications	Recreation，Education and Culture	Residence	Miscellaneous Goods and services
1995	4282.95	3537.57	1766.02	479.20	296.94	110.11	171.01	312.71	250.18	151.39
2000	6279.98	4998.00	1958.31	500.46	439.29	318.07	395.01	627.82	500.49	258.54
2005	10493.03	7942.88	2914.39	800.51	446.52	600.85	996.72	1097.46	808.66	277.75
2010	19109.44	13471.45	4804.71	1444.34	908.01	871.77	1983.70	1627.64	1332.14	499.15
1995		100.0%	49.9%	13.5%	8.4%	3.1%	4.8%	8.8%	7.1%	4.3%
2000		100.0%	39.2%	10.0%	8.8%	6.4%	7.9%	12.6%	10.0%	5.2%
2005		100.0%	36.7%	10.1%	5.6%	7.6%	12.5%	13.8%	10.2%	3.5%
2010		100.0%	35.7%	10.7%	6.7%	6.5%	14.7%	12.1%	9.9%	3.7%

Source: China Urban Living and China’s Price Yearbook (various issues)
Note: Disposable income and total consumption are measured in nominal terms.

Table 2. Structure of food consumption in urban household at the national level, 1995-2010

Year	Grains	Edible oils	Meat	Poultry	Eggs	Fish	Vegetables	Fruits	Dairy products	other food	FAFH
1995	14.75%	4.13%	17.36%	6.22%	3.94%	6.83%	10.75%	6.35%	1.78%	9.10%	18.80%
1996	14.26%	3.62%	16.96%	6.07%	4.13%	6.93%	10.85%	6.18%	1.92%	9.78%	19.30%
1997	12.26%	3.64%	17.42%	6.24%	3.79%	7.26%	10.50%	6.54%	2.13%	10.47%	19.76%
1998	11.77%	3.91%	16.48%	5.90%	3.48%	7.39%	10.22%	6.27%	2.49%	11.78%	20.31%
1999	11.15%	3.82%	15.57%	5.58%	3.39%	7.45%	10.07%	6.73%	2.91%	12.92%	20.42%
2000	9.63%	3.39%	15.46%	5.54%	2.89%	7.33%	9.82%	6.51%	3.50%	14.70%	21.22%
2001	9.34%	2.92%	15.12%	5.41%	2.82%	7.55%	9.65%	6.52%	3.98%	15.60%	21.09%
2002	8.38%	2.84%	14.75%	5.28%	2.60%	7.47%	9.40%	7.38%	4.61%	18.20%	19.08%
2003	8.03%	3.25%	14.58%	5.00%	2.52%	7.05%	9.78%	7.24%	5.16%	18.13%	19.26%
2004	8.81%	3.29%	14.87%	4.57%	2.52%	6.57%	9.47%	7.00%	4.89%	19.69%	18.33%
2005	8.31%	2.93%	14.64%	4.75%	2.45%	6.48%	9.45%	7.08%	4.76%	20.84%	18.32%
2006	7.92%	2.80%	13.37%	4.17%	2.17%	6.52%	9.59%	7.72%	4.83%	22.21%	18.71%
2007	7.67%	3.23%	14.41%	4.97%	2.31%	6.72%	9.61%	7.50%	4.43%	20.97%	18.16%
2008	7.71%	3.87%	15.99%	5.06%	2.15%	6.58%	9.61%	6.89%	4.46%	20.61%	17.08%
2009	7.46%	2.89%	14.59%	4.78%	2.07%	6.73%	9.97%	7.43%	4.38%	21.79%	17.90%
2010	8.02%	2.61%	14.39%	4.64%	2.04%	6.80%	10.44%	7.88%	4.13%	21.21%	17.83%

Source: China Urban Living and Price Yearbook (various issues)

Note: Grains consist of rice and wheat; meat consists of pork (the dominant part), beef and mutton; poultry includes chicken and duck. Fish covers all kinds of fish and the other aquatic products, fruits include the dry fruits (but not important part), and milk and its product are included in the dairy products group. The other food is the expenditure on food which is not covered by main food group and dining out. The dominant parts of the other food are tobacco and drinks.

Table 3 Long-run expenditure elasticities and price elasticities for broad commodity groups estimated by two-stage DLES-LA/DAIDS system

	main food	FAFH	other_food	clothing	houseapp	healthcare	transport	recreation	residence	miscellaneous
	long-run uncompensated price elasticities									
main food	-0.66	0.02	-0.03	-0.01	-0.01	0.01	0.05	0.01	0.00	0.00
FAFH	-0.14	-1.37	-0.06	-0.02	-0.01	0.03	0.10	0.01	0.01	0.00
other_food	-0.07	0.02	-0.41	-0.01	-0.01	0.01	0.05	0.01	0.00	0.00
clothing	-0.09	0.03	-0.04	-0.88	-0.01	0.02	0.07	0.01	0.01	0.00
houseapp	-0.07	0.02	-0.03	-0.01	-0.87	0.02	0.05	0.01	0.00	0.00
healthcare	-0.12	0.04	-0.06	-0.02	-0.01	-1.29	0.09	0.01	0.01	0.00
transport	-0.17	0.05	-0.08	-0.02	-0.02	0.03	-1.55	0.02	0.01	0.00
recreation	-0.10	0.03	-0.05	-0.01	-0.01	0.02	0.08	-1.07	0.01	0.00
residence	-0.11	0.03	-0.05	-0.02	-0.01	0.02	0.08	0.01	-1.06	0.00
miscellaneous	-0.09	0.03	-0.04	-0.01	-0.01	0.02	0.07	0.01	0.01	-0.98
	long-run compensated price elasticities									
main food	-0.49	0.06	0.02	0.06	0.04	0.05	0.11	0.09	0.07	0.03
FAFH	0.23	-1.28	0.05	0.14	0.08	0.12	0.23	0.18	0.14	0.06
other_food	0.11	0.06	-0.35	0.07	0.04	0.06	0.11	0.09	0.07	0.03
clothing	0.15	0.08	0.03	-0.78	0.06	0.08	0.15	0.12	0.09	0.04
houseapp	0.12	0.07	0.02	0.07	-0.82	0.06	0.12	0.10	0.08	0.03
healthcare	0.20	0.11	0.04	0.12	0.07	-1.21	0.21	0.16	0.13	0.05
transport	0.28	0.16	0.06	0.17	0.10	0.14	-1.39	0.22	0.17	0.07
recreation	0.17	0.10	0.03	0.10	0.06	0.09	0.18	-0.94	0.11	0.04
residence	0.18	0.10	0.04	0.11	0.07	0.09	0.19	0.15	-0.95	0.04
miscellaneous	0.15	0.08	0.03	0.09	0.05	0.08	0.15	0.12	0.09	-0.94
	long-run expenditure elasticities									
	0.66	1.39	0.68	0.92	0.74	1.24	1.70	1.05	1.11	0.90

Table 4 Estimated long-run expenditure elasticities and price elasticities for primary foods based on two-stage DLES-LA/DAIDS system

	grain	edible oils	meat	poultry	eggs	fish	vegetables	fruits	Dairy products
conditional long-run uncompensated price elasticities									
grains	-0.66	0.02	0.11	0.07	0.16	0.14	0.05	0.02	-0.13
edible oils	-0.06	-0.40	0.13	0.12	-0.25	-0.06	-0.07	-0.22	-0.10
meat	-0.03	0.03	-0.82	-0.02	0.01	-0.05	0.03	0.00	0.01
poultry	0.04	0.09	-0.07	-0.98	0.00	-0.06	-0.06	0.19	-0.03
eggs	0.67	-0.25	0.28	0.08	-0.52	0.01	0.22	-0.20	-0.11
fish	0.06	-0.06	-0.24	-0.08	-0.06	-1.11	0.01	0.08	0.06
vegetables	-0.09	-0.04	-0.03	-0.05	0.00	0.03	-0.95	0.02	-0.02
fruits	-0.22	-0.15	-0.22	0.06	-0.16	0.03	-0.07	-1.04	0.03
dairy products	-0.72	-0.18	-0.37	-0.16	-0.20	-0.02	-0.28	-0.04	-0.61
conditional long-run compensated price elasticities									
grains	-0.62	0.03	0.16	0.08	0.17	0.16	0.09	0.04	-0.11
edible oils	0.09	-0.35	0.34	0.18	-0.21	0.03	0.08	-0.12	-0.04
meat	0.11	0.08	-0.62	0.04	0.04	0.03	0.16	0.10	0.06
poultry	0.18	0.13	0.14	-0.91	0.04	0.03	0.07	0.29	0.03
eggs	0.64	-0.26	0.23	0.07	-0.53	0.00	0.19	-0.22	-0.12
fish	0.28	0.02	0.08	0.02	0.00	-0.99	0.23	0.23	0.14
vegetables	0.09	0.03	0.24	0.03	0.05	0.13	-0.77	0.15	0.05
fruits	0.06	-0.06	0.21	0.19	-0.09	0.19	0.21	-0.84	0.14
dairy products	-0.30	-0.04	0.25	0.03	-0.09	0.21	0.13	0.25	-0.45
conditional long-run expenditure elasticities									
	0.23	0.90	0.84	0.88	-0.17	1.33	1.13	1.74	2.57
unconditional long-run uncompensated price elasticities									
grains	-0.65	0.02	0.13	0.07	0.17	0.15	0.07	0.02	-0.12
edible oils	-0.01	-0.38	0.20	0.14	-0.23	-0.03	-0.02	-0.19	-0.08
meat	0.02	0.05	-0.75	0.00	0.02	-0.02	0.07	0.03	0.03
poultry	0.08	0.10	0.00	-0.95	0.01	-0.03	-0.02	0.23	-0.01
eggs	0.66	-0.25	0.26	0.08	-0.53	0.01	0.21	-0.21	-0.11
fish	0.14	-0.03	-0.13	-0.04	-0.04	-1.07	0.09	0.13	0.09
vegetables	-0.03	-0.01	0.06	-0.02	0.02	0.06	-0.89	0.06	0.00
fruits	-0.13	-0.12	-0.07	0.11	-0.14	0.08	0.02	-0.97	0.07
dairy products	-0.58	-0.13	-0.16	-0.09	-0.16	0.06	-0.14	0.06	-0.55
unconditional long-run compensated price elasticities									
grains	-0.62	0.03	0.16	0.08	0.17	0.16	0.09	0.04	-0.11
edible oils	0.09	-0.35	0.34	0.18	-0.21	0.03	0.08	-0.12	-0.04
meat	0.11	0.08	-0.62	0.04	0.04	0.03	0.16	0.09	0.06
poultry	0.18	0.13	0.14	-0.91	0.04	0.03	0.07	0.29	0.03
eggs	0.64	-0.26	0.23	0.07	-0.53	0.00	0.19	-0.22	-0.12
fish	0.28	0.02	0.08	0.02	0.00	-0.99	0.23	0.23	0.14
vegetables	0.09	0.03	0.24	0.03	0.05	0.13	-0.77	0.15	0.05
fruits	0.06	-0.06	0.20	0.19	-0.09	0.19	0.21	-0.84	0.14
dairy products	-0.30	-0.04	0.25	0.03	-0.09	0.21	0.13	0.25	-0.45
unconditional long-run expenditure elasticities									
	0.15	0.59	0.55	0.58	-0.11	0.88	0.74	1.14	1.69

Table 5 Comparison of results with earlier estimates from the literature on food demand in China

author	pub_time	journal	data_time	data_type	household	model	grains	edible oils	meat	poultry	eggs	fish	vegetables	fruits	dairy products
expenditure elasticity															
Our Study			**1995-2010**	**panel**	**urban, China**	**DLES-LA/DAIDS**	**0.15**	**0.59**	**0.55**	**0.58**	**-0.11**	**0.88**	**0.74**	**1.14**	**1.69**
Gould	2002	Agribusiness	1995-1997	pooled	urban, Jiangsu, Shandong, Guangdong	Translog	1.30			0.64	1.36	0.70	1.03	1.07	
Huang and Bouis	1996	IFPRI report	1991	cross section	urban, China	LA/AIDS	0.09	0.70	0.93				2.25	1.43	
Wu Li and Samuel	1995	AE	1990	cross section	urban, China	AIDS-AIDS	0.98 [a]		1.17 [b]		0.54	0.20	1.19	1.45	
Zheng and Henneberry	2009	RAE	2004	cross section	urban, Jiangsu	GAIDS	0.80	0.72	1.04	1.00	0.82	1.20	0.81	0.98	1.37
Zheng and Henneberry	2010	JAAE	2004	cross section	urban, Jiangsu	QUAIDS	0.72								
Fan el al.	1995	AJAE	1982-1990	Pooled	rural, China	LES-AIDS	0.50 [a]		0.90				0.67		
Gao, Wailes and Cramer	1996	AJAE	1990	cross section	rural, Jiangsu	AIDS-GLES	0.52			0.29	0.91	0.89	1.26	0.72	
own price elasticity															
Our Study			**1995-2010**	**panel**	**urban, China**	**DLES-LA/DAIDS**	**-0.62**	**-0.35**	**-0.62**	**-0.91**	**-0.53**	**-0.99**	**-0.77**	**-0.84**	**-0.45**
Gould	2002	Agribusiness	1995-1997	pooled	urban, Jiangsu, Shandong, Guangdong	Translog	-0.91			-1.22	-1.15	-1.28	-1.38	-1.21	
Huang and Bouis	1996	IFPRI report	1991	cross section	urban, China	LA/AIDS	-0.43	-0.30	-0.28				-1.09	-0.87	
Wu Li and Samuel	1995	AE	1990	cross section	urban, China	AIDS-AIDS	-0.70 [a]		-0.65 [b]		-0.47	-1.40	-0.88	-1.14	
Zheng and Henneberry	2009	RAE	2004	cross section	urban, Jiangsu	GAIDS	-1.22	-1.31	-0.85	-0.35	-0.85	-0.10	-0.50	-0.87	-1.21
Zheng and Henneberry	2010	JAAE	2004	cross section	urban, Jiangsu	QUAIDS	-0.57								
Fan el al.	1995	AJAE	1982-1990	Pooled	rural, China	LES-AIDS	-0.63 [a]		-0.31				-0.36		
Gao, Wailes and Cramer	1996	AJAE	1990	cross section	rural, Jiangsu	AIDS-GLES	-0.99			-0.53	-0.90	-0.81	-0.83	-0.96	

Note: [a] denotes the elasticity for rice. [b] The elasticity for pork which is the dominant part in meat group.

Appendix:

Given a vector time series approach, a general dynamic linear model can be written as follow

$$A(L)Q_t = B(L)x_t + u_t$$

where $A(L)$ and $B(L)$ are lag polynomials, $A(L) = I - A_1L - A_2L^2 \cdots - A_pL^p$ and $B(L) = B_0 + B_1L + B_2L^2 \cdots + B_qL^q$. Q_t is a vector of demand at the period t, which depends upon the non-stochastic expenditure and price variables x_t . u_t is the error term. With the Bewley transformation structural model (Bewley, 1979), the general dynamic linear model can be rewritten as follows

$$Q_t = C(L)\Delta Q_t + \Omega x_t + D(L)\Delta x_t + v_t$$

where $C(L) = 1 + C_1L + C_2L^2 \cdots + C_{p-1}L^{p-1}, C_i = -\sum_{j=i+1}^{p} A_j / A$,

$$D(L) = D_0 + D_1L + D_2L^2 \cdots + D_{p-1}L^{p-1},\ D_i = -\sum_{j=i+1}^{q} B_j / A,$$

$$\Omega = \sum_{j=0}^{q} B_j / A, v_t = A^{-1}u_t .$$

where Δ is the difference operator. This general dynamic model directly identifies the long run steady state condition parameters along with the short run dynamics, and long run multiplier matrix Ω is estimated with a standard error.