Estimating Flexible Consumption Functions for Urban and Rural Households in China

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Key Words: Consumption demand functions, China, households

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Abstract

There are few comprehensive studies of household consumption in China due to data restrictions. This prevents the calculation of inequality indices based on consumption. Secondly, this makes a comprehensive analysis of policies that affect consumption difficult; economy-wide models used for analysis often have to employ simple consumption forms with unit income elasticities. We estimate a translog demand system distinguished by demographic characteristics, giving price and income elasticities that should be useful for policy analysis. We estimate separate functions for urban and rural households using household expenditure data and detailed commodity prices (1995-2006). This allows future analysis of social welfare and inequality based on consumption to supplement existing studies based on income. To illustrate an application of the model, we project consumption composition based on projected prices, incomes and demographic changes – aging, education improvement and urbanization.

1. Introduction

While there is long tradition of estimating household demand functions for China, most of them have focused on particular items, especially food and energy. We estimate a comprehensive demand function covering all commodities, separately for urban and rural households. The estimates from our translog utility function serve two important purposes.

The first is to provide the foundation for a consumption-based measure of welfare and inequality. The rising urban-rural income gap and overall inequality that has accompanied the rapid economic growth in China since 1978 has been widely noted and recognized by the government as a key policy metric (Kanbur and Zhang 1999; Yang 1999; Sicular et al. 2007). However, some economists have argued that consumption may be a better measure of welfare levels and inequality, and many papers have noted the distinct trends between income and consumption among different income groups in other countries (for example, the survey of consumption inequality research by Attanasio and Pistaferri 2016). Consumption measures of household welfare could help us understand the welfare trends better as argued by Fisher et al. 2018, but there are few studies discussing the differences in consumption between urban and rural households in China. Our utility function will allow a measure of welfare that recognizes the distinct characteristics of different households such as size and age, and generate indices of inequality across time and regions.

Policy makers in China are particularly concerned about the inequality between urban and rural households, given that urban incomes were rising faster than rural incomes during some periods despite substantial efforts to alleviate rural poverty. The urban-rural wage gap is the force driving China’s rapid urbanization, the urban share rose from 29% in 1995 to 56% in 2015[1]. This urbanization has profound implications for the path of future economic development and for the impact on the environment; the consumption patterns of urban households are distinctly different from rural ones even for the same incomes. For example, urban households use cleaner and more efficient energy than rural households (Cai and Jiang 2007). On the other hand, urban households are smaller, and each family tends to have its own dwelling, household equipment, vehicle, etc., driving up energy consumption per capita. There are, however, few studies of consumption in China which can give a comprehensive account for these effects.

Our model of household consumption take household characteristics into account, allowing the calculation of "household equivalent" indices that recognize that a 4-person family with 2 children does not need twice the expenditures as a 2-adult family to reach the same level of welfare. We also take into account differences in prices and inflation between urban and rural areas when converting expenditure data into quantities. The parameters of such a consumption function allows one to construct social welfare indices that have both efficiency and equity components – an objective we pursue in the next step of our research. The data and parameters we present here, however, should be of immediate interest to those making urban-rural comparisons.

Our second aim for estimating household demand functions is to construct an aggregate demand function for commodities that can be used for policy analysis. Our formulation allows for a direct sum over households to deliver an aggregate demand that is a function only of prices, aggregate income and indices of demographic composition. Such an aggregate function is useful for economy-wide analysis and in empirical general equilibrium (CGE) models. For example, the Jorgenson and Slesnick

[1] China Statistical Yearbook 2016, Table 2-1.

(2008) model of U.S. household consumption is used in the model of the U.S. economy in Jorgenson et al. (2013) to analyze tax policies in a way that distinguishes the different impacts on different types of households. Caron, Karplus and Schwarz (2017) discuss how analysis of energy use in developing countries using CGE models often rely on unitary income elasticities due to the lack of estimates; our work here using a flexible function is a contribution to providing income and price elasticities.

While many CGE models use simple demand functions such as the CES that do not require cross-price elasticities, econometricians have used a wide variety of flexible models to describe consumption behavior; Muellbauer (1977) used the price-independent generalized linear (PIGL) system and Ray (1982) used the AIDS model specified by Deaton and Muellbauer (1980) to estimate the expenditure patterns for the United Kingdom. Blanciforti, Green and King (1986) used the AIDS model and Jorgenson and Slesnick (1987) used the Translog model to estimate expenditure patterns in the U.S. Yen et al. (2004) also use a Translog model for a China consumption function. All these estimates are based on cross-section observations on individual expenditure data, sometimes supplemented by time series aggregates. Such flexible models allow for a richer description of demand behavior and may be preferable to homothetic functions in policy analysis.

To illustrate an application of our aggregate demand function, we combine it with a multisector CGE model of China to project changes in national consumption patterns. We use price and income projections from the economy-wide model and combine with population projections including demographic changes and urbanization. We are able to attribute the projected changes in consumption shares to distinct price, income and demographic effects.

There is a strand of literature dealing with total household consumption, how it is affected by income, liquidity constraints or interest rates, or how it is related to labor supply. We are concerned here with the literature dealing with household commodity consumption in China. Much of this research so far has focused on narrowly defined goods or regions. Ortega, Wang and Eales (2009) estimated meat demand, while Hovhannisyan and Gould (2014) use the AIDS model to estimate food demand in urban China. Both papers use time series of macro consumption data, not household data. Chen and Xing (2011) estimated the demand for cigarettes in urban China using household data from 1999 to 2001, while Cao, Ho and Liang (2016) estimated the energy demand in urban China using a two-stage AIDS model with household data from 2002 to 2009.

Yen. Fang and Su (2004) estimated urban household food demand using a year 2000 national survey, while Jiang and Davis (2007) is a study of rural food demand using surveys (1991-95) by the provincial statistical bureaus. Jiang and Davis also gives a summary of prior studies of household demand in China, highlighting how few of them take household characteristics into account. There are very few studies that include a complete set of consumption items; Fan, Wailes and Cramer (1995) who estimated a 2-stage LES-AIDS model using rural provincial data from 1982 to 1990, and Cao et al. (2017) estimated a translog model using urban data.

This paper is a first effort at estimating a comprehensive demand function using household survey data from both urban and rural Chinese households covering the period 1995 to 2006. We use a translog model, distinguishing households by size, location and characteristics of the head of household. The model allocates total expenditures into food, consumer goods, services and housing.

To estimate our model we combine expenditure data from the Urban Household Income and Expenditure Survey (UHIES) with rural household surveys from the

Research Center for Rural Economy (RCRE) from 1995 to 2006. A major obstacle to using these data for consumption research is the lack of estimates for owner-occupied housing, which now cover more than 80% of urban households in China. We construct rental equivalents using the value of homes in the surveys and using estimates of rent-to-price ratios which take into account location and housing characteristics. Another obstacle to previous research has been the lack of regional price indices that allow comparison at a point in time. Here we construct detailed regional prices in a benchmark year to properly deflate the expenditure data.

We find that food is both income and price inelastic, while services is more price elastic and income elastic. Urban households have higher expenditure shares on consumer goods as their income increases, and the demand is less price elastic than for services. However, for rural households, the income elasticity for consumer goods is very close to unity and we thus project that urbanization will accelerate the growth in demand for consumer goods.

In Section 2 we introduce the model of consumer behavior where households allocate their consumption among four items based on total expenditures, prices of commodities and demographic characteristics. We discuss the data, the results and show the different consumption patterns of urban and rural households in Section 3. In Section 4, we project consumption patterns based on projections of the population, as well as prices and incomes from the CGE model. We conclude and summarize the results in Section 5.

2. Methodology

We follow the approach of Jorgenson and Lau (1975) and Jorgenson and Slesnick (1987) in using an indirect utility function for each household and briefly describe the main features here. We use the following notation:

$\mathrm{p} = (p_1, p_2, \dots, p_N) -$ vector of prices of consumption bundles.

$x_k = (x_{1k}, x_{2k}, \dots, x_{Nk}) -$ vector of quantities consumed by the *k*th household.

$M_k = \sum_{n=1}^{N} p_n \cdot x_{nk} -$ total expenditures of the *k*th household.

$w_{nk} = p_n \cdot x_{nk} / M_k -$ expenditure share of the *n*th commodity.

$w_k = (w_{1k}, w_{2k}, \dots, w_{Nk}) -$ vector of expenditure shares of the *k*th household.

$A_k -$ vector of (0,1) attribute indicators. E.g. A_{1k}=1 if the head of the household is in the 35-55 age group, A_{2k}=1 if in 56+, A_{1k}= A_{2k}=0 if in 0-35.

We assume that households allocate expenditures in accord with a translog indirect utility function, V(p,M), of the form:

$$\ln V_k = \ln\left(\frac{p}{M_k}\right)' \cdot \alpha + \frac{1}{2} \ln\left(\frac{p}{M_k}\right)' \cdot B \cdot \ln\left(\frac{p}{M_k}\right) + \ln\left(\frac{p}{M_k}\right)' \cdot B_A \cdot A_k \qquad (2.1)$$

In this form, the preference differences among households are introduced through the attribute vector A_k. The matrices α, B and B_A are constant parameters that are the same for all households.

Lau (1982) discusses the conditions required for exact aggregation of the translog function, that is, the restrictions needed so that an aggregate demand function is obtained by explicit aggregation over households. These conditions are:

$$\mathrm{i}' \cdot B \cdot i = 0, \ \mathrm{i}' \cdot B_A = 0 \qquad (2.2)$$

where i is a vector of 1's. In addition, homogeneity of the demand function (only relative prices matter) allows us to choose a normalization:

$$\mathrm{i}' \cdot \alpha = -1$$

The vector of demand shares can be derived by applying Roy's identity to (2.1):

$$w_k = \frac{1}{D(p)} \cdot (\alpha + B \cdot \ln p - B_M \cdot \ln M_k + B_A \cdot A_k) \tag{2.3}$$

The denominator, D(p), takes the following form under the aggregation conditions in (2.2):

$$D(p) = -1 + B_M{}' \cdot \ln p \tag{2.4}$$

$$B_M = Bi$$

Integrability of the demand system also requires that the matrix of price substitution effects be symmetric and nonpositive definite (concavity restriction):

$$B' = B \tag{2.5}$$

The aggregate expenditure share vector, w, is obtained by multiplying household k expenditure shares by M_k and summing over all households:

$$w = \frac{\sum_k M_k w_k}{M}; \qquad M = \sum_{k=1}^{K} M_k w_k \tag{2.6}$$

This works out to be:

$$w = \frac{1}{D(P)}\left[\alpha + B \ln p - B_M \frac{\sum_k M_k \ln M_k}{M} + B_A \frac{\sum_k M_k A_k}{M}\right] \tag{2.7}$$

The aggregate consumption shares thus depend on expenditures through statistics of the joint distribution of expenditures (M_k) and attributes (A_k), that is, the national "income effect" depends on the joint distribution, not just total income. While textbooks write consumption as a function of income and prices, the M_k here is not income but total expenditures. We therefore mostly use the term "expenditure elasticity" instead of income elasticity.

Holt and Goodwin (2009) describe the elasticities of translog demand systems and give the uncompensated (Marshallian) price elasticities as:

$$\eta_{ij} = -\delta_{ij} + \frac{\beta_{ij}/w_i - \beta_{Mi}}{-1 + \sum_k \beta_{Mk} \cdot \ln(p_k/M)} \tag{2.8}$$

where δ_{ij} is the Kronecker indicator (=1 for i=j, and 0 otherwise). The expenditure elasticity for good *i* is:

$$\eta_{iy} = 1 - \frac{\sum_j \beta_{ij}/w_i}{-1 + \sum_k \beta_{Mk} \cdot \ln(p_k/M)} \tag{2.9}$$

The compensated (Hicksian) price elasticities are:

$$\eta_{ij}^C = \eta_{ij} + \omega_j \eta_{iy} \tag{2.10}$$

The implementation of concavity constraints for matrix B is discussed in detail by Holt and Goodwin (2009) and by Moschini (1999).

Econometric issues

The shares in (2.3) sum to 1 and we drop the last equation in the estimation, and express all prices relative to the price of housing. We assume the disturbances are additive and estimate:

$$w_{kt} = \frac{1}{D(p)} \cdot (\alpha + B \cdot \ln p_{kt} - B_M \cdot \ln M_{kt} + B_A \cdot A_k) + \varepsilon_{kt} \tag{2.11}$$

These disturbance represent unobserved shocks and optimization errors.

3. Data and Results

In this section, we describe the data used and the results of implementing the econometric model of consumer behavior described above. We divide consumer expenditures among four commodity groups:

1. Food (FD) – Purchased and in-kind food (including dining out)
2. Consumer goods (CG) – Clothing, household equipment, medical goods, educational goods, transportation equipment, communications equipment, recreational goods, and other goods.
3. Services (SV) – Medical care, education services, transportation services, communication services, recreation services and other services.
4. Housing (HS) – Rental equivalents, water, electricity and household fuels.

We employ the following demographic characteristics as attributes of individual households (represented by 0-1 indicator variables):

1. Age of the household head: Under 35, 35-55, Above 55.
2. Gender of the household head: Female, Male.
3. Employment of the household head: Private Sector, Public Sector.
4. Education of the household head: Less than Secondary School, Secondary School, and College (or above).
5. Number of members in the household: 1-2, 3, 4+.
6. Has Child: if there is someone under age 16 in the household.
7. Has Aged: if there is someone aged 60+ in the household (60 is the retirement age for men in most urban jobs).
8. Location: West, East and Central.

These characteristics were chosen because they were the most salient during preliminary analysis. We found significant differences between those who worked in the public sector versus those who do not; such workers often receive in-kind income and have access to subsidized dining. There are different ways to represent the size and composition of households and we found that using an indicator for the presence of a child is sufficient without having an explicit count of the number of children. An indicator for the presence of someone aged 60+ is also sufficient to capture the differences without needing to enumerate them; 60 is the official retirement age for many urban men in this period, 55 for most women.

Data and Summary Statistics

Our observations on household expenditures for each commodity group and demographic characteristics are taken from the Urban Household Income and Expenditure Survey (UHIES) and the Research Center for Rural Economy (RCRE) survey[2]. The UHIES is the only comprehensive source of information on household income, expenditures for all consumption items, demographics and housing characteristics for urban households. It is conducted by the National Bureau of Statistics (NBS)[3].

"Table 1 about here"

The UHIES is conducted every year, using a stratified design and probabilistic sampling. The micro data is not made publicly available unfortunately; the NBS provided a subsample of the UHIES from 1995 through 2006, covering 9 provinces, to

[2] The RCRE is part of the Ministry of Agriculture and their work is described at http://www.rcre.agri.cn/ .
[3] Other household surveys, such as the China Household Income Panel (CHIP) survey and the China Family Panel Survey (CFPS), all focus on incomes, with limited expenditure information. The CHIP data is a subset of the UHIES with some additional question.

the Tsinghua University China Data Center which we were able to access[4]. The 9 provinces in this subsample were chosen by the NBS to represent poor provinces (Anhui and Gansu), rich ones (Guangdong, Zhejiang and Beijing) and others in-between (Liaoning, Hubei, Sichuan and Shaanxi). It would, of course, be much better if there were observations from every province since conditions vary significantly from one province to another. These 9 provinces are, however, what is available and we compare them to the national averages below[5].

In Table 1, we show the summary statistics of the 167,389 urban households in our sample. 63.8% of households are headed by someone aged 35-55 while 19.7% are headed by those aged 55+. 61.9% of household heads have secondary school education while 32.4% have some college education. 43% of households have a child under age 16 while 22% has at least one person aged 60+. In this period, 57.9% of the heads of households are in the public sector (a government agency or state-owned enterprise).

In order to see how our 9-province sample compare to the nation's 30 provinces, we tabulate in Table 2 the average household income, expenditures and durable equipment owned based on the complete UHIES sample calculated by the NBS[6]. We then tabulate the same variables from our subsample. We can see that our sources of income and composition of consumption bundles are close to the national ones, in particular for the most important consumption group, food (39.97% in our sample versus 39.94%). The biggest difference is for Other Goods & Services, 3.58 versus 3.97.

The two samples have very similar household sizes, 2.95 versus 2.98, and sources of income. Households in our 9-province sample have slightly higher disposable

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[4] The China Data Center is managed by the School of Economics and Management, Tsinghua University; one of the authors, Cao Jing, is a Professor at the School.
[5] We should note that the CHIP survey that is used in many studies (e.g. Li et al. 2011) also covers a small set of provinces.
[6] China Statistical Yearbook 2007, Tables 10-5, 10-7, 10-10.

income and 4% higher total expenditures. There are some slight differences in the number of durable appliances with the largest gap in air-conditioner ownership (1.12 in our sample versus 0.88 in the national sample) and automobiles (0.28 versus 0.25). We are thus confident that elasticities and demographic effects estimated from our sample would not be very different from those estimated from the national sample.

"Table 2 about here"

The National Bureau of Statistics also conducts the Rural Household Income and Expenditure Survey (RHIES) in parallel with the UHIES. Unfortunately, the RHIES data for recent years is not available for outside researchers. The RCRE survey from the Ministry of Agriculture provides information on household income, demographic variables, housing, and expenditures on a few aggregated categories. It cover all provinces except Tibet, but unlike the NBS data, the sample of households in the RCRE is fixed. We have the whole sample for the 2003 to 2006 period but unfortunately only have a subsample of 6 provinces[7] from 1995 to 2002. We also compared the expenditure shares in our RCRE sample with the national ones published in the Statistical Yearbook and the differences are of the same magnitude in Table 2 for urban households. There are 101,207 rural households in our sample in 2006 and Table 3 gives the summary statistics.

"Table 3 about here"

We can see significant differences between urban and rural households; the latter are bigger (66.1% are of size 3+ versus 17.9%), and are more likely to have children

[7] The 6 provinces are Liaoning, Zhejiang, Shandong, Guangdong, Yunnan and Gansu.

(53.7% versus 43.0%). The head of households in urban areas are better educated (32.4% has a bachelor's degree or above versus 5%) and are more likely to work in the public sector (57.9% versus 2.1%). The expenditure shares are quite different but we defer a discussion of that until we bring in the income and relative price aspects.

There are obvious extreme values and errors in this dataset; we replace the extreme expenditures for any item by the average spending on that item by the same income group[8]. These consumption data include in-kind consumption, which are more important for rural farmers and state workers in the earlier era. We follow Jorgenson and Slesnick (1987) in distinguishing durable and nondurable expenditures in our model on annual consumption. Unfortunately, there is little information on the stock of durables and we impute an annual flow of services from durables as described in Appendix A.2.

In China today, most households live in their own homes, nationally less than 5% live in rented housing, with about 10% of urban households in rental units. Unfortunately, the NBS did not make comprehensive estimates of the rental equivalents; in the National Accounts for GDP for that period they merely imputed the depreciation value of the structures. The urban survey uses a similar method to estimate the rental equivalents and they are very low (see Cao et al. 2017a for more details). The survey does ask for estimates of the value and size of the homes. We combine this information with estimates of rental-price ratios to impute the rental equivalents using the following procedure.

The Hung Lung Center for Real Estate in Tsinghua University estimates the rent-price ratio of about 110 cities in China from 2009 to 2013, based on households'

[8] The data issues are discussed in greater detail in Cao et al. (2017a). There were only 29 observations with extreme consumption values.

estimates of the rental equivalents and the current price of their homes[9]. Of these 110 cities, 29 are in our UHIES sample, covering all 9 provinces. Let ρ_t^r denote the rent-price ratio in province *r* at time *t*, and VH_t^r denote the value of the housing unit. The annual rental value of owner-occupied unit *i* in province r_i is then:

$$Rent_t^{r_i} = \rho_t^r \cdot VH_t^{r_i} \qquad (3.1)$$

We need prices over time and begin with the CPI for housing expenses. These indexes are calculated by the NBS for each province, separately for urban and rural consumers; they include prices for detailed commodities including "building materials," "rent," and "water, electricity, fuels". We use the urban CPI for rents over the 1995-2009 period as a proxy for the housing consumption price trend. First, we express the rental value in (3.1) as the rental price per square meter multiplied by the floor area given in the UHIES survey:

$$Rent_t^{r_i} = RP_t^{r_i} Area_t^{r_i}$$

We assume that the imputed rental price, averaged over all households in region r, RP_t^r, change over time like the CPI for rents in that province:

$$RP_t^r = \frac{\sum_{k=1}^{K_r} Rent_t^{r_k}}{\sum_{k=1}^{K_r} Area_t^{r_k}} \qquad (3.2)$$

$$\frac{RP_t^r}{RP_{t-1}^r} = \frac{CPI_{rt}^{rent}}{CPI_{r,t-1}^{rent}} \qquad t=1995,\ldots,2009$$

We have not been able to find any estimate of rural rental-price ratios and thus have to make some simplifying assumptions. There are three types of housing units classified in the RCRE data: Multi-unit buildings, Brick houses and Others (e.g.

[9] The Center for Real Estate Tsinghua University generously shared their data with us; their research and price indices are described in http://www.cre.tsinghua.edu.cn/publish/cre/9183/index.html.

thatched cottage). We use the simple cost of capital equation linking annual rents to the market interest rate, depreciation and capital gains, ignoring tax and risk issues. Let P_t denote the price of the property, and π_t be the capital gain rate, we have:

$$Rent_t = P_{t-1} \cdot (r_t + \delta_t \cdot (1 + \pi_t) - \pi_t) \qquad (3.3)$$

$$\pi_t = P_t / P_{t-1} \text{-} 1$$

The rent-price ratio is then:

$$\rho_t = Rent_t / P_t = (r_t - \pi_t)/(1 + \pi_t) + \delta_t \qquad (3.4)$$

In that period of low housing inflation in the rural areas, we may approximate the rural ratio as:

$$\rho^R = \mathrm{r} + \delta \qquad (3.5)$$

In the rural regions, the interest rates for housing are generally very low, and we simply set them at 2%. We assume that the useful life for multi-unit buildings, brick houses and thatched cottage are 40yrs, 20yrs and 12.5 years, respectively. The corresponding depreciation rates are 2.5%, 5% and 8%. The rent-price ratios are thus assumed to be 4.5%, 7% and 10%.

With the above calculations for rental equivalents and durable flows we obtain the four bundles of consumption expenditures for each household in the sample. We next turn to prices. The UHIES and RCRE record the RMB expenditures for the different items and some limited quantity data (e.g. kilograms of rice), but not systematic information on prices paid. A number of earlier studies have used the 1990 commodity prices by region estimated by Brandt and Holz (2006) in the most detailed work up to that time. We needed more recent prices and thus estimate regional price levels using four different sources of data for 2009.

The first is the National Development and Reform Commission (NDRC) surveys which provide price data for many items and we chose the ones for comparable services such as local bus fares, taxi fares, telephone fees, and cable TV fees. The second source of prices is the unit values derived from the UHIES data on expenditures and quantities for fairly homogenous items such as rice, men's shirts, water, electricity, and fuels. The third type of price data comes from provincial Development and Reform Commissions (DRC). The fourth source of prices is the websites of service suppliers such as tutoring. The prices are estimated separately for the urban and rural areas for each province. We compute the price of the four consumption bundles using a Tornqvist index over the component commodities following Slesnick (1998, 2002). The prices are then extended backwards in time using the provincial CPI at the commodity level. Further details of the price construction are given in Cao et al. (2017).

We next describe the sample averages. In Figure 1, we show the average expenditure shares separately for urban and rural households. The share of food fell continuously until the mid-2000s while the shares of services rose steadily until the end of that period. The housing shares rose until the early 2000s and then flattened out. The shares of consumer goods do not show any particular long term trend. Although urban and rural households have similar trends in the expenditure shares, they are at different levels. The food share for rural households are much higher than that for urban households since they have much lower incomes. The rural households have a slightly higher services share and slightly lower consumer goods share. For housing, the gap between urban and rural households is very small at the beginning of our sample period. Over the 1995-2006 period the housing share for urban households doubled, while it rose only 40% for rural households. The rapid urbanization in China raised urban housing prices significantly faster; during this period, as shown in Figure 2, housing prices rose 260% in the urban areas, but only 130% in the rural areas. This price change contributed to the big rise in the urban expenditure share.

On the other hand, the price of consumer goods fell 25% in the urban areas, and 8% in the rural areas; this bundle includes information technology equipment and other electrical equipment. The urbanization process likely contributed to this deflation by reducing transportation costs. The services price in the rural areas had a slightly higher inflation rate perhaps due to a small convergence to urban services patterns. Food price inflation is very similar between urban and rural areas.

"Figure 1 about here"

"Figure 2 about here"

Estimation Results

Earlier work, such as Jorgenson and Slesnick (1984) have limited cross-sectional price data and have to combine a cross-section from 1 year and time series of aggregate prices to estimate the demand system in (2.11). We have cross-sectional price data for every year and can estimate equation (2.11) directly. We first estimate the system separately for urban and rural households, and then combine the samples. The detailed estimated coefficients are given in Appendix Tables A2-A4, here we discuss the elasticities derived from the estimated coefficients and demographic effects.

The elasticity formulas given in (2.8-2.10) are functions of shares, prices and incomes; that is, they are not constant elasticity forms. In our discussions below we compute the elasticities for the reference household in the base year (2006): one with children, no aged member, size=3, in the East region, with a head of household who is male, aged 35-55, secondary school education, and works in the private sector. These price and expenditure elasticities, together with the standard errors, are given in Table 4.

"Table 4 about here"

All the income elasticities are significantly different from 1 with very small standard errors. For both urban and rural households, food have low expenditure elasticities ($\eta_{iy} < 0.75$) and housing is also income inelastic. The expenditure elasticities of services are above 1.3 for all types of households, and for consumer goods it is 1.1 for rural demand and 1.3 for urban demand.

The uncompensated price elasticities also differ by goods and region. Services are more price elastic for rural households (-0.61) compared to urban demand (-0.52) which is consistent with the expenditure elasticities; rural households are slightly less eager to spend additional income on services and so are more sensitive to prices. We should note that services is a bundle of very distinct items, it includes likely inelastic expenditures such as schooling and daily transportation to work, and more elastic items such as holiday travel and entertainment. The rural and urban households spend different shares of total services on all these items. The price elasticity for consumer goods are similar for urban (-0.74) and rural (-0.69) households.

Food is less price elastic for rural households (-0.27 versus -0.43), likely due to two reasons. One is the higher share of eating out in the food bundle for urban households and this has a higher price elasticity (in our sample, dining out is 15% of total food for urban households but only 5% for rural). Two, about 30% of rural food consumption is in-kind (own-grown), which is likely price inelastic. The price elasticity for housing is -0.63 for rural consumers and -0.54 for urban ones, consistent with the lower income elasticity for urban households. We note that most rural households build their own single-unit homes, unlike the vast majority of urban families buying apartments.

The differences among household types are given by the B_A coefficients in (2.11); note that since the $D(p)$ term is negative, a positive B_A means the share is lower than the compared group. We first discuss the urban household coefficients given in Table A2. Household size has the largest effect on the consumption choices, bigger households spend more on food, and less on consumer goods. The average urban food share is 33% (Table 1) and a size 3 urban household has a food share about 3 percentage points higher than a size 1-2. Households with children have expenditure shares about 1 to 2 percentage points lower for food and housing, and correspondingly higher shares for consumer goods and services. Urban households with an aged member shifts demand slightly away from services and housing, and raise the food share by 1 percentage point. The regional differences are small but statistically significant, with households in the Central region spending less on consumer goods.

The characteristics of the head of household also have statistically significant effects. Urban households with a head younger than 35, compared to one with age 35-55, shifts 1 percentage point from services to consumer goods. Heads with college education, compared to those with less than secondary schooling, spend 3 percentage points less on food, but more on consumer goods and services. As the public sector often provide in-kind food and housing (sometimes subsidized), urban households with a head working in the public sector spend less on housing, and correspondingly more on consumer goods.

Rural households have slightly different demographic effects. The household size effect for food is similar to urban households but large rural households have a smaller housing share compared to smaller households unlike urban preferences. The presence of a child has effects of the same sign as urban demand but smaller in magnitude. The presence of someone aged 60+ has the similar effects in rural and urban functions. The rural regional effects are much bigger than urban ones; rural households in the East and Central regions have food shares that are 5 to 6 points lower than those in the West. The age effects are mostly of the same sign as urban households but different magnitudes; those with age 35-55 spend 1 percentage point less on food compared with younger heads of household. The differences in consumption among different levels of education are similar between rural and urban households.

While these differences between rural and urban households are noticeable, it may be necessary to impose one aggregate demand function for some analysis using economy-wide models, especially infinite-horizon foresighted models. The model of the U.S. economy in Jorgenson et al. (2013) is a good example where an aggregate demand is needed. For such purposes, where separate urban and rural demands are not tractable, we have estimated the model in (2.11) where we include all urban and rural households. The difference now is that we add an additional demographic indicator (0=urban, 1=rural) in the A_k vector allowing the intercepts to be different while imposing common price coefficients. The time series covers the same 1995-2006 period and the estimated coefficients are also given in Appendix A3.

The elasticities of the combined urban-rural estimation are given in the bottom section of Table 4. The expenditure elasticities here are between those estimated separately for the urban and rural samples, except for Food, where the combined elasticity is 0.748, slightly higher than the separately estimated 0.739 and 0.704. The uncompensated price elasticities for the combined sample is mostly less elastic than for the separate samples. For example, the price elasticity for food is -0.27, the same as the rural value and less elastic than the -0.43 for the urban sample. For Housing, the combined price elasticity is -0.49 versus -0.54 for urban and -0.63 for rural. These more inelastic estimates for the combined sample is due to the differences between the average price levels in urban areas versus the rural areas; the difference in averages is likely bigger than the range of prices observed within the rural and within the urban areas. The standard errors in the combined sample are smaller than the standard errors in the separate samples reflecting this big difference in price averages between urban and rural areas.

"Table 5 about here"

As emphasized above, the elasticities (eq. 2.8-2.10) depend on total expenditures. Table 5 shows how the price and expenditure elasticities change across 5 expenditures (income) quintiles for the reference household, together with the standard errors.

The expenditure elasticities, η_{iY}, (Table 5C) for the 4 bundles generally become smaller as the households become richer. There is a clear, strong, monotonic trend for the Food expenditure elasticity of both urban households (.78 down to .67) and rural households (.74 to .66). There is some variability in the elasticity for the first 3 quintiles for Services and Housing among both urban and rural households. The income effect for Services is large for the poorest 40% among urban and rural households – an elasticity about 1.4. There is a clear monotonic trend in η_{iY} for consumer goods among urban households, but it is bouncing around 1.3 for rural demand.

The uncompensated price elasticities, η_{ij}, (Table 5A) varies a lot over the 5 quintiles. Food again has the clearest trend of becoming more price inelastic as incomes rises, for both urban (-.54 up to -.26) and rural (-.38 up to -.15) households. Housing, like food, is income inelastic, but has no clear trend in the price elasticities. The demand for Consumer Goods become more price sensitive as income rises among urban households, but η_{ij} has a V-shape for rural households.

4. Projection of consumption shares

Detailed projections of the economy are key components of economic policy analysis; one needs, not just GDP, but also the consumption and other variables. Analysis of food and energy policies, for example, requires estimates of future food and energy demand. In this section, we show how the household model estimated above can be used to project consumption behavior in combination with a general equilibrium model of the economy.

To illustrate the method we use a multi-sector growth model of China described in Nielsen and Ho (2013) which has been used for analysis of environmental policies. Our aim here is not to give the best possible projection of consumption of the four bundles, but to illustrate how the model parameters estimated in the previous section may be used in conjunction with a model that simulates GDP, household incomes and commodity prices. Readers interested in the model details may consult Nielsen and Ho (2013) or an online Appendix for details[10]. The growth model identifies 33 sectors and we aggregate the 33 prices to the 4 consumption bundles in the aggregate demand function (2.7) above. This CGE model uses standard constant returns to scale assumptions and CES production functions. The baseline assumes that there is a continuing rebalancing of the economy away from investment to consumption and thus consumption grows a bit faster than GDP.

There are 2 ways to illustrate the use of an econometrically estimated consumption function with such a CGE model. One is to embody the consumption function into the model and allow the estimated coefficients to drive the income and price effects on

[10] The China growth model Appendix is available at the webpage of the Harvard China Project on Energy, Economy and Environment: https://chinaproject.harvard.edu/files/chinaproject/files/chinaces-hhmodel.2019.pdf

commodity distribution. Another way is to simply take a CGE model's preset simple consumption function and use the projected prices and GDP as exogenous inputs to the richer estimated equation 2.7 and project the consumption bundles. In our example below we employ the first method so that all the endogenous variables in the CGE model is consistent with the estimated aggregate consumption function.

In the first step, we project the set of exogenous variables that provide the distribution terms in the aggregate consumption share system (equation 2.7)[11]. We rewrite that vector of shares for Food, Consumer Goods, Services and Housing in terms of type *K* households:

$$w_t = \frac{1}{D(p)} \cdot (\alpha + B \ln p_t - B_M(\xi_t^d + \ln M_t) + B_{pA} \cdot \xi_t^L) \tag{4.1}$$

where

$$\xi_t^d = \sum_K n_{Kt} \frac{m_{Kt}}{M_t} \ln \frac{m_{Kt}}{M_t} \tag{4.2}$$

$$\xi_t^L = \sum_K n_{Kt} m_{Kt} A_K / M_t \tag{4.3}$$

$$M_t = \sum_K n_{Kt} \cdot m_{Kt}$$

m_K is the expenditure of households of type *K*, and n_{Kt} is the number of households of that type in the whole country. The *K* index here is shorthand for the cross-classification of demographic categories used – the age of the head(*a*), sex of the head(*s*), job of the head(*j*), education of the head(*e*), has a child (*c*), has an aged(*g*), number of members(*n*), region(*r*), and location(*l*) – so that $n_K \equiv n_{asjecgnrl}$. The distribution terms represent the effects of the changing composition of families on aggregate consumption demands; ξ_t^d represents the demographic effect on aggregate total expenditure and ξ_t^L represents the effect due to different household types having different baskets when faced with the same prices.

[11] This approach follows that taken in Jorgenson et al. (2013, Chapter 3) model of the U.S. economy with a similar translog consumption function.

For the sample period the distribution terms, ξ_t^d and ξ_t^L, are obtained from the UHIES data and RCRE data. Beyond the microdata sample period we assume that the relative expenditures by type of households are fixed, that is, that the ratios m_{k_1}/m_{k_2} are fixed, but allow the number of households of type *K* to change according to population projections. We first define the mean expenditure share of group *K* for the last year of the sample:

$$\bar{m}_K^0 = \frac{\bar{m}_{K,T=2006}}{M_{T=2006}} \tag{4.4}$$

where M_T is the national total expenditures in base year T. We fix the m_{kt}/M_t term in (4.2) and (4.3) at the base year shares, $\bar{m}_K^0$, and the distribution terms (4.2) are then written as:

$$\xi_t^d = \sum_K n_{Kt} \cdot \frac{\bar{m}_K^0}{M_T^0} \cdot \ln \frac{\bar{m}_K^0}{M_T^0} \qquad t=2007,2008,\ldots \tag{4.5}$$

$$\xi_t^L = \sum_K n_{Kt} \cdot \frac{\bar{m}_K^0}{M_T^0} A_k \tag{4.6}$$

"Figure 3 about here"

The projection of the number of households, n_{Kt}, is discussed in Appendix A.4. In Figure 3, we plot the type *K* expenditure shares ($n_{Kt}\frac{\bar{m}_K^0}{M_T^0}$ in the ξ_t^L expression) of the main household types. Our population projections point to a rising share of older, better-educated and urbanized households. Under our assumption of fixed relative expenditures by households of each type, the expenditure share of households with head over age 55 are projected to rise from 18.9% in 2006 to 34.4% in 2040, while that of households with a college-educated head rises from 34.0% to 48.6%. The share of expenditures due to urban households rises from 76.1% in 2006 to 93.6% in 2040 under the assumption that income gaps do not close.

The aggregate consumption function (4.1) with these projected distribution terms, ξ_t^d and ξ_t^L, is then combined with the projections of prices and incomes from our CGE model of China. The projected price vector of the 4 consumption bundles, $\hat{p}_t$, and national household disposable income, $\widehat{M}_t$, from the growth model is plugged into the share vector (4.1):

$$w_t = \frac{1}{D(\hat{p}_t)} \cdot (\alpha + B \ln \hat{p}_t - B_M(\hat{\xi}_t^d + \ln \widehat{M}_t) + B_A \hat{\xi}_t^L) \qquad (4.7)$$

The change of the expenditure shares between the base year and year t is then:

$$\Delta\varepsilon_t = \frac{1}{D(\hat{p}_t)} \cdot (\alpha + B \ln \hat{p}_t - B_M(\hat{\xi}_t^d + \ln \widehat{M}_t) + B_A \cdot \xi_t^L)$$
$$- \frac{1}{D(\hat{p}_0)} \cdot (\alpha + B \ln \hat{p}_0 - B_M(\hat{\xi}_0^d + \ln \widehat{M}_0) + B_A \cdot \xi_0^L) \qquad (4.8)$$

$\frac{1}{D(\hat{p}_t)}$ is very close to $\frac{1}{D(\hat{p}_0)}$, and when normalized to 1 in the base year, $D(\hat{p}_t) = -1$. With this simplification, the change in the expenditure shares is:

$$\Delta\varepsilon_t = -B \cdot \Delta\ln \hat{p}_t + B_M \cdot (\Delta\hat{\xi}_t^d + \Delta \ln M) - B_A \cdot \Delta\xi_t^L \qquad (4.9)$$

where $-B \cdot \Delta\ln \hat{p}_t$ is the price effect, $B_M \cdot \Delta\hat{\xi}_t^d$ is the income effect, and $-B_A \cdot \Delta\xi_t^L$ is the demographic effect.

In Figure 4, we plot the projected prices and expenditure per capita from the growth model of China. The model has a 2014 base year, and we add to the graph the actual CPI for 2006-2014. The prices are normalized to 1 in 2006. The total expenditure in the historical period is taken from the growth of real consumption per capita from the National Accounts. Expenditure per capita rises over the whole projection period, but decelerates with the slowing GDP growth. By 2040, the real expenditure per capita is about 4 times the 2014 level.

"Figure 4 about here"

The model projects that the relative price of consumer goods (CG) will fall substantially while the price of services will rise. The projected behavior after 2014 is somewhat different from actual 2006-2014 price trends, which were dominated by the aftershocks of the Financial Crisis. By 2040, the price of CG relative to food is expected to be only half of the 2006 price. The housing price first rises, peaking around 2025, and then fall; this is due to the rapid capital accumulation, which eventually lowers the cost of capital (the model does not take into account land prices). We should also note that the projected population starts falling around 2025.

We compare our simulated results with the actual national urban consumption shares during 2007 to 2014 reported in the *Statistical Yearbook*. Since the consumption groups in the *Yearbook* tables are not the same as our 4 bundles, we first reorganize the national data to match our categories.[12]

The consumption shares from the actual 2007-14 surveys and those projected from our estimated parameters are plotted in Figure 5. On average, we overestimate the food share and underestimate the consumer goods share a little. The actual services and housing shares are quite volatile compared to our smoother projections, but on average, they are close. However, for all 4 consumption bundles, the actual shares change in the same way as we project, and the errors are less than 1.5 percentage points, eight years out.

"Figure 5 about here"

[12] We split the transportation, communication, medical and education categories in the China Statistical Yearbook (CSY) into two parts: goods versus services, using the relative shares in our detailed household data from 2006 to 2009. We impute the rental equivalent of OOH but the CSY tables derived from the household survey do not. However, the National Accounts estimate of Urban Consumption does include a housing imputation, and so we use it to give the rental equivalents for 2007-14. The NBS also changed its methods for estimating in-kind consumption and housing after 2013 and we adjust for that too.

Plugging the prices and expenditures from the simulation into (4.9), we get the price, income and demographic effects on consumption shares which are shown in Appendix Figures A.1-A.4. With rapid growth of food prices in the first few years, the price effect is strong for all the goods. However, the income effect gradually dominates the price effect as income keeps growing but changes in relative price moderates. Interestingly, the demographic effect is small over the whole period, though the demographic distribution changes significantly. Two opposite effects occur as the population becomes older and better educated. A household with an aged head prefers spending more on food and housing, while a household with a better-educated head prefers consumer goods and services. These two trends cancel each other and the net demographic effect due to the urbanization is small over the whole period.

“Figure 6 about here”

In Figure 6, we plot the projected expenditure shares. The shares before 2006 are the actual shares from our sample, the shares for 2007-13 are from Figure 5, and the rest are simulated from the growth model. The services share continues its historical rise due to higher incomes, rising from 20.5% in 2006 to 32.8% in 2040. Consumer goods trended like services with a slower increase in the projection period, unlike the historical fall in its share due to falling goods prices; the share rises from 22.9% in 2006 to 24.9% in 2040.

As necessities, food and housing shares fall with the rapidly rising incomes in the projection period. The food share drops from 32% in 2014 to 20.9% in 2040. Note that this projected fall is in contrast to the somewhat stable share between 2002 and 2014 that is driven the high food prices and demographic effects. The housing share continues to fall, driven by the income elasticity that averages 0.9 (from 22.9% in 2014 to 21.9% in 2040). This is quite different from the historical behavior when it rose from 14.5% in 1995 to 27.6% in 2002 due to the rising property prices.

5. Conclusion

We have estimated consumption functions for China based on household level data that gives us the differences in demand between urban and rural areas in addition to price and income elasticities. We cover all consumption categories unlike most previous studies that focused on particular items, and allow different household types to have different consumption shares. These estimated utility functions serves two major aims. One, they provide the key parameters needed for a measure of welfare and inequality based on consumption to complement the many studies of inequality based on income. Two, they provide the price and income elasticities for policy analysis.

While we are not able to obtain the ideal data set covering all provinces and surveys which cover the urban and rural areas in an identical fashion, we believe the data we do have provide useful information on the key elasticities and demographic differences of interest. The relatively large sample size and long time series of prices allowed us to estimate the elasticities and demographic effects quite well. The lack of official imputed owner-occupied housing rentals has left a gap in previous research on China household income and consumption and we have made a first effort to close this gap by using data on rent-price ratios.

Our estimates show income inelastic demands for food and housing but quite elastic demands for consumer goods and housing. Rural households have lower income elasticity for consumer goods but higher for housing compared to urban households. The price elasticity of food is lower for rural households but price elasticities of services and housing are higher. These estimates of elasticities should be useful for CGE models to avoid commonly used homothetic functions and to calibrate income and price elasticities based on China specific data.

To illustrate how our estimates may be used for policy analysis we derived a national demand function that is exactly aggregated over household types and used it to project national demands for the major consumption bundles by combining with projections of prices and incomes from a multi-sector growth model. The projected food share falls and the services share rises as the rapidly rising income dominates the price effects. With the rapid urbanization, as rural households migrate to the urban areas they adopt the urban expenditure patterns, leading to a significant change in national expenditure shares, in particular, higher housing expenditures. Demographic changes have opposing effects on consumption composition; the aging effect is offset by higher educational attainment.

We noted the importance of measuring consumption inequality to supplement the existing income based indices. Our future task is to employ the utility function used here to calculate household welfare based on consumption and distinguished by demographic characteristics. Such a measure would allow an econometric adjustment for the size of households and other characteristics as in Jorgenson and Slesnick (1984) instead of relying on rules of thumb like counting a child as a fraction of an adult in all cases. Our more recent price data would also give a better comparison of real consumption across provinces.

Appendix.

A.1: The components of our 4 consumption bundles are given in Table A1, these are the categories in the Urban Household Income and Expenditure Survey (UHIES).

"Table A1 about here"

A.2: Service flow from durable goods

The annual service flow from durable goods should ideally be calculated from data on stocks of different types of consumer durables and their depreciation rates. Unfortunately, neither the UHIES nor other sources of data allow us to estimate the household stocks well. The UHIES does indicate that most households own durables such as refrigerators and vehicles, and gives the expenditures for the households that purchased them in the survey year. We approximate the service flow by noting that in the steady state households replace each type of durable when it has completely depreciated. We thus divide the purchases of durables by households of a particular group to all households in that group. We allocate the households into deciles according to the expenditures on non-durable goods per capita within each region, in each year. We sum over all households the consumer durable purchases of household i (CD_i) in region r, in each decile I and then divide the total purchases by the sum of all household weights (fw_{it}) in group rI :

$$S_{rI,t} = \sum_{i \in rI}(fw_{i,t} \cdot CD_{i,t}) / \sum_{i \in rI} fw_{i,t} \qquad I=1,2,\ldots 10 \qquad \text{(A.1)}$$

We interpret $S_{rI,t}$ as the annual service flow from durables in each household decile I of region r at time t.

A.3. The estimates of the detailed coefficients in the translog demand function (equation 2.11) are given in Tables A2-A4.

"Table A2 about here"

"Table A3 about here"

"Table A4 about here"

A.4. Projection of the population distribution terms, ξ_t^d and ξ_t^L

As discussed in section 4, the projection of ξ_t^d and ξ_t^L requires a projection of the number of households of each type, $n_{asjecgnrl}$. We construct a household bridge matrix (H) that links the distribution of household types to a population matrix of dimension 2 sexes, 16 age groups, 3 education levels, and 2 locations based on the 2010 population census and labor survey data. The population projection for these dimensions is from Cao, Ho, and Hu (2019). We assume that the distribution for location, household size, presence of child and aged, and employment type remain unchanged in the future, given the relative stability in the recent years. We focus on two characteristics that will likely change the most: age of the head, and educational attainment of the head.

The bridge matrix (H) links the population by age-sex-education-location (Pop_{asel}) to the number of households by age of head, education, and location of head (nf_{ael}):

$$\overrightarrow{nf}_{ael,t} = H_{asel}^{ael} \cdot \Lambda_{asel}^{asel} \cdot \overrightarrow{Pop}_{asel,t} \quad \text{(A.2)}$$

$\overrightarrow{Pop}_{asel,t}$ is the population matrix transformed into a vector by rearranging the indexes.

Λ_{asel}^{asel} is a diagonal matrix that links the population distribution in our sample to the population distribution in the census data. The elements on the diagonal are the ratios for each type of population in our sample and the census data, with all 0's off the diagonal. That is, $SamplePop_{asel,2006} = \Lambda_{asel}^{asel} \cdot Pop_{asel,2006}$.

We construct the bridge H_{asel}^{ael} from our household sample using the following steps:

1. We first link individuals in the population data to households. Let *J* index the individual type (cross-classified by sex, age, location) and *I* index the household type (cross-classified by age, education, location). Matrix TX allocates individuals to each type of household; TX(*I*,*J*) is the share of all type *J* people that is allocated to household type *I*, and the sum of all elements in row *I* is 1. The number of rows, n(I)=3ages x 3 educ x 2 locations = 18.

2. We define a diagonal matrix SX of size n(I) x n(I), where the element SX_{II} is the reciprocal of the average size of type *I* of households:

$$\mathrm{SX} = \mathrm{diag}(\frac{1}{Size_I}) \tag{A.3}$$

Then the bridge matrix H_{asel}^{ael} is defined as:

$$H_{asel}^{ael} = \mathrm{SX} \cdot \mathrm{TX} \tag{A.4}$$

A.5. Projected demographic, income and price effects for expenditure shares

The change in expenditure shares over the projection period is driven by 3 effects as laid out in equation 4.9: changes in demographic characteristics of households, the rise in disposable incomes and changes in relative prices. Figures A1 to A4 give the three effects for the four consumption bundles – food, consumer goods, services, and housing, respectively.

“Figure A1 about here”

“Figure A2 about here”

“Figure A3 about here”

“Figure A4 about here”

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Tables

Table 1

Sample summary statistics - Urban Household Consumption (Sample size: 167,389)

Variable	Mean	Std. dev.	Minimum	Maximum
Total Expenditures	33109	24645	1166	478342
Share: Food	0.329	0.112	0.011	0.875
Share: Cons. goods	0.237	0.094	0.013	0.807
Share: Services	0.149	0.091	0.001	0.829
Share: Housing	0.285	0.134	0.015	0.972
Age 35-55	0.638	0.481	0	1
Age 55+	0.197	0.397	0	1
Male	0.762	0.426	0	1
Public employee	0.579	0.494	0	1
Secondary School	0.619	0.486	0	1
College	0.324	0.468	0	1
Has Child	0.430	0.495	0	1
Has Aged	0.222	0.415	0	1
Size 3	0.588	0.492	0	1
Size 4+	0.179	0.384	0	1
East region	0.486	0.500	0	1
Central region	0.240	0.427	0	1

Table 2

Comparison between our 9-province sample and National averages; 2006

Variable	National	9-Province Sample
Total Expenditure (Excluding Housing), yuan	7792	8261
Food	3112	3302
Clothing	902	906
Household appliances and supplies	498	565
Medical & Health	621	707
Transportation & Communication	1147	1236
Entertainment & Recreation	1203	1250
Other Goods & Services	309	296
Expenditure shares		
Food	39.94%	39.97%
Clothing	11.57%	10.96%
Household appliances and supplies	6.40%	6.84%
Medical & Health	7.96%	8.56%
Transportation & Communication	14.72%	14.96%
Entertainment & Recreation	15.44%	15.13%
Other Goods & Services	3.97%	3.58%
Household Size	2.95	2.98
Disposable Income Per Capita	11759	12177
Income Per Capita	12719	13317
Wage Income Per Capita	8767	9251
Management Income Per Capita	810	907
Capital Income Per Capita	244	281
Transfer Income Per Capita	2899	2971
Wage Income Share	68.93%	69.47%
Management Income Share	6.36%	6.81%
Capital Income Share	1.92%	2.11%
Transfer Income Share	22.79%	22.31%
Durables per household		
# Automobile	0.043	0.057
# Motorcycle	0.25	0.28
# Washing Machine	0.97	0.97
# Refrigerator	0.92	0.94
# Color TV	1.37	1.42
# Air Conditioner	0.88	1.12
# Water heater	0.75	0.85
# Personal Computer	0.47	0.54
# Microwave Owen	0.51	0.55
# Exercise Equipment	0.050	0.055
# Mobile Phone	1.53	1.58

Table 3. Sample summary statistics - Rural Households (Sample size: 101,207)

Variable	Mean	Std. dev.	Minimum	Maximum
Total Expenditures	9955	7755	587	137893
Share: Food	0.445	0.154	0.012	0.927
Share: Cons. Goods	0.193	0.099	0.007	0.943
Share: Services	0.186	0.145	0.000	0.936
Share: Housing	0.176	0.114	0.019	0.953
Age 35-55	0.642	0.479	0	1
Age 55+	0.213	0.409	0	1
Male	0.929	0.256	0	1
Public employee	0.021	0.142	0	1
Secondary School	0.513	0.500	0	1
College	0.051	0.219	0	1
Has Child	0.537	0.499	0	1
Has Aged	0.338	0.473	0	1
Size 3	0.200	0.400	0	1
Size 4+	0.661	0.473	0	1
East region	0.395	0.489	0	1
Central region	0.342	0.474	0	1

Table 4. Price and Income Elasticities (Reference Household: 35-55, Male, Private Sector, Middle School, Has Child, No Aged, Size 3, East, 2006)

	Good	Uncompensated Price Elasticity	Compensated Price Elasticity	Expenditure Elasticity
Urban	Food	-0.432	-0.202	0.739
		(0.018)	(0.020)	(0.008)
	Consumer Goods	-0.739	-0.450	1.298
		(0.012)	(0.016)	(0.010)
	Service	-0.523	-0.307	1.450
		(0.031)	(0.034)	(0.014)
	Housing	-0.545	-0.310	0.819
		(0.012)	(0.015)	(0.008)
Rural	Food	-0.270	-0.028	0.704
		(0.017)	(0.018)	(0.007)
	Consumer Goods	-0.691	-0.435	1.119
		(0.023)	(0.025)	(0.009)
	Service	-0.610	-0.292	1.339
		(0.019)	(0.021)	(0.009)
	Housing	-0.629	-0.444	0.969
		(0.022)	(0.025)	(0.012)
Combined Urban-rural	Food	-0.268	-0.023	0.748
		(0.005)	(0.005)	(0.001)
	Consumer Goods	-0.738	-0.473	1.175
		(0.002)	(0.002)	(0.001)
	Service	-0.524	-0.254	1.399
		(0.007)	(0.007)	(0.001)
	Housing	-0.487	-0.282	0.859
		(0.004)	(0.004)	(0.001)

Table 5A. Uncompensated Price Elasticities for different income groups (Reference Household: 35-55, Male, Private Sector, Middle School, Has Child, No Aged, Size 3, East, 2006)

	Uncompensated Price Elasticity	(0-20%)	(20%-40%)	(40-60%)	(60%-80%)	(80%-100%)
Urban	Food	-0.542	-0.478	-0.466	-0.403	-0.259
		(0.015)	(0.017)	(0.017)	(0.019)	(0.022)
	Consumer Goods	-0.683	-0.714	-0.728	-0.740	-0.778
		(0.016)	(0.014)	(0.013)	(0.012)	(0.010)
	Service	-0.495	-0.569	-0.542	-0.621	-0.664
		(0.033)	(0.027)	(0.029)	(0.023)	(0.020)
	Housing	-0.587	-0.567	-0.575	-0.537	-0.466
		(0.011)	(0.012)	(0.012)	(0.012)	(0.014)
Rural	Food	-0.378	-0.349	-0.332	-0.321	-0.152
		(0.015)	(0.015)	(0.015)	(0.016)	(0.019)
	Consumer Goods	-0.661	-0.652	-0.633	-0.666	-0.660
		(0.026)	(0.027)	(0.028)	(0.025)	(0.026)
	Service	-0.608	-0.572	-0.610	-0.644	-0.708
		(0.019)	(0.022)	(0.019)	(0.017)	(0.013)
	Housing	-0.562	-0.660	-0.650	-0.549	-0.510
		(0.026)	(0.021)	(0.021)	(0.027)	(0.029)

Table 5B. Compensated Price Elasticities for different income groups (Reference Household: 35-55, Male, Private Sector, Middle School, Has Child, No Aged, Size 3, East, 2006)

	Compensated Price Elasticity	(0-20%)	(20%-40%)	(40-60%)	(60%-80%)	(80%-100%)
Urban	Food	-0.159	-0.121	-0.115	-0.087	-0.043
		(0.016)	(0.018)	(0.019)	(0.020)	(0.025)
	Consumer Goods	-0.163	-0.189	-0.202	-0.215	-0.268
		(0.020)	(0.018)	(0.016)	(0.016)	(0.012)
	Service	-0.102	-0.133	-0.121	-0.163	-0.195
		(0.036)	(0.030)	(0.032)	(0.026)	(0.022)
	Housing	-0.154	-0.141	-0.145	-0.124	-0.092
		(0.013)	(0.014)	(0.014)	(0.015)	(0.017)
Rural	Food	-0.111	-0.097	-0.089	-0.085	-0.030
		(0.016)	(0.016)	(0.017)	(0.017)	(0.021)
	Consumer Goods	-0.155	-0.149	-0.137	-0.158	-0.154
		(0.028)	(0.029)	(0.030)	(0.027)	(0.028)
	Service	-0.193	-0.167	-0.194	-0.224	-0.304
		(0.021)	(0.024)	(0.021)	(0.019)	(0.015)
	Housing	-0.087	-0.133	-0.127	-0.083	-0.071
		(0.030)	(0.023)	(0.024)	(0.031)	(0.033)

Table 5C. Expenditure Elasticities for different income groups (Reference Household: 35-55, Male, Private Sector, Middle School, Has Child, No Aged, Size 3, East, 2006)

	Expenditure Elasticity	(0-20%)	(20%-40%)	(40-60%)	(60%-80%)	(80%-100%)
Urban	Food	0.783	0.757	0.752	0.727	0.669
		(0.007)	(0.008)	(0.008)	(0.008)	(0.010)
	Consumer Goods	1.384	1.335	1.314	1.296	1.238
		(0.012)	(0.011)	(0.010)	(0.010)	(0.008)
	Service	1.481	1.400	1.429	1.342	1.295
		(0.015)	(0.013)	(0.014)	(0.011)	(0.009)
	Housing	0.834	0.827	0.829	0.816	0.791
		(0.007)	(0.008)	(0.007)	(0.008)	(0.009)
Rural	Food	0.743	0.732	0.726	0.722	0.662
		(0.006)	(0.007)	(0.007)	(0.007)	(0.008)
	Consumer Goods	1.131	1.135	1.143	1.129	1.132
		(0.010)	(0.011)	(0.011)	(0.010)	(0.010)
	Service	1.341	1.380	1.339	1.302	1.232
		(0.009)	(0.010)	(0.009)	(0.008)	(0.006)
	Housing	0.963	0.971	0.970	0.962	0.959
		(0.014)	(0.011)	(0.011)	(0.015)	(0.016)

Table A1. Classification of Expenditures in the UHIES

FD (Food)	**SV (Service)**
Food and tobacco	Transportation Service
Dining Out	Vehicle Fuel
	Transportation fees
CG (Consumption Goods)	Vehicle Maintenance
Clothing	Communication Services
Household equipment and articles	Communication Fees
Transportation equipment	Postage
Vehicles	Medical Services
Communication Goods	Health Care
Medical Goods	Education Services
Medicine	Tuition
Medical Devices	Child-Care Fees
Education Goods	Recreation Services
Recreation Goods	Tourism
Recreational Durables	Gyms, Sports
Recreational Articles	**HS (Housing)**
Magazines	Rental Equivalent
Miscellaneous Goods	Water, Electricity and Fuels

Table A2. Estimated Coefficients for Urban Households

Variable	Estimate	SE	Estimate	SE
	Food		Consumer Goods	
CONST	-0.327	(0.0067)	-0.154	(0.0065)
Log PFD	-0.202	(0.0055)	0.030	(0.0032)
Log PCG	0.030	(0.0032)	-0.043	(0.0027)
Log PSV	0.071	(0.0038)	0.032	(0.0025)
Log PHS	0.020	(0.0042)	0.048	(0.0028)
Log EXPEN	-0.081	(0.0025)	0.066	(0.0021)
35-55	0.001	(0.0028)	0.011	(0.0032)
55+	-0.017	(0.0041)	0.016	(0.0047)
MALE	-0.005	(0.0023)	0.007	(0.0033)
PUBLIC	-0.003	(0.0025)	-0.013	(0.0029)
SECONDARY SCHOOL	0.014	(0.0041)	-0.012	(0.0049)
COLLEGE	0.032	(0.0045)	-0.018	(0.0050)
HAS CHILD	0.009	(0.0022)	-0.011	(0.0031)
HAS AGED	-0.010	(0.0032)	-0.001	(0.0039)
SIZE 3	-0.028	(0.0031)	0.032	(0.0039)
SIZE 3+	-0.052	(0.0035)	0.073	(0.0044)
EAST	-0.006	(0.0026)	0.003	(0.0035)
CENTRAL	-0.006	(0.0031)	0.012	(0.0033)

	Services		Housing	
CONST	-0.059	(0.0067)	-0.460	(0.0067)
Log PFD	0.071	(0.0038)	0.020	(0.0042)
Log PCG	0.032	(0.0025)	0.048	(0.0028)
Log PSV	-0.061	(0.0046)	0.026	(0.0036)
Log PHS	0.026	(0.0036)	-0.146	(0.0035)
Log EXPEN	0.067	(0.0021)	-0.052	(0.0023)
35-55	-0.011	(0.0037)	-0.001	(0.0032)
55+	0.007	(0.0044)	-0.006	(0.0044)
MALE	0.003	(0.0029)	-0.005	(0.0028)
PUBLIC	-0.001	(0.0028)	0.018	(0.0027)
SECONDARY SCHOOL	-0.007	(0.0043)	0.004	(0.0044)
COLLEGE	-0.013	(0.0054)	-0.001	(0.0050)
HAS CHILD	-0.015	(0.0028)	0.017	(0.0027)
HAS AGED	0.008	(0.0032)	0.002	(0.0034)
SIZE 3	-0.008	(0.0035)	0.005	(0.0035)
SIZE 3+	-0.003	(0.0040)	-0.018	(0.0040)
EAST	-0.005	(0.0032)	0.009	(0.0031)
MIDDLE	0.000	(0.0036)	-0.006	(0.0033)

Table A3. Estimated Coefficients for Rural Households

Variable	Estimate	SE	Estimate	SE
	Food		Consumer Goods	
CONST	-0.253	(0.0072)	-0.314	(0.0077)
Log PFD	-0.286	(0.0099)	0.089	(0.0030)
Log PCG	0.089	(0.0030)	-0.064	(0.0040)
Log PSV	0.084	(0.0072)	0.059	(0.0031)
Log PHS	0.111	(0.0067)	-0.057	(0.0034)
Log EXPEN	-0.102	(0.0008)	0.027	(0.0007)
35-55	0.010	(0.0023)	-0.001	(0.0023)
55+	-0.003	(0.0042)	0.002	(0.0042)
MALE	0.019	(0.0010)	-0.005	(0.0010)
PUBLIC	0.022	(0.0010)	0.003	(0.0010)
SECONDARY SCHOOL	0.019	(0.0012)	-0.012	(0.0012)
COLLEGE	0.023	(0.0016)	-0.011	(0.0016)
HAS CHILD	0.002	(0.0012)	0.003	(0.0012)
HAS AGED	-0.015	(0.0024)	0.004	(0.0024)
SIZE 3	-0.029	(0.0015)	0.010	(0.0015)
SIZE 3+	-0.051	(0.0026)	0.023	(0.0026)
EAST	0.064	(0.0024)	-0.048	(0.0019)
CENTRAL	0.049	(0.0018)	-0.011	(0.0018)

	Services		Housing	
CONST	-0.111	(0.0071)	-0.322	(0.0073)
Log PFD	0.084	(0.0072)	0.111	(0.0067)
Log PCG	0.059	(0.0031)	-0.057	(0.0034)
Log PSV	-0.074	(0.0076)	0.011	(0.0059)
Log PHS	0.011	(0.0059)	-0.072	(0.0053)
Log EXPEN	0.081	(0.0007)	-0.006	(0.0007)
35-55	-0.005	(0.0023)	-0.004	(0.0023)
55+	0.012	(0.0042)	-0.012	(0.0042)
MALE	0.003	(0.0010)	-0.017	(0.0010)
PUBLIC	-0.012	(0.0010)	-0.013	(0.0010)
SECONDARY SCHOOL	0.004	(0.0012)	-0.011	(0.0012)
COLLEGE	-0.005	(0.0016)	-0.007	(0.0016)
HAS CHILD	-0.006	(0.0012)	0.001	(0.0012)
HAS AGED	0.006	(0.0024)	0.005	(0.0024)
SIZE 3	0.011	(0.0015)	0.008	(0.0015)
SIZE 3+	0.014	(0.0026)	0.015	(0.0026)
EAST	0.010	(0.0024)	-0.026	(0.0022)
MIDDLE	-0.016	(0.0018)	-0.022	(0.0018)

Table A4. Estimated Coefficients for Combined Urban and Rural Households

Variable	Estimate	SE	Estimate	SE
	Food		Consumer Goods	
CONST	-0.313	(0.0008)	-0.188	(0.0010)
RURAL	0.040	(0.0009)	0.022	(0.0003)
Log PFD	-0.267	(0.0016)	0.045	(0.0004)
Log PCG	0.045	(0.0005)	-0.050	(0.0005)
Log PSV	0.097	(0.0012)	0.024	(0.0004)
Log PHS	0.042	(0.0007)	0.021	(0.0006)
Log EXPEN	-0.083	(0.0002)	0.039	(0.0001)
35-55	0.015	(0.0003)	-0.001	(0.0003)
55+	-0.002	(0.0005)	0.000	(0.0007)
MALE	0.009	(0.0001)	-0.001	(0.0001)
PUBLIC	0.004	(0.0002)	-0.022	(0.0002)
SECONDARY SCHOOL	0.022	(0.0002)	-0.011	(0.0001)
COLLEGE	0.032	(0.0003)	-0.018	(0.0003)
HAS CHILD	0.005	(0.0002)	-0.005	(0.0002)
HAS AGED	-0.013	(0.0003)	0.005	(0.0003)
SIZE 3	-0.029	(0.0003)	0.022	(0.0002)
SIZE 3+	-0.052	(0.0005)	0.048	(0.0004)
EAST	0.019	(0.0003)	-0.022	(0.0004)
CENTRAL	0.003	(0.0003)	0.009	(0.0002)

	Services		Housing	
CONST	-0.098	(0.0012)	-0.401	(0.0012)
RURAL	-0.010	(0.0007)	-0.053	(0.0006)
Log PFD	0.097	(0.0012)	0.042	(0.0007)
Log PCG	0.024	(0.0005)	0.021	(0.0006)
Log PSV	-0.077	(0.0013)	0.033	(0.0009)
Log PHS	0.033	(0.0006)	-0.131	(0.0010)
Log EXPEN	0.077	(0.0001)	-0.034	(0.0001)
35-55	-0.012	(0.0003)	-0.002	(0.0003)
55+	0.005	(0.0005)	-0.003	(0.0004)
MALE	-0.001	(0.0002)	-0.007	(0.0001)
PUBLIC	-0.008	(0.0001)	0.026	(0.0001)
SECONDARY SCHOOL	0.003	(0.0002)	-0.014	(0.0001)
COLLEGE	-0.002	(0.0003)	-0.012	(0.0003)
HAS CHILD	-0.012	(0.0002)	0.012	(0.0002)
HAS AGED	0.008	(0.0003)	-0.001	(0.0003)
SIZE 3	0.001	(0.0002)	0.006	(0.0002)
SIZE 3+	0.009	(0.0004)	-0.004	(0.0003)
EAST	0.008	(0.0004)	-0.006	(0.0002)
MIDDLE	-0.001	(0.0003)	-0.012	(0.0002)

Figures

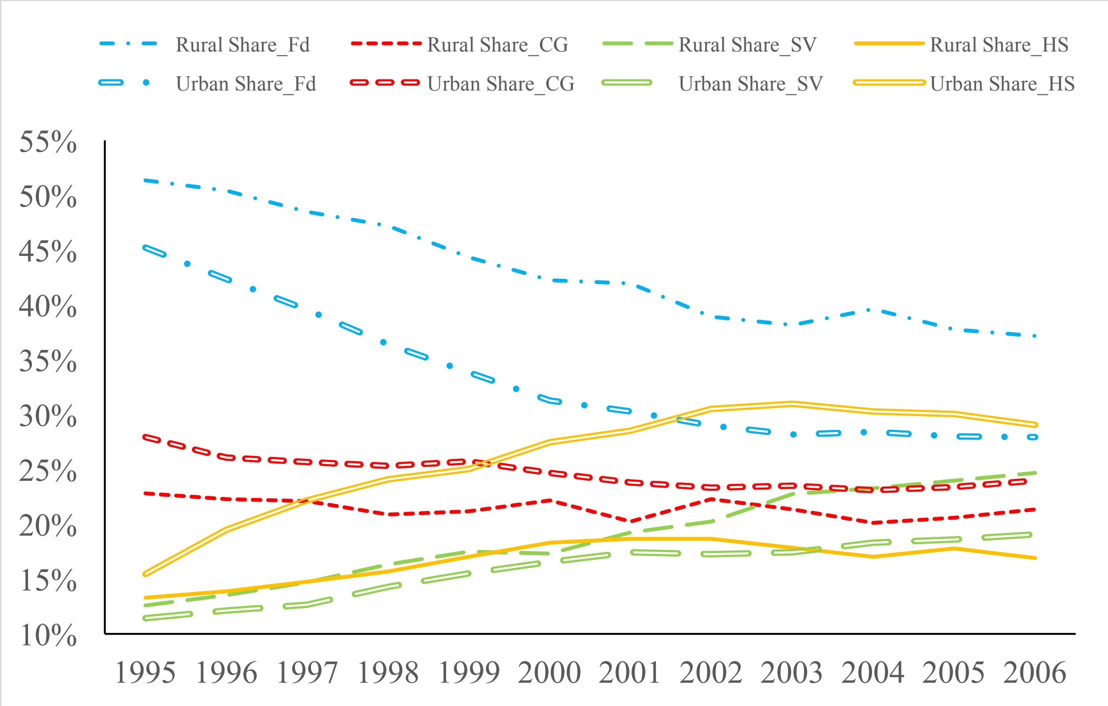

Fig.1 Expenditure Shares (Urban Vs. Rural)

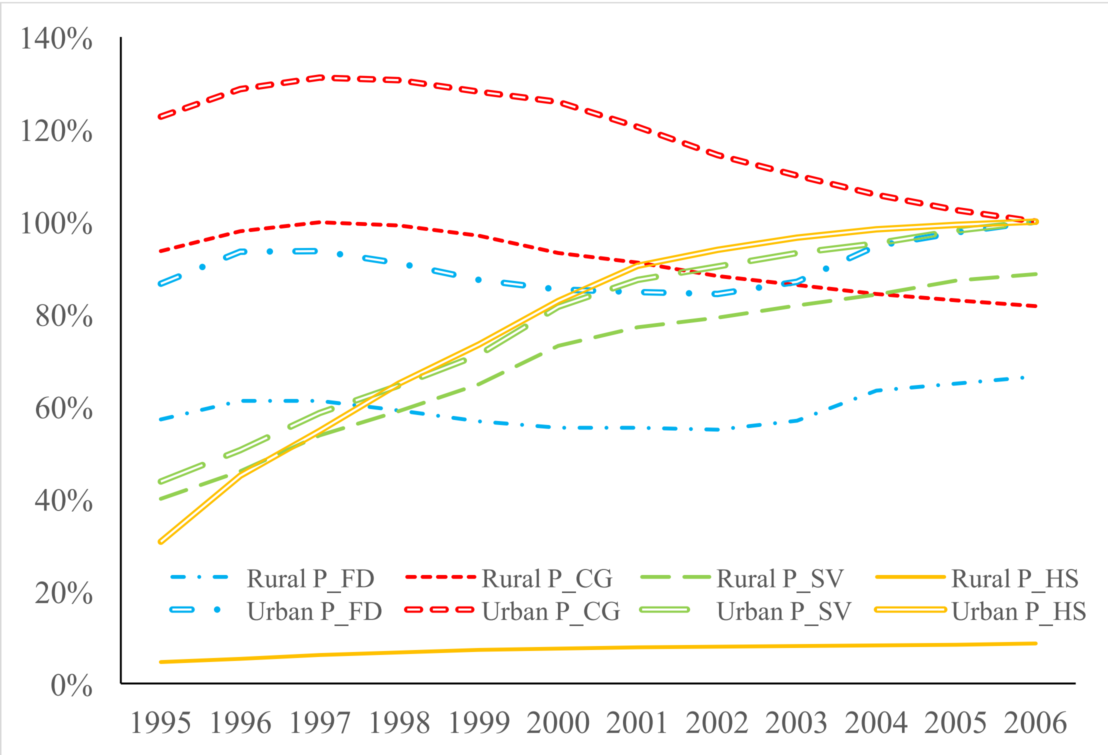

Fig.2 Prices (Urban Vs. Rural, 2005 Urban=100%)

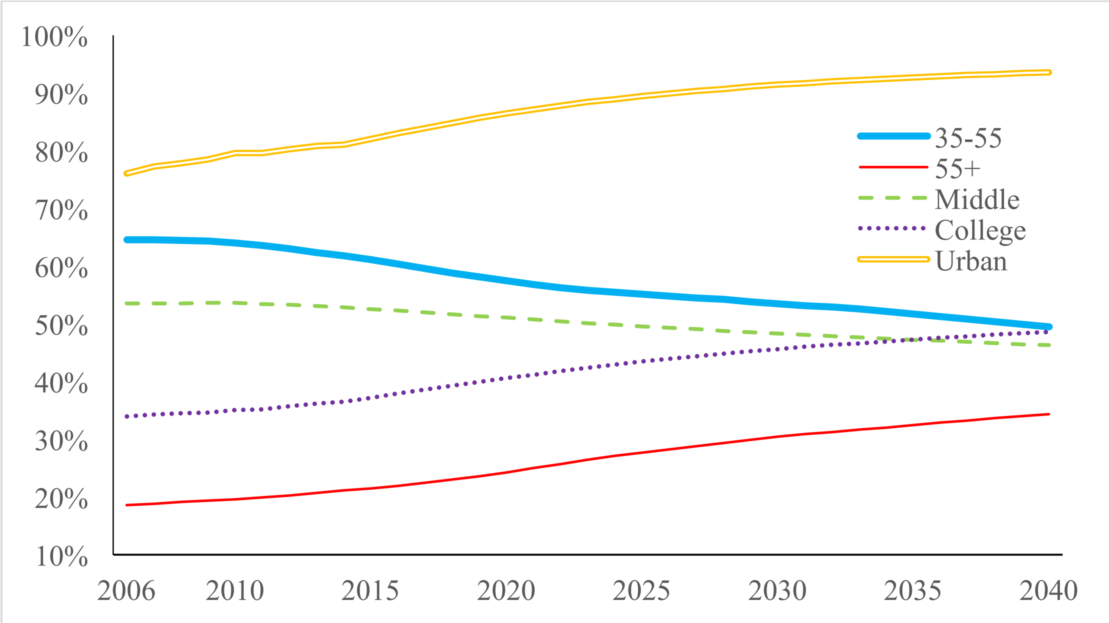

Fig 3. Projection of expenditure shares by household types in the distribution term ξ_t^L

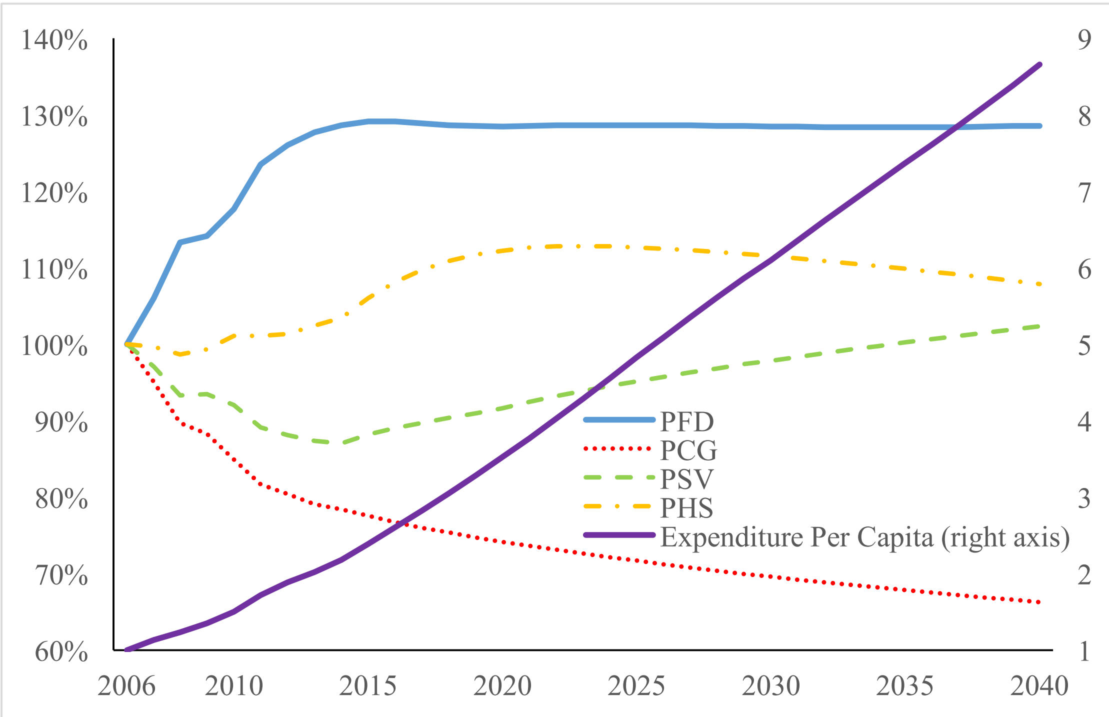

Fig 4. Projection of Prices and Expenditure per capita from China Model

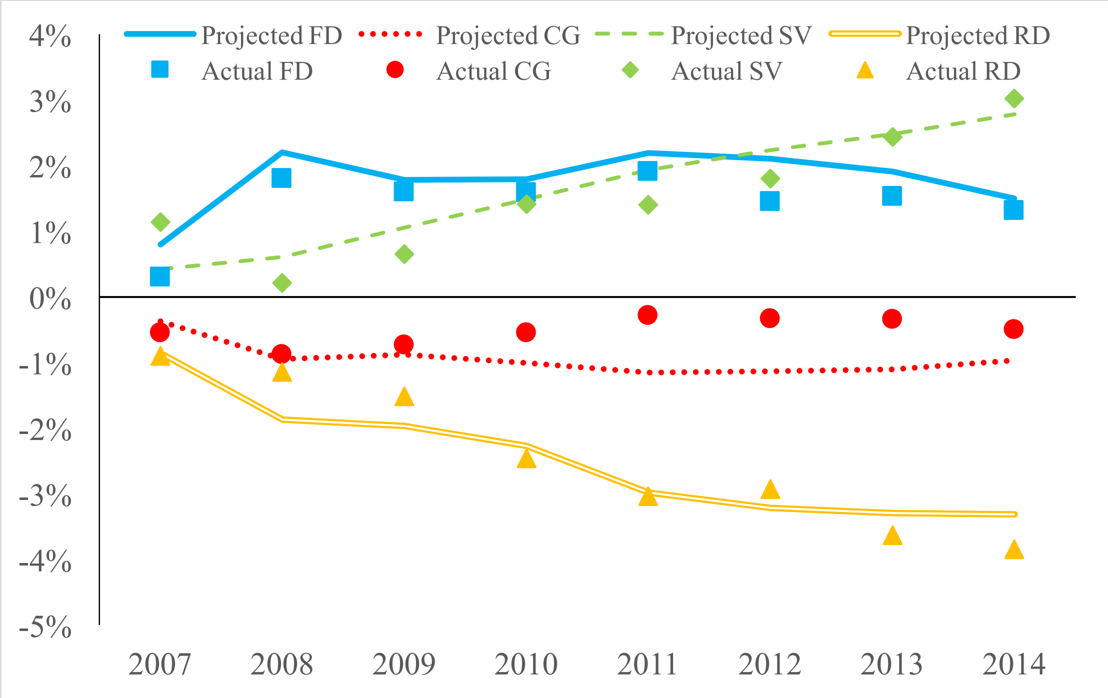

Fig 5. Changes in Expenditure Shares (Projected Case V.s. Actual Case)

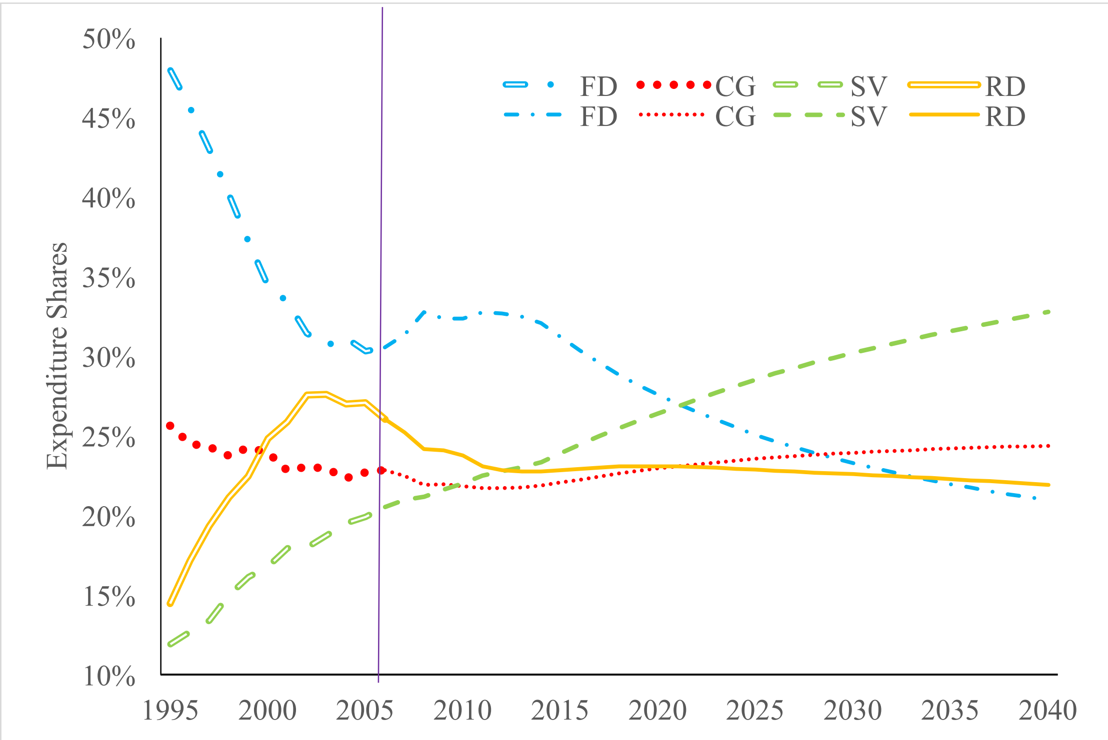

Fig 6. Expenditure Shares

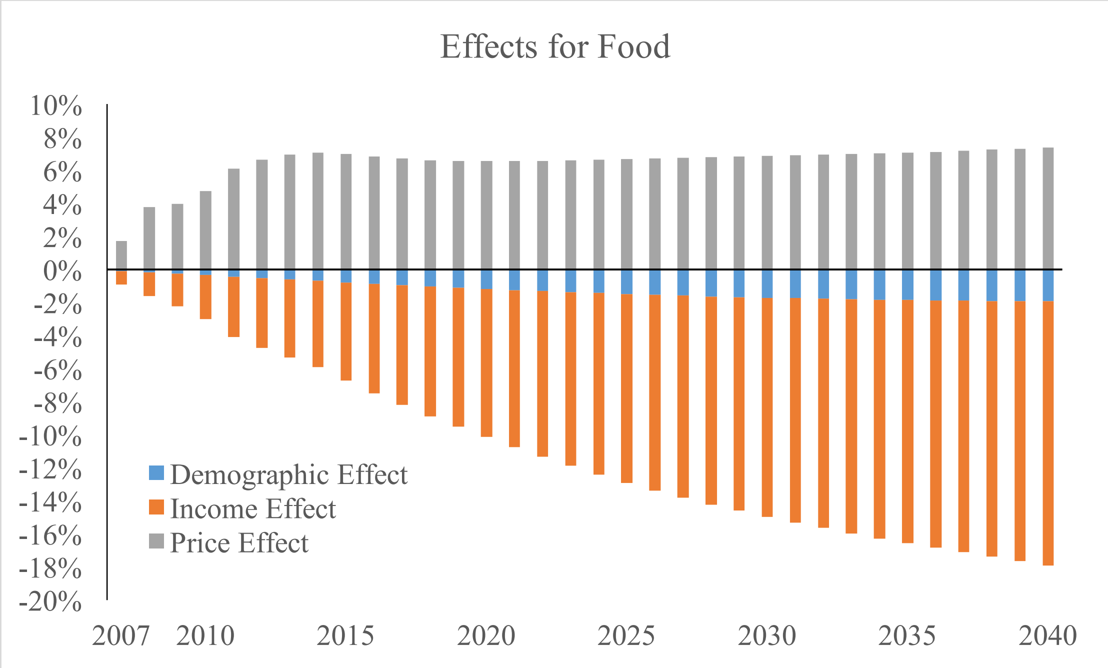

Fig A1. Price, Income and Demographic effects on aggregate consumption; Food

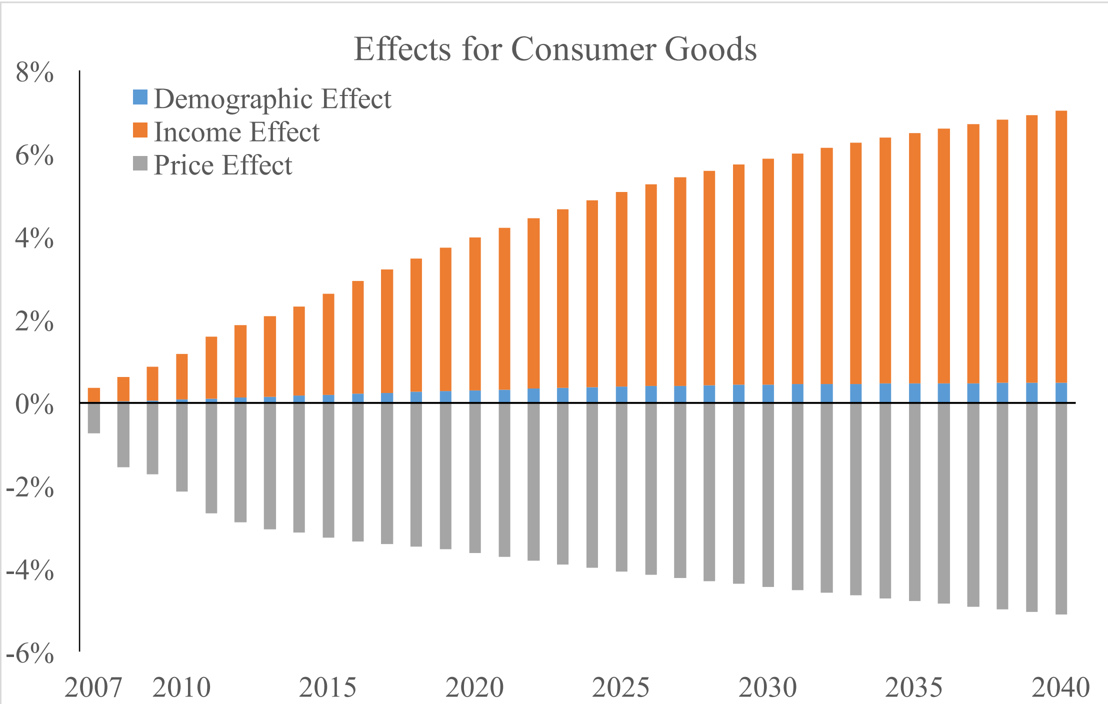

Fig A2. Price, Income and Demographic effects on aggregate consumption; Consumer Goods

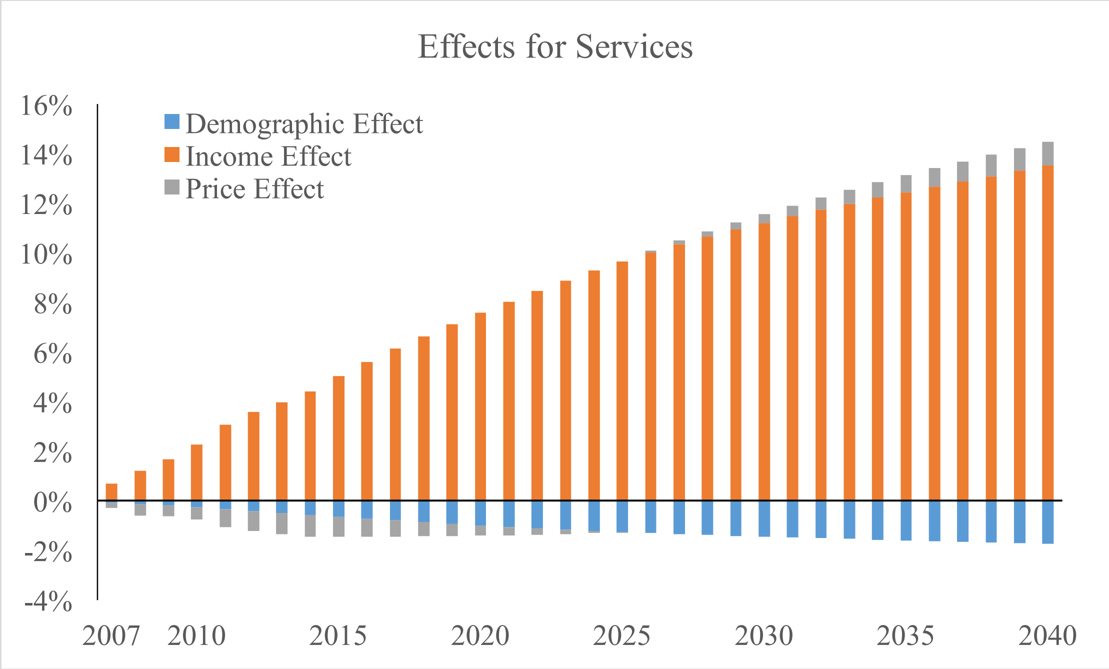

Fig A3. Price, Income and Demographic effects on aggregate consumption; Services

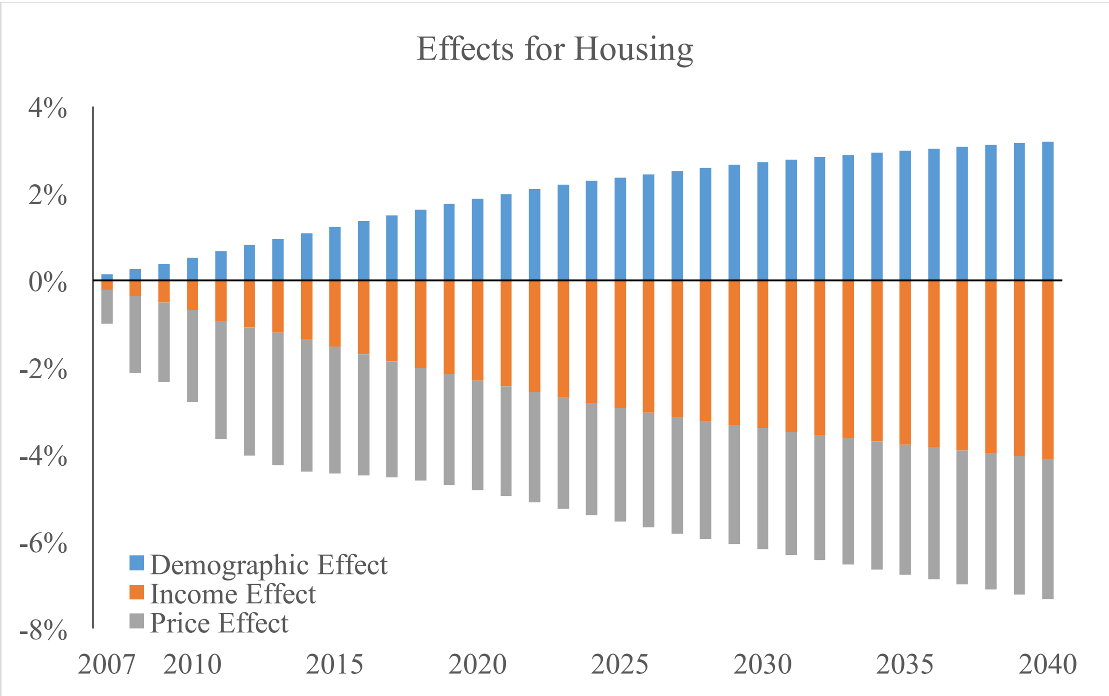

Fig A4. Price, Income and Demographic effects on aggregate consumption; Housing