Consumption Structure Evolutions in an Aging Society and Implications for the Social Security System*  

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Abstract  

China’s social security system sees a critical challenge with the rapidly aging population. This paper assesses the heterogeneous effects of population aging on personal budget allocation across domestic expenditure categories. With China’s household survey data, we break down each component of a household expenditure to its constituent members. We find consistent and robust age profiles of the composition of personal consumption expenditures. Incorporating the estimated results with the population forecast data, we predict that the shares of food, household facilities, articles and services, health care and medical services, and residence in domestic consumption tend to rise, whereas the shares of clothing, transportation and communication, education, culture and recreation services, and miscellaneous goods and services tend to fall in the near future. The evolution of China’s domestic consumption structure along with its demographic change have important implications to the sustainability issue of its social security system.  

Keywords: Personal budget allocation, population aging, domestic consumption, social security system, structural change  
JEL classification: D12, E21, J11, O14  

I. Introduction  

With the natural population growth rate plunging from 33.33‰ in 1963 to below 5‰ in 2011, China’s demographic structure has been aging rapidly. The second national census in 1964 shows that people below 15 accounted for 40.4% of the total population. The share

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declined to 22.9% in the fifth census in 2000, and further fell to 16.6% in the sixth census in 2010. In contrast, the share of people above 64 rose from 7% in 2000 to 8.9% in 2010. Thus, the world’s most populous country has joined the club of aging populations, whose members are often advanced economies, typically European nations and Japan. Moreover, China’s demographic transition was noticeably faster than historical observations of other countries, because the great deceleration of its population growth was by and large a result of the family-planning policy. In fact, the death rate in China has almost remained flat around 7‰ since the mid-1960s. But the birth rate dropped dramatically from 33.43‰ in 1970 to 11.9‰ in 2010 after the policy was implemented. As a result, China inevitably foresees a quickly aging population in the future.

The aging population imposes a great challenge to China’s social security system. The system used to feature a pay-as-you-go benefit scheme, in which current workers’ contributions were used to pay current retired people. With the share of retired people increasing and the share of young workers declining, the sustainability of this old scheme has inevitably become a critical issue. In 1997, China formally adopted a new hybrid scheme, in which a part of benefits were still realized through the old pay-as-you-go system under the name of “social pooling account”, while the rest of benefits were realized through a new funded scheme under the name of “individual account”. In the meantime, contributions to the social security system started to be shared among the state, the employer, and the employee, rather than being almost entirely a financial burden of the employer, as it had remained in practice until 1990s. However, since people who retired or worked before the transition did not accumulate enough funds in their individual accounts, current young workers’ contributions to their individual accounts were frequently used to pay retired people’s pensions. In other words, the individual account is in fact merely a nominal account with no real funds being accumulated. Although China has maintained a positive social security balance (i.e. more revenues than expenses) each year since 1989 when the data started to be published and the total amount of accumulation reached almost two trillion yuan in 2011, the country actually needs to deal with a serious deficit if the social pooling account is strictly managed in separation from the individual account.\(^1\)

As a result, China’s ratio of pension expenditures to total wage costs has increased from 17.3% in 2000 to 21.3% in 2011 and the replacement ratio has declined from 65-75% in the 1990s to 44.7% in 2011. Obviously, aside from conventional methods to solve the sustainability issue of the social security system such as expanding revenues, reducing expenditures, and managing the value of the social security fund, the impacts of population aging shall be reexamined at a more detailed level to improve the design of the benefit scheme and to coordinate the social security system with other public expenditure policies and even industry policies. In particular, population aging not only substantially changes the aggregate level of consumption, about which a large amount of empirical studies have already investigated, but also significantly influences the composition of expenditures.

\(^1\) According to various estimations, the amount of this implicit deficit ranges from two to ten trillion yuan.
According to Pasinetti (1981), “the proportion of income spent by each consumer on any specific commodity may be very different from one commodity to another”. In other words, there are two consequences of population aging that must be equally well noted: first, the amount of pension expenditures will inevitably increase; second, the money will be allocated to significantly different product compositions from the current expenditure basket. If products that foresee an increasing demand are undersupplied, their prices will rise, which as a result will undermine the purchasing power of pension benefits. In contrast, industries that tend to shrink along with population aging may substantially lay off workers. This will incur even more stresses on the social security system if these industries cannot make immediate upgrading and transformations or these workers cannot be effectively retrained for new skills. In addition, some products, such as health care and medical services, are typically provided by the government. To satisfy the need of these products critically relies on relevant public expenditure policies and industry policies, not only a sufficient amount of pension benefits. Therefore, implications of personal budget allocation age profiles to the social security system shall not be overlooked.

In order to examine how demographic impacts differ across products, we give a specific account of personal budget allocations over different components of consumption expenditures. Although some studies inspected the spending on a particular product such as food, few of them took the overall pattern of budget allocations into account. An exception is Foot and Gomez (2006). They studied the heterogeneous impacts of population aging across product categories in UK. They found that the country’s demographic change tended to benefit industries such as medical services and impair industries such as education. However, they did not particularly take care of decomposing the total spending by all household members to each individual when they drew consumption age profiles. Aguiar and Hurst (2008) found that not each spending component exhibited an inverse U-shape over one’s life time, defying the lifecycle hypothesis. However, their description of consumption age profiles is left-truncated at the age of 26. They also only examined shifts in expenditure amounts, instead of the composition of these expenditure components, or in other words, budget allocations.

We try to improve the literature by deriving complete age profiles of expenditure amounts and budget allocations at the more detailed individual-level. In order to do so, we break down each household’s spending to its constituent members by introducing age dummies as Mankiw and Weil (1989). They in particular assumed that people had a fixed demand for housing at each age, so the household’s total demand was simply the sum of all its members. And they obtained best linear predictions of these fixed demand by regressing the value of a family’s house on age dummies of its members. Poterba (2001) employed a similar method to decompose asset holdings. However, to our best knowledge, it has not yet been applied to consumption budget allocations. This technique differentiates our paper from most other studies on demography and consumption that rely on extremely broad age groups, and the large literature that attempts to link household expenditures to the age of household head, which can “flatten” the age profiles because this method obscures the distinct age structure.
within households according to Deaton and Paxson (2000).

Using the urban household survey data in 18 Chinese provinces from 2002 to 2009, our paper provides direct solutions to the two biases, i.e. confounding each distinct age in broad age groups and overlooking the underlying expenditure composition beyond the total amount of consumption, from which the previous literature has frequently suffered. Firstly, we discover starkly different consumption budget allocations for people at each age. In general, young people have larger consumption shares of food and education, culture and recreation services. The middle-aged spend substantially more on clothing, and transportation and communication. And the old have significant consumption shares of food, and health care and medical services. In addition, adults also have greater shares of household facilities, articles and services, and residence, than the rest of the people. Secondly, people within each age group tend to exhibit distinct consumption behaviors, verifying that the old dependency ratio cannot fully characterize the aging population. In particular, total consumption expenditures decrease until one is 15 years old. They start to increase up to the age of 45, and then begin to fall again. These age profiles of personal budget allocations were consistent and stable over time from 2002 to 2009.

We then take the estimated age profiles of personal budget allocations to China’s population forecast data, and predict the changes in different domestic markets along with population aging. We first exclude other effects and assume all social-economic conditions remain unchanged from the period of 2002-2009. We find that up to 2030, the shares of food, household facilities, articles and services, health care and medical services, and residence in total domestic consumption will increase along with the aging population alone. In contrast, shares of clothing, transportation and communication, education, culture and recreation services, and miscellaneous goods and services will decrease. We next allow income to grow together with population aging, and find that most expenditure shares will still change in the same direction, but will become much smoother. One exception is the share of food, which tends to fall in line with the Engel’s Law.

This paper also sheds light on the relationship between demography and structural change. Structural change was often thought of as a result of growth differentials in sectoral productivities (e.g. Ngai and Pissarides, 2007; Acemoglu and Guerrieri, 2008; Mao and Yao, 2012) or the difference of income elasticities across products (e.g. Echevarria, 1997; Kongsamut et al., 2001). However, few studies noticed that personal consumption budget allocations are different for people at each age. This paper’s finding imply that population aging could have direct impacts on structural change, because each sector tends to respond to the demographic shift in different ways.

It shall be noted that our paper is limited in that the data is confined in the urban sector. Rural and urban households can exhibit distinctly different budget allocation patterns. According to the China Statistical Yearbooks, 44% of household expenditures were on food in the rural sector from 2002 to 2009 on average, whereas the number was only 37% in the urban sector. Relative to their urban counterparts, rural residents also exhibited a larger expenditure share on residence (17% vs. 10%) and a slightly larger share on healthcare (8%
In contrast, urban residents allocated more spending to education and entertainment (14% vs. 9%), clothing (10% vs. 6%), as well as transportation and communication (12% vs. 9%). Since the data that we use only surveyed urban areas, we are unable to capture these rural-urban differences. In other words, our findings should be considered relevant only for the urban sector. However, the urban sector dominates the Chinese economy. In particular, 75% of China’s domestic consumption was attributed to the urban sector in 2010. Therefore, implications of our findings can be extended to the whole country as well.

The rest of the paper is organized as follows. In Section 2, we briefly review China’s social security system. In Section 3, we break down the household total consumption and expenditures on different products to its members, and estimate age profiles of personal budget allocation. In Section 4, we use population forecast data to estimate the effects of population aging on future consumption budget allocation change. In Section 5, we draw implications of the personal budget allocation age profiles on the social security system and conclude the paper.

II. China’s social security system

II-1. History

When the People’s Republic of China was founded, its social security system basically only covered workers in the urban sector, especially employees of governments, public institutions and state-owned enterprises (SOEs). The system was sometimes referred to as a mechanism of “firm insurance” instead of “social insurance”, because while the Ministry of Finance ran the insurance for people in the public sector, firms were financially on their own for their employees. Thanks to China’s relatively low share of old people by that time, this system sustained in general throughout the 1950s, when the payment rate was only 3% of the wage rate and the gross pension replacement rate hit the range between 50% and 70%. The system was then paralyzed by the ensuing political turmoil during the 1960s and 1970s. When it was eventually restored in the late 1970s, a lot of SOEs found themselves with a heavy financial burden, because the number of retired people that they needed to pay substantially increased. In addition, since the system was still a mechanism of “firm insurance” by and large, the performance of the social security system significantly differed across firms, depending on each one’s financial conditions. Continuous reforms were implemented since then to tackle these problems as a result.

The first thing that these reforms focused on was the disparity of social security performances. This disparity was fundamentally caused by the fact that in the old system, each firm was basically an independent manager of its employees’ social security. The firm’s

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In 2010, per capita consumption was 13,471 yuan in urban China and 4,382 yuan in rural China. Urban residents accounted for 49.7% of China’s total population in that year. So the consumption of urban households was about 75% of China’s total domestic consumption.
operating profit, the number of employees relied on pensions and other social security benefits, and the amount of subsidies that the firm could get from the government all influenced the firm’s social security performances. Since 1984, China started to coordinate social security operations at the county and the city levels. And since 1986, the coordination further moved up to the province level. In the meantime, China also initiated a nationwide coordination of social security operations in industries that had high state capital penetrations, given that these industries were essentially state-owned. Before 1991, 96% of Chinese cities and counties realized a basic coordination of social security operations. Before 1994, a basic coordination was realized in 13 provinces and 11 industries. \(^3\) Up to now, almost all Chinese provinces have established a system of province-level pooling.

The second area of reform was the composition of contributions to the social security system. Before 1984, all contributions to the social security system were essentially made by employers. The payment rate was uniformly at 3% of workers’ wage rates across the country. When China formally introduced the labor contract system in 1986, the coverage of the social security system extended to all employees with contracts. As a result, contributions to the social security system were shared between employers and employees. Payment rates of employers and employees were respectively 15% and 3% of workers’ wage rates. Since 1991, China began to build a contribution system with three layers. The first was a nationwide compulsory contribution which was known as the basic social insurance. It was applied to all urban workers. The second was a supplementary contribution made by employers (latter known as the enterprise annuity since 2005). And the third was a voluntary contribution made by employees. However, in reality, due to differential opinions of this new system and conflicting interests between the upper- and lower-level governments as well as between governments and firms, the detailed design of this system substantially varied within China. In 1997, the State Council proposed a uniform system featuring these three layers of contributions, which was then revised several times in subsequent years and eventually stipulated a payment rate of 20% for employers and a payment rate of 8% for employees in 2005.

Thirdly, along with the redesigned contribution scheme of its social security system, China also reformed the system’s benefit scheme. Regardless of the expanding coverage of the social security system and a more complete sharing scheme of its contributions, China had maintained a pay-as-you-go benefit scheme with defined benefits until 1997. When contributions were finally set to be made through three main channels, i.e. the state, the employer, and the employee, in 1997, a new benefit scheme also emerged. This new scheme was essentially a hybrid of the previous pay-as-you-go scheme and a funded scheme which resembles that of the United States, the United Kingdom and Australia. In particular,

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\(^3\) These provinces (or province-level municipalities) are Beijing, Tianjin, Shanghai, Jilin, Hebei, Shanxi, Qianghai, Jiangxi, Hunan, Fujian, Ningxia, Shaanxi, and Sichuan. And these industries include the railway industry, the coal industry, the water industry, the electricity industry, the postal industry, the construction industry, the transportation industry, the People’s Bank of China, the civilian aviation industry, the petroleum and gas industry, and the metallurgy industry.
payments by employers were split further into two parts. With a payment rate equivalent to 17% of the wage rate, a part of the employer’s contributions went into the social pooling account that was operated under the old pay-as-you-go scheme, while with a payment rate equivalent to 3% of the wage rate, the rest of the employer’s contributions went into the individual account that was accumulated and managed under a new funded scheme. In contrast, with a payment rate equivalent to 8% of the wage rate, all contributions made by the employee were entirely added to the individual account. This new benefit scheme on the one hand guaranteed a nationwide uniform minimum level of social security that could be achieved through the social pooling account, and on the other hand, allowed for flexibilities with regards to people’s current economic status through the individual account. In order to manage and improve the investment returns of funds in both accounts, China established the National Social Security Fund in 2000 to separate fund operations from administrative management.

II-2. Challenges

China’s aging population substantially changed the operation of its social security system in three ways. First of all, the financial burden rapidly and consistently increased. Pension payments accounted for only about 0.7% of GDP in 1989, yet regardless of China’s miraculous economic growth, the share climbed to about 2.7% in 2011. Secondly, the support ratio continued to decline. The ratio of workers to pensioners dropped from 5.4 in 1989 to 3.2 in 2011. This was a result of the social security system’s expanding coverage. In the urban sector, the system’s coverage ratio increased from 19.3% in 1989 to 41.1% in 2011. Thirdly, the replacement ratio slightly declined as well. In the 1990s, the replacement ratio was about 65-75% of urban workers’ average wage rate. In 2011, the replacement ratio dropped to 44.7%.

These changes challenge China’s social security system in the following three ways. First of all, the management of social security fund becomes a particularly important guarantee of the sustainability of this system. Since China has maintained the pay-as-you-go scheme for quite a long time, when the contribution system reformed, payments to workers retired before the reform and did not accumulate any benefits by themselves suddenly became a heavy financial burden. In order to keep the system working properly, funds in individual accounts of young workers were frequently used to pay benefits of retired workers. As a result, individual accounts were in fact only nominal and even empty. In other words, the pay-as-you-go scheme was still maintained in practice after the reform, because the social pooling account could not immediately accumulate enough money.

Secondly, the current financial burden and the future of population aging result China in a dilemma in pushing forward social security reforms. On the one hand, the present condition that not enough funds have been accumulated to pay retired workers at the moment indicates that the old pay-as-you-go scheme is still a necessary option temporarily. On the other hand, the future of population aging clearly rules out the possibility to sustain this old scheme in
the future, in that the payment ratio might otherwise achieve 40% of the wage rate in 2030. China’s current choice is a hybrid scheme that does not go too extreme to the old pay-as-you-go scheme or to the new fully funded scheme. However, it in the meantime postpones the date for the transition to be eventually completed. Since the population aging continues, to push forward social security reforms becomes a greater challenge.

Thirdly, the social security system is still lagged behind in the rural sector. Population aging is not an urban-specific phenomenon in China. Seeing its huge amount of young migrants leaving the farm and joining the urban sector, the challenge which population aging brings to the social security system might be indeed greater in the rural sector. In the meantime, the emigrant of young people from the rural sector resulted the old “insurance system”, i.e. to be taken care of by family members, effectively in failure. In particular, rural families with less than four members accounted for more than 80% of all rural families in 2010. Most old people lived either with their spouses or grandchildren. Although China has been experimenting the social security system in the rural sector since 1980s, a fully-fledged system has not yet been established across the whole country up to now. The fundamental cause to the stagnated development of a rural social security system is that the government used to see rural families, communities, and villages shared the responsibility of the rural social security, while the government only needed to offer supportive policies. Only since 2009, the New Rural Pension System was piloted in 10% counties across the country, which included not only supportive policies, but also fiscal funds that can offer a coordinated minimum insurance to all rural residents. However, due to its late start, this new social security system has not yet accumulated enough funds and thus incurred even more financial burdens to the state.

III. Age profiles of personal budget allocation

III-1. Data and method

The National Bureau of Statistics has been carrying out household bookkeeping surveys in China’s urban regions since 1956. They were suspended during 1966 and 1979 when the Bureau was closed upon the onset of the Cultural Revolution, and then resumed in 1980 with the sample size increasing over the years. Our data is a subsample of this dataset that covers 18 provinces, autonomous regions, or municipalities from 2002 to 2009. These areas were scattered around the country. Their average household income levels differed starkly, which reflects the diverse regional development stages in China. For each urban region included in the sample, usually a city or a county, households were randomly drawn among those who

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4 In 2011, China’s pension benefit expenditures totaled 1.28 trillion yuan, equivalent to 21.3% of its total wage costs. The ratio already surpassed the international critical level of 20%.

5 They are: Anhui, Beijing, Chongqing, Gansu, Guangdong, Heilongjiang, Henan, Hubei, Jiangsu, Jiangxi, Liaoning, Shandong, Shaanxi, Shanghai, Shanxi, Sichuan, Yunnan, and Zhejiang.
had stayed there for more than half a year, regardless of which hukou, i.e. rural or urban, they held. Each household could be observed for several successive years, but any household that had entered the sample three times must be replaced by a new one. Altogether, our data has taken 155,905 different households over this eight year period, with 294,422 household observations. This means on average, a household entered our sample 1.89 times.

Households in the sample were asked to keep daily records of total spending and its eight components. The “food” category includes processed and whole foods, condiments, and beverages, alcohol and tobacco. The “clothing” category includes clothes, headwear, footwear, and materials to make them. The “household facilities, articles and services” category includes home appliances, furniture, ornaments, and miscellaneous items such as dishes and tea-things. The “health care and medical services” category includes medicines, equipment, and hospital bills. The “transportation and communication” category includes vehicles, fuels, and public transportation expenses. The “education, culture and recreation services” category includes books and magazines, stationery, musical instruments, sporting goods, and electronic equipment such as computers. The “residence” category includes rents for tenants or imputed rents for homeowners, decoration and maintenance costs, and utility fees. The “miscellaneous goods and services” category includes purchase of other items such as jewelries, cosmetics, hotel accommodations, and haircuts.6 Expenditure information was aggregated over a year for each household and reported to the Bureau in January of the next year.

The greatest challenge to our study is that the expenditure data was recorded at the household level. In order to draw age profiles, we have to decompose the household spending to constituent members. Mankiw and Weil (1989) proposed a method to infer personal housing demand from the total value of houses in which their families live. In particular, they introduced dummy variables to characterize the age composition of each family. They then regressed the total value of the family’s house on these dummies to get the best linear predictors of each individual’s housing demand. This method can be immediately applied to decomposing household expenditures. Let \( k \) be the total consumption or a spending component, then any household’s consumption \( E_k \) can be written as the sum of all its members’ expenditures. Let \( E_{jk} \) be the spending of the \( j^{th} \)’s member, which as we assume is a function of age:

\[
E_{jk} = \alpha_{0k} \text{DUMMY0}_{jk} + \alpha_{1k} \text{DUMMY1}_{jk} + \ldots + \alpha_{80k} \text{DUMMY80}_{jk} + e_{jk} \tag{1}
\]

It is worth noting that in these eight categories, some products are durable, such as home appliances, while others are not, such as food. Therefore, to compare the expenditure shares of these products at a given time is like comparing apples and oranges. However, the purpose of this paper is to examine how these shares change over time. To make this study meaningful, we have to impose many assumptions. In particular, we assume that the durability of each product does not change relative to other products. This allows us to exclude the possibility that consumers shift their spending from products that are becoming more durable to those becoming less durable. Note that this assumption does not exclude the possible of change in durability itself.
Here, $DUMMY_{tjk}$’s are a series of dummy variables. If the $j^{th}$ member is of age $t$, then $DUMMY_{tjk}$ equals 1 and other dummies equal 0. $\alpha_{tk}$ is the expected spending by a person of age $t$. It measures the expenditure of a “representative agent” of that age. Therefore, the household’s spending is:

$$E_k = \alpha_{0k} \sum_{j=1}^{N} DUMMY_{0jk} + \alpha_{1k} \sum_{j=1}^{N} DUMMY_{1jk} + \ldots + \alpha_{80k} \sum_{j=1}^{N} DUMMY_{80jk} + \sum_{j=1}^{N} e_{jk}, \quad (2)$$

where $N$ is the family size. Regressing Equation (2) then gives the best linear predictors of $\alpha_{tk}$’s.

Note that the largest $t$ is set at 80 in Equation (2). It is chosen for two reasons. Firstly, according to the sixth national census, the life expectancy of urban males was 78.7 and that of urban females was 82.9 in 2010. The average life expectancy of an urban resident was about 80. Secondly, less than 1% of the people in our sample were above the age of 80. Introducing more dummy variables for very old will make these parameters inaccurately estimated.

### III-2. Total consumption

We first look at age profiles of total consumption expenditures. Let $E_k$ be each household’s total consumption and values of $DUMMY_{tjk}$’s be set according to its members’ ages in Equation (2). Parameter $\alpha_{tk}$ then characterizes the total expenditure by the representative agent of age $t$. We pool the data from 2002 to 2009 together and run the OLS regression to estimate these parameters. We then plot the representative agents’ expenditure in the order of their ages and get the following age profiles.

Figure 1 shows that total consumption expenditures and age evolve along with an S-shaped trajectory. In particular, infants have high annual consumption levels about 8,000.
However, when they grow older, their consumption levels dramatically drop. A typical 14-year old consumes the least, only slightly above 2,000. This age is usually when the nine years of compulsory education are over. If a person decides to continue education, they must pay more tuition fees for high schools, or vocational schools. This may lead their total consumption to rise. If the individual decides to work instead, their consumption may also increase due to more living expenditures, because schools usually provide subsidies for certain products such as food, transportation, and sometimes even housing. This explains why total consumption expenditures rise dramatically after the age of 14. The expenditure level peaks at about 13,000 when a person reaches the age of 44, which is the period in which they have both the money and the need to consume. Total consumption expenditures start to fall again afterwards, and eventually return below 8,000.

The traditional neo-classical model typically predicts that the young and the old have low consumption levels. They believe that when the total population has a large share of either group, the national domestic consumption tends to fall. Figure 1 favors this argument, but does not follow it exactly. In fact, we do see that in general, the young and the old spend less than the middle-aged, but their spending does not remain low at all times. Particularly, infants have significantly more spending than the rest of the young, and the young-old between 60 and 70 spend significantly more than the rest of the old. Therefore, if an economy has lots of infants or young-olds, its domestic consumption will inevitably fall, but may not immediately show a decline. Due to this heterogeneity among the young and the old, to draw conclusions on domestic consumption simply from youth and old dependency ratios could be biased.

It is also worth noting that the S-shaped trajectory in Figure 1 does not imply that the LCPIH (life cycle-permanent income hypothesis) fails. Although the LCPIH expects a person to smooth her consumption over time, it in fact does not require her to remain at a constant consumption level. Friedman (1957) noted that preferences, habits, and social statuses may change a person’s spending in different ages by altering their utility function. In particular, in order to meet their social statuses and life styles, the middle-aged may consume more than the young and the old. As long as discounted marginal utilities are equalized over her life, the LCPIH still holds.

### III-3. Personal budget allocation

We can directly apply the same specification of Equation (2) to obtaining estimates of each spending component for the representative agent at each age and consequently, examine how their budget allocations differ. In particular, let $E_k$ be any household’s expenditures on the $k^{th}$ product out of the eight categories that the UHS classifies. Then, $\alpha_{tk}$ measures the expenditure by the $t$-year old representative agent on product $k$. In order to get the pattern of their budget allocations, we divide $\alpha_{tk}$ by an agent’s total consumption $\Sigma_k (\alpha_{tk})$, which represents the share of their spending on product $k$. Figure 2 shows how these shares change along with age.
The first thing to notice from Figure 2 is that people have starkly different budget allocations at each age. The share of food expenditures in total spending follows a U-shaped path. Both the young (especially infants) and the old allocate a big share of consumption to food. The share of clothing changes almost in an opposite manner. People in the middle age groups have larger shares and those on the two ends have comparatively smaller shares. Nevertheless, even compared with children, the old still allocate a significantly smaller part of consumption to clothing. This general pattern is very close to what the share of consumption to clothing exhibits. To be specific, the share of transportation and communication remains small before one is 20. Thereafter, it grows quickly, and remains high throughout middle-age. But for the old, this share apparently shrinks. It is worth noting that both clothing and transportation and communication are related to personal social activities. Consequently, the old, who are less socially active in China, have smaller shares in both categories.
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Since both kids and the old tend to suffer from weak physical conditions, they substantially consume more health and medical services than other people. In particular, infants have an especially large share of medical expenditure, exceeding 20%. The share then falls as they grow up to the age of five. Afterwards, it remains small throughout their childhood and adolescence, and starts to grow when they step into their 20s. In adulthood, this share remains stable until they reach the age of 50. It then expands quickly as they grow older, and finally exceeds 20% again in their late 70s.

While children and adolescents have tiny consumption shares of health and medical services, they have huge shares of education, culture and recreation services. The 16-year-olds have the largest share which exceeds 60%. So undoubtedly, education, culture and recreation services are the most important product that the young consume. Education expenditure becomes extremely large in two periods. The first period is when kids go to kindergartens around the age of four to six. The second period is when they go to high schools, vocational schools, and universities between 15 and 22. Both periods are beyond the coverage of China’s nine-year compulsory education. It is noteworthy that in China, schools may provide free or subsidized products such as food and medical services. This partly explains a falling consumption share of food whilst the share of education, culture and recreation services peaks during those two periods, in addition to the tiny share of health care and medical services. It also sheds light on the low total spending levels throughout childhood and adolescence evident in Figure 1. In order to examine how pure educational expenditures evolved, we are going to further break down this product category in the next section of robustness checks.

The consumption share of household facilities, articles and services is related to the share of residence. First, infants have larger shares in both items than the rest of the young. This is sensible because as newborns, they increase the number of family members. They thus make additional claims on household facilities and residence. Both shares remain low for the most of the time before one is 20 years old. However, there is a rise in the share of residence for children in primary schools. This could be because they start to require more space for living and studying during that period. Afterwards, both shares begin to rise in one’s early 20s and then remain stable. This implies that for the increase in housing-related expenditures, the most important drivers are those who step into adulthood and form new families. In contrast, these expenditures do not tend to change much along with population aging. Mankiw and Weil (1989) discovered that housing demand rose during one’s 20s and 30s, and then started to fall gradually. However, because we are looking at consumption shares instead of monetary levels, we find that in relative sense, the housing demand stabilizes earlier, at about the age
of 25, and then remains roughly unchanged. The rising housing-related expenditures in one’s 20s that we found also echo with the argument of Wei et al. (2012) that rising housing prices in urban China was partly due to marriage motives.

To sum up, people have heterogeneous expenditure budget allocations across products at each age. Generally speaking, the young have larger consumption shares of food, and education, culture and recreation services. The middle-aged have greater consumption shares of clothing, and transportation and communication. And the old consume substantially more food, and health care and medical services. In addition, all adults have significant consumption shares of household facilities, articles and services, and residence, compared with people of other ages. These results imply that demographic shifts not only affect the total domestic consumption, but also change its allocation over product categories.

IV. Effects of population aging on the allocation of domestic consumption

The personal budget allocation significantly differs by age. Meanwhile, the existing trend of an aging population is certain to continue and increase in scale. According to the prediction by Hu et al. (2010), the peak median population age will reach 60 in 2050, far exceeding recent years’ average of 45. Therefore, we can use our study to predict how future aging trend will affect China’s consumption.

In the first part of this section, we predict the effect of aging on future consumption alone. To be more precise, the question we are concerned with is: what are the effects of an aging population on the allocation of China’s domestic consumption if all the other factors remain unchanged? That is, if we still consider the representative agents of the period 2002-2009, but, society contains a greater proportion of elder agents, how will the share of each product sector change? In the second part of this section, we evaluate the accuracy of the prediction using a method of counterfactual analysis, which shows that demography is one of the key factors in driving consumption changes. To ease the inaccuracy, the income effect is additionally included in our prediction.

IV-1. Effects of population aging alone

China faces the problem of a rapidly aging population over the next few decades, according to the forecast by Hu et al. (2010). The forecast predicted the population for each age from 0-100 in China’s rural, urban and migrant sectors based on the fifth national census in 2000. In particular, they used China’s official aggregate-level rural and urban population data from 2002 to 2009 to calibrate the fertility model, the mortality model and the migration model. They then predicted the number of people at each age from 2002 to 2050 based on the census data using these models, ensuring that their prediction aggregated up to the official data for the corresponding year from 2002 to 2009. They considered several scenarios. First, they allowed the total fertility rate to take three different values, 1.4, 1.5 and 1.6, throughout the prediction period. Second, they allowed two urbanization outlooks, i.e. to continue at the
current pace and to stop permanently. That is, there were six cases altogether. In this section, we only focus on one of them, which we consider closest to reality, i.e. the total fertility rate equals 1.5 and urbanization continues. Figure 3 compares the age distribution of China’s urban population in 2011 and 2050 in this case. The apparent rightward shift of its peak manifests China’s daunting future of an aging population.

When we consider the effects of population aging alone, we let \( a_{tk} \) be a typical \( t \)-year-old’s spending on product \( k \) in any year \( \tau \), where \( a_{tk} \)’s are still estimated according to Equation (2) for the period of 2002-2009. However, the number of \( t \)-year-olds in year \( \tau \), which we denote as \( N_{it\tau} \), comes from the population forecast data. Therefore, the total expenditure on product \( k \) by China’s urban residents in year \( \tau \) can be written as:

\[
C_{k\tau} = \sum_{t=1}^{80} a_{tk} N_{it\tau}. \tag{3}
\]

We first analyze the household total consumption expenditures on all products. Equation (3) thus gives the sum of total expenditures by all urban residents. We then divide \( C_{k\tau} \) by the number of urban residents in year \( \tau \) to get that year’s per capita expenditures.

Figure 4 shows how the figure evolves over time. Since the demographic prediction into the distant future can be inaccurate, for example, the total fertility rate may not be constant for such a long time, 2030 is set as the final year for this study. It is apparent that the per capita consumption expenditures will generally follow a U-shaped curve that peaks in 2026, if population aging is the only driver and other factors such as people’s social-economic conditions all remain unchanged from the period 2002-2009. The curve increases first, because the majority who were 25 to 35 years old in 2011 will turn 40 or 50 in 2026. Those people, according to Figure 1, have the largest consumption expenditures compared with agents in other age groups. Nevertheless, this curve eventually declines because more and more people get old and their consumption expenditures fall. As a result, the curve generally

Figure 3. The age distribution in urban China, 2011 vs. 2050

Note: The data source is Hu et al. (2010).
has a U-shaped pattern. It is worth noting that Figure 1 does not include other effects that could push the per capita consumption expenditures upward over time, such as increasing incomes and assets. With improving social-economic conditions, expenditure levels are in fact very likely to rise throughout the examination window. By excluding these effects, Figure 1 can focus more sharply on the impacts of demographic shifts.

We then let $k$ indicate each product successively and calculate product-level expenditures in urban China. To answer how the consumption share of each product changes over time, we first divide the sum of expenditures on each product $C_{kt}$ by the total expenditures on all products in that year to get the consumption share, and then calculate the annualized growth rate for each share. As before, we restrict the prediction to the period of 2013-2030. The result is shown in the first row of Table 1. In particular, the consumption share of food and that of health care and medical services will increase as the population ages. The reason is that as Figure 2 demonstrates, the old generally have larger consumption shares on these two items compared to people of other ages. During 2013-2030, the consumption share of health care and medical services will increase at an average rate of 1.12%, and that of food will increase at an average rate of 0.2%. Similarly, consumption shares of residence and household facilities, articles and services will increase along with an aging populace, but at slightly lower rates of 0.15% and 0.06% respectively. In contrast, products like clothing, transportation

![Figure 4. Per capita consumption expenditures from 2013 to 2030 in urban China](image)

Table 1. Average annualized growth rates of consumption shares in urban China (2013-2030%)

<table>
<thead>
<tr>
<th></th>
<th>Food</th>
<th>Cloth</th>
<th>Facilities</th>
<th>Medical</th>
<th>Trans.</th>
<th>Education</th>
<th>Residence</th>
<th>Misc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population aging</td>
<td>0.20</td>
<td>-0.59</td>
<td>0.06</td>
<td>1.12</td>
<td>-0.56</td>
<td>-0.33</td>
<td>0.15</td>
<td>-0.22</td>
</tr>
<tr>
<td>+ income growth</td>
<td>-0.01</td>
<td>-0.57</td>
<td>0.22</td>
<td>1.08</td>
<td>-0.19</td>
<td>-0.21</td>
<td>0.13</td>
<td>0.01</td>
</tr>
</tbody>
</table>
and communication, and education, culture and recreation services are mostly consumed by the young. Hence, population aging will bring down these products’ shares of consumption. The consumption share of clothing will fall the most dramatically. Its average growth rate will be -0.59%. The consumption share of transportation and communication will fall slightly slower, with an average growth rate of -0.56%. Even the consumption share of education, culture and recreation services will only grow at an average rate of -0.33%.

IV-2. Other effects

The pattern shown in the first row is only a result of population aging, with other factors such as social-economic conditions all unchanged from the period of 2002-2009. But in China, the rapid growth and economic transition imply that these other factors will also be important. To completely predict evolutions of these factors is difficult, especially when some factors such as household assets, social status and preferences are hard to even measure. Our next step is to consider only one additional factor, i.e. income. In other words, we believe income is a relatively good indicator of the general level of social development. We assume there is a linear relationship between this indicator and expenditures. So Equation (2) becomes:

\[ E_k = \alpha_k^* \sum_{j=1}^{N} DUMMY_{0j} + \ldots + \alpha_{80k}^* \sum_{j=1}^{N} DUMMY_{80j} + \beta \cdot inc + \sum_{j=1}^{N} e'_{jk}, \]  

where \( inc \) is the household income. Then in any year \( t \), a \( t \)-year-old’s expenditures on product \( k \) is defined as:

\[ c_{kt} = \alpha_{tk}^* + \beta \cdot inc_{tr}, \]  

where \( inc_{tr} \) is the income of the \( t \)-year-old in year \( r \). We can re-calculate the annualized growth rates of consumption shares and compare them with what we obtained before using Equations (4) and (5). The result is shown in the second row of Table 1.

Since the real income has been growing at 7% on average in China from 1979 to 2011, we assumed that this trend will continue and that for the entire population, income will grow at an annual rate of 7% from 2009 levels. This is a heroic assumption because the income growth rates could differ across age groups. Unfortunately, no historical income data of sufficient duration is available to calculate the trend in income growth for people at each age. Table 1 shows that when income growth is considered, all consumption shares except for food and miscellaneous goods and services will still change in the same direction. In particular, because Engel’s law says that richer people spend a smaller share on food, the consumption share of food will actually fall slightly along with population aging if people’s income keeps increasing. In contrast, because miscellaneous goods and services include gold and jewelries, cosmetics, and hotel charges which are income-elastic expenditures, their consumption share will actually rise slightly. In addition, it is also worth noting that for most products, changes in consumption shares become smoother when income growth is considered. The only exception is the share of household facilities, articles and services,
whose average annual growth rate moves from 0.06% up to 0.22%. Finally, Table 1 highlights that whenever the effect of income growth is taken into account, the consumption share of health care and medical services will always rise dramatically in conjunction with population aging. However, the health care and medical system is largely provided by the government in China, and is already under pressures. The rising consumption share thus indicates an even greater challenge to the government created by its aging population.

V. Policy implications and concluding remarks

China’s aging population imposes a serious financial challenge to its social security system. This paper assess the heterogeneous effects of population aging on domestic consumption budget allocations at product levels. With the urban household survey data in 18 Chinese provinces from 2002 to 2009, we break down household consumption expenditures to constituent members. We find distinct age profiles of each consumption component. In particular, young people tend to have larger consumption shares of food and education, culture and recreation services. The middle-aged spend substantially more on clothing, and transportation and communication. In contrast, the old have significant consumption shares of food, and health care and medical services. Adults also exhibit greater shares of household facilities, articles and services, and residence, than the rest of the people. These age profiles of personal budget allocation were consistent and stable over time. By incorporating the estimated results into China’s population forecast data, we find that due to its demographic change, the shares of food, household facilities, articles and services, health care and medical services, and residence in total domestic consumption tend to rise along with population aging, while the shares of clothing, transportation and communication, education, culture and recreation services, and miscellaneous goods and services tend to fall in the near future.

The change of domestic consumption budget allocations along with population aging has several important implications to the sustainability of China’s social security system. First of all, since the allocation of consumption expenditures tends to change in substantially different ways from product to product, the government needs to closely monitor and facilitate the economy’s industrial structure. During the process of population aging, industries that face declining demand will shrink. Without appropriate precautionary policies such as subsidizing product upgrading and transformations and training workers with new skills, these industries may lay off a great amount of workers. As a result, the social security system may have to support more people whereas in the meantime receive fewer contributions. In contrast, some other industries tend to face increasing demand during population aging. Without fostering these industries to meet people’s needs in the future, the supply of their products may fall short and consequently, their product prices may shoot up. In other words, in order to keep pensioners’ living standards, the financial burden of the social security system will have to increase.

Secondly, the effectiveness of the social security system in some specific industries
critically depend on complementary public expenditure policies. Population aging on the one hand implies a larger proportion of old people in the total population, on the other hand indicates fewer young dependents and more grownups to establish their own families. However, it is usually the case in China that parents tend to leave the house when children get married, because of the traditional idea of “no marriage without an own house”. Hence, expenditure shares on residence and related household facilities, articles and services tend to increase along with population aging. In order to meet these needs of the old, policies of affordable houses and public rental houses will be critical seeing that the old usually have limited income sources. Aside from residence and related needs, the old will also substantially demand more for health care and medical services. Even without considering the increasing life expectancy and the high income elasticity of these expenditures, the total medical expenses as a share of GDP will be highly probable to reach 12% in 2025 from about 5% in 2005. A great part of these increasing health care and medical needs will be about hospitals, facilities and doctors that will be invested, purchased and trained with public funds. Obviously, the social security system alone will not be able to solve basic living problems, such as residence and medical demand, without the help of complementary public expenditures and investment.

Finally, the change of domestic consumption budget allocations also suggests the direction of future social security reforms. In particular, health care and medical services expenditures foresee the fastest growth along with population aging. However, China’s medical insurance system still adopts the pay-as-you-go scheme. With fewer young workers contribute into this system and more old people benefit from it, its operation will inevitably face a serious challenge. In addition, the life expectancy has substantially increased in China. As for the average of the total population, it grew by more than six years in only two decades from 68.55 in 1990 to 74.83 in 2010. The longer people live, the longer they rely on the medical insurance system. And the older people get, the more they tend to make health care and medical services expenditures. Unless gradually shifting to a new funded scheme, the old pay-as-you-go scheme can hardly maintain as the old dependency ratio further increases.

Aside from adopting a different medical insurance scheme, seeing that the government’s fiscal burden tends to be aggravated by increasing health care and medical services expenditures, the management of the medical insurance fund also becomes essentially important. The large scale of migrant workers has already resulted in noticeable management problems such as a great number of people being simultaneously involved in the New Rural Cooperative Medical Care Program that is only applicable to rural residents and the Urban Resident or Urban Employee Medical Care Program that only applies to urban residents\(^7\), a frequent inconsistency between the location where a person paid into the insurance program and the location where the benefit will be realized, and etc. Without properly addressing these management issues as a part of future reforms, the sustainability of the social security system alone will not be able to solve basic living problems, such as residence and medical demand, without the help of complementary public expenditures and investment.

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\(^7\) People involved in both rural and urban medical insurance programs were estimated to account for about 10% of all insurants and cause fiscal costs of 20 billion yuan annually.
system will face even more obstacles.

China decided to change its “one-child policy” in the end of 2013, and will gradually allow families where one of the couple was the only child to have two children since 2014 with different time-tables across provinces. The change was made against the background of its rapidly aging population, which resulted in a decline in the working-age (between 15 and 59) population in 2012, and it also complied with China’s tradition and Chinese families’ inclination to have more children as well as the government’s goal to increase the country’s total fertility rate to 1.8 from the current low level of 1.5. Although the new policy helps to ease the population aging problem, immediate effects could be limited. The “one-child policy” was mainly implemented in the urban sector. But thanks to expensive housing, education, and general living costs in cities, some urban families may have difficulties to afford a second child. In the meantime, some urban families may decide to work, instead of raising an additional child, in view of increasing wage returns. In the short-run, more young dependents also tend to dilute household incomes which will otherwise be spent on taking care of old members or simply saved into pension plans, and thus may even aggravate the challenge that the social security system faces. Therefore, although the recent policy change will undoubtedly improve China’s demographic structure in the future, the sustainability issue of its social security system still remains an uneasy task and requires immediate policy and management reforms.

References


