Intrahousehold Allocation in Multi-generational Households: Evidence from China*

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April, 2024

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Abstract

In this study, I develop a new approach to identify intrahousehold resource allocation and the extent of joint consumption for extended families using a collective household model. Unlike the traditional method, this new approach (i) allows for endogenous living arrangement decisions and (ii) requires less data. Using nationally representative household survey data from China, I first document that intrahousehold factors also matter for co-residence decisions — only when both wife and husband agree on living with the husband's parents would significantly increase the likelihood of post-marriage co-residence behavior. I then apply this new approach to recover the individual-level resource shares for women, men, and the elderly, as well as the economies of scale. Results suggest that the elderly are allocated the least resource shares, and women tend to be more altruistic in consumption sharing than men. Co-residence households indeed enjoy economic efficiency gains compared to nuclear households, but there is still room for explanations on why multi-generations choose to live together, and that cultural factors might still play a role in living arrangement decisions in Chinese societies even today.

JEL codes: D13, D11, D12, I32, J14, J12

Keywords: Collective household model, Resource shares, Scale economies, Extended families

*I am grateful to my advisors Rossella Calvi and Flávio Cunha for guidance and support. I also thank Naijia Guo, Seema Jayachandran, Jacob Penglase, Isabelle Perrigne, Fisher Yu, Jipeng Zhang, participants at the 2022 AMES China conference, EEA-ESEM Milano 2022, 2022 AMES Tokyo conference, 2nd Workshop in Applied Microeconomics 2022-23, AASLE 2022 Conference, and Rice Economics Department Seminar for valuable comments and suggestions. All errors are my own.

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1 Introduction

Households in the developing world tend to be larger in family sizes compared to developed countries and usually involve multiple generations. While most of the literature tends to attribute living arrangement decisions to economic factors, such as skyrocketing housing prices (Li and Wu, 2019), the need for elder care, and reduced costs of sharing household public goods (Pezzin and Schone, 1997; Pilkauskas et al., 2020; Salcedo et al., 2012), there is another potential channel that was often ignored by the literature, namely intrahousehold factors related to social norms. Cultural factors, such as deeply-rooted son preferences or filial piety, may also play a non-negligible role in household decisions, especially in countries like China.

Living in a large extended family increases the gains from economies of scale of consumption (Brown and Van de Walle, 2021). Nevertheless, when constrained by social norms, the extended family is more likely to suffer from efficiency loss than a core household with only the adult couple. Understanding this trade-off is essential and evaluating individual well-being implications in different household compositions is important. Since the unitary model is limited in depicting individual preferences,[1] this paper applies a collective household model framework. The model framework is beneficial for identifying intrahousehold resource allocations. Specifically, it can identify resource shares and economies of scale.[2] Individual-level resource shares are closely connected to each household member's bargaining power and can measure consumption inequality within households. Economies of scale can quantify the efficiency gain of extended families. Once we know the extent of the contribution of the economic factor to living arrangement decisions, we can better assess the contribution of non-economic factors and understand the interactions between the two. The traditional collective household model assumes that the household acts efficiently with exogenous household compositions (Chiappori, 1988, 1992). To allow for more flexible settings, there is a need to extend the existing collective model framework.

In this paper, I develop a new method to study the intrahousehold resource allocations for multi-generational families based on the collective household model. One of the uniqueness of the method is that it allows for endogenous living arrangement decisions. The new method can also identify resource shares with fewer data requirements, especially when no private

[1] The unitary approach is also limited in capturing potential disagreement between members.

[2] Resource shares are defined as the fraction of a household's total resources or budget (spent on consumption goods) allocated to each household member. Scale economy is the cost-savings that a person experiences when living in a larger household due to consumption sharing.

assignable goods are available.[3] Specifically, the current model has several key features: First, I let the co-residence decision – whether to live with elder parents after marriage for young couples – affect how resources are divided amongst household members, but I do not allow it to affect each member's indifference curves over goods to keep the model tractable. Second, I allow the household's consumption technology to vary with the co-residence decision, so that different living arrangement settings may have different efficiency levels. Due to the convenience of the model setting, the efficient collective household model can be extended to a *conditional efficiency* framework, similar to Lewbel and Pendakur (2022). In other words, households are conditionally efficient, conditioning on their living arrangement decision. Once controlled for the living arrangement setting, the *conditional efficiency* framework reduces to the traditional BCL. Therefore, the resource share functions and economies of scale (i.e., the cost savings associated with joint consumption) in this new model can still be identified with mildly modified assumptions from Browning et al. (2013) (hereafter BCL) and Lewbel and Pendakur (2008).

I rely on four main assumptions for identification: First, to recover the intrahousehold allocation of resources and scale economies in consumption with only household-level demand data and no private goods consumption, I impose preference stability across different types of individuals (those living alone or in a couple regardless of their living arrangement decisions) (Lewbel and Pendakur, 2008). In other words, I use singles' consumption data to identify preference parameters.[4] Once consumption preferences are known, the remaining changes in consumption for adult couples and co-residence families can be ascribed to intrahousehold resource sharing and economies of scale. Second, I need to impose that some of the consumption goods have nonlinear budget shares that are sufficiently different across individuals to generate enough variation (Blundell et al., 1998; Browning et al., 2013; Lewbel and Pendakur, 2008). Third, I assume that economies of scale in consumption can be summarized by a single parameter that inflates household expenditure (Blundell et al., 1998; Calvi et al., 2023; Lewbel and Pendakur, 2008). Fourth, I assume that resource shares and scale economies are independent of household expenditure (Calvi et al., 2023; Lewbel and Pendakur, 2008). Under these assump-

[3]A good is private if it is not shared nor generates any externalities. A good is assignable if we can observe who is consuming the goods.

[4]Though a bit strong, in the estimation, I allow for heterogeneity in preferences by adding a series of household and individual characteristics as control variables, including age, education level, urban or rural hukou, and the number of children in the households. Therefore, the preference stability assumption can be interpreted as individuals of the same type would have the same preferences for consumption across different living arrangement settings, once conditional on these characteristics.

tions, I can identify resource shares and economies of scale for adults. The method is limited in identifying resource share or economies of scale for children, since they usually do not live alone. Nevertheless, with additional data on the consumption of private assignable goods, the identification argument can readily be extended to investigate children's well-being (Dunbar et al., 2013).

I then apply the method to study intrahousehold welfare implications of co-residence decisions, using a nationally representative household survey from China — the 2014 wave of the China Family Panel Studies (CFPS). China constitutes an interesting test ground for this problem because of the rising trend of co-residence rates starting from the early 2000s (Guo et al., 2022; Li and Wu, 2019). As depicted in Appendix Figure C1, the co-residence rate was close to 50% in 2018 and keeps rising nowadays. Compared to most western countries, where the co-residence rate is only about 20-30%, the large number of co-residence families makes China a salient case to study the underlying mechanisms and potential consequences of co-residence within households. Meanwhile, the uniqueness of the data is that it provides detailed information on personal attitudes towards co-residence from both husband and wife. Thus, I am able to document the existence of disagreement over household decisions within the young couple and study how that relates to the actual co-residence decision. I find that intrahousehold factors also matter for co-residence decisions — only when the wife and the husband both agree on living with the husband's parents would lead to a higher likelihood of post-marriage co-residence behavior. Hence, the mutual agreement of the adult couple serves as a valid instrument to solve the endogeneity of the co-residence decision in my empirical application.[5]

With a conditional efficiency framework that emphasizes the potential disagreement over the co-residence decision within the adult couple, I structurally estimate the model to obtain individual resource shares within the household and the economies of scale of consumption. The model specifications accommodate heterogeneity in preferences across a range of household and individual characteristics, including age, educational attainment, urban or rural hukou, and the number of children. Importantly, as it has been shown that rising housing price in China plays a significant role in household living arrangement decisions (e.g., Li and Wu, 2019; Rosenzweig and Zhang, 2019), in the estimation, I also control for home ownership status, i.e., whether the current house is owned by the elderly parents or the adult couple, constructed

[5]The mutual agreement also presents a strong first stage, as shown in Table C1. I discuss more details of the validity of the instrument in Section 4.2.

from the CFPS, and the province-level housing price index,[6] obtained from the 2014 China Statistical Yearbook, to capture the effects of one of the critical economic factors for Chinese households – the housing prices – on the efficiency scale.

Understanding inequality at the individual level rather than the household level helps reveal household dynamics, which has fruitful implications for policy targeting and evaluation. I find that the elderly are allocated the least resources compared to adult women and adult men. This can be seen from the estimates that the elderly are, on average, allocated only 5.2% of the household expenditure, whereas men and women are allocated around 72% and 19%, respectively. Additionally, I find that women tend to be more altruistic towards the elderly in consumption sharing than men since the estimates show women's resource shares experience a drop from 39% to 19% when living with the elderly. As for the scale economy estimates, I find that co-residence households indeed experience benefits in economies of scale compared to non-coresidence households. However, there is still room to explain why people choose to co-reside, even after accounting for housing market factors. This suggests that cultural factors such as social norms might be driving more of the co-residence decisions for my study sample.

With the estimated individual resource shares, I continue to conduct a series of post-estimation analyses to investigate intrahousehold inequality. First, the richness of the data allows me to check the robustness of my model estimates by comparing the estimated individual resource shares with the self-reported decision-maker status, i.e., *who has the final say on household expenditure*, from the Household Decision Panel of the CFPS. I find that for all three categories of individuals (men, women, and the elderly), the mean of the estimated resource shares is highly correlated with the survey responses, reassuring the validity of model estimates. Second, I link the elderly's resource shares with the living arrangement settings. Results show that the husband's parents, on average, are allocated more resource shares than the wife's parents, which may be closely tied to the patriarchic culture in China.

The added value of the model is that I can further do poverty measure corrections by incorporating intrahousehold inequality. The structural poverty estimates account for potential disparities in resource sharing within households, resulting in a more precise calculation. I find that poverty rates for women and the elderly are underestimated when intrahousehold inequality is not taken into account by the conventional per-capita household expenditure measure, but not for men. Poverty rates for the elderly are generally lower when they are living alone.

[6]The role of the housing price index in my empirical model only serves as some factors representing the macro-level housing market condition.

This phenomenon echos the findings in Guo et al. (2021) and is likely due to the fact that those extended families tend to be more credit constrained, with lower overall incomes to start with. Studying the association between the elderly's poverty status and their living arrangement settings has broader welfare implications for society at large.

In this paper, I make three major contributions. First, this study makes a methodological contribution to the collective household model literature. To my knowledge, it is the first to explore intrahousehold resource allocation and scale economies with no private assignable goods while allowing for endogenous household composition. This study is closely related to the theoretical framework of Lewbel and Pendakur (2022) who relax Browning et al. (2013) framework to allow for conditional efficiency and introduce the so-called "cooperation factor." However, their identification argument relies on the availability of data on private assignable goods, which is often challenging to observe in the majority of datasets from developing countries. Apart from Lewbel and Pendakur (2022), the new method proposed in this study does not require observing expenditure on goods that are consumed exclusively by each individual, which means it can be generally applied to different settings. Moreover, this paper further estimates the model and analyzes behaviors of extended families, allowing for a larger number of categories of individuals instead of only husband and wife. It focuses on the consequences of household inefficiency on the elderly's welfare outcomes, which is absent in Lewbel and Pendakur (2022).

Second, this study contributes to understanding the underlying mechanisms and consequences of living arrangement decisions. Existing research studying multi-generational households ascribes the causes of co-residence decisions to the need for elder care and reduced costs of sharing household public goods (Pezzin and Schone, 1997; Pilkauskas et al., 2020; Salcedo et al., 2012).[7] In addition to these mechanisms, the global macro environment, particularly the skyrocketing housing prices, is inevitably often identified as one of the primary reasons behind the rising trend of the intergenerational co-residence pattern in developing countries like China (Li and Wu, 2019). More policy-relevant, evidence suggests that the high-cost childcare and the

[7]For example, Pezzin and Schone (1997) model the bargaining process between an adult daughter and her elder parents, relying on the need of formal care and cash transfer between family members to explain the intergenerational co-residence pattern in the U.S. Salcedo et al. (2012) ascribe the co-residence phenomenon in the U.S. to the reduced costs of sharing household public goods. Their structural model highlights the endogeneity of the equivalence scales and the importance of changing social norms. A recent literature review by Pilkauskas et al. (2020) uses long panel data in combination with historical data to explore the pattern of multi-generational households in the U.S. between 1870 and 2018. They find that the association between parental education and the co-residence decision is gradually changing, and the link varies with different race/ethnicity groups.

launch of pension programs are linked to living arrangement decisions (Chen, 2017; Guo et al., 2022).[8] A large strand of literature explores the consequences of the co-residence decision, including the effect on female labor supply (Frimmel et al., 2020; Khanna and Pandey, 2020; Pezzin and Schone, 1999), saving rate (Rosenzweig and Zhang, 2019), mortality rate (Zang and Campbell, 2018), and marriage formation (Raymo et al., 2015; Tian and Davis, 2019; Yu and Kuo, 2016). My paper adds to the literature by providing empirical evidence on the role of cultural factors in driving household behaviors. It also takes a step further in studying the correlation between cultural factors and various socioeconomic outcomes in the developing world. To the best of my knowledge, this paper is the first to quantify the welfare effects of conflicting personal attitudes due to cultural factors, measured by intrahousehold recourse allocations.

Third, this study is closely related to the literature on welfare implications of the elderly and the aging society (Bertrand et al., 2003; Blundell et al., 2023; Calvi, 2020; Chen, 2017; Chen and Fang, 2021; Cherchye et al., 2012; Giustinelli and Shapiro, 2019; Guo et al., 2021; Guo and Zhang, 2020; Liu and Bai, 2022). By using a collective model framework to uncover intrahousehold inequality, this paper provides a unique angle to quantify the status of the elderly in multi-generational families. Sociology and demography literature document the strong influence of the long-lasting norms of filial piety associated with Confucianism (Chu et al., 2011; Liu and Bai, 2022). However, recent works also show that as a result of modernization, filial piety has gradually declined, resulting in the decline of the family status of the elderly (Raymo et al., 2015). The rising issue of population aging and the continued decline in the elderly's ability or power to participate in family decisions create a growing tension. This study, aiming to identify the power status of the elderly by the intrahousehold resource allocations and its implications on individual-level poverty, is of great significance not only to the quality of life of an elderly, but also to the stability of his family and, ultimately, to the sustainable development of society.

The rest of the paper is organized as follows. Section 2 briefly introduces the context of the elderly's living arrangements in China and describes motivating evidence from the data. Section 3 introduces the collective household model framework for multi-generational households and

[8] Chen (2017) apply a regression discontinuity design method to study the effect of old age pension program on intergenerational living arrangements in China. The author considers the pension program a positive income shock and conducts a cost-benefit analysis of the program. On top of the effect of housing price, Guo et al. (2022) model co-residence behavior via a one-to-one matching framework between the young couples and their elder parents. The gist of the paper is that young couples compete with their siblings to enjoy the benefits of elder parents providing childcare, whereas the cost is the provision of elder care. Elder parents are on the other side of the matching market, deciding whether to accept offers from their adult children.

the identification results. Section 4 presents the estimation sample and empirical specifications. Section 5 shows estimation results and post-estimation analysis. Section 6 concludes.

2 Institutional Background and Motivating Evidence

2.1 The Elderly's Living Arrangements in China

The global phenomenon of population aging is inevitable. As a notable example, China's population ages more rapidly than that of the majority of developed countries. According to United Nations (2019), the proportion of adults 65 and older is expected to increase from 5.5% in 1990 to 13.3% in 2025 and reaches 23%, or 114 million people, by 2040. However, in contrast to the eldercare arrangements in the U.S. or other developed economies, which are composed of relatively high marketization levels of the eldercare system, the eldercare system in China tends to be informal, mostly relying on personal savings and support from adult children (He et al., 2021).

Living with elderly parents is one approach to providing caregiving assistance. The Chinese cultural norm of filial piety, which refers to the general expectation that children must provide full support to their aging parents, also reinforces this practice. Due to the limited and early-stage development of the institutional care system in China, the elderly have few options other than living alone or with their spouses if they decide not to live with their adult children.[9]

With rapid economic development and demographic changes, Chinese society has experienced a similar progressive erosion of social norms as other nations (Hu and Scott, 2016; Liu and Bai, 2022). Households in the urban area of China tend to reside in a family structure of "4-2-1" (four grandparents; two parents, neither of whom has siblings; and one child). Along with the relaxation of the *One Child Policy* in late 2015, the burden of eldercare has increased significantly, which may conflict with the rising cost of childcare for adult couples. The increasing trend of the out-migration flow of young adults in rural regions may also have an impact on the erosion of cultural norms, as well as the economic concerns of eldercare. All of these aspects raise concerns about whether the filial piety tradition or the economic factor alone

[9]Recent literature has documented an increasing trend of the elderly living alone being accompanied by a rise in living close to their adult children, typically in the same village or community (Lei et al., 2015; Meng et al., 2017). In my study, I consider those elderly parents living near their adult children as separate families since they report expenditures separately in the data. Note that I do not explicitly model inter-generational transfers at the current stage.

can adequately explain the elderly's living arrangements nowadays, and support the willingness and capacity of adult children to care for their aging parents. It is worthwhile examining how each component separately shapes the family-based eldercare arrangements in China in order to make policy recommendations for better meeting the needs of the aging population.

2.2 Motivating Evidence

In this section, I first explore evidence on the changing patterns of heterogeneous attitudes on family dynamics by gender across generations using the CFPS.[10] The CFPS data is unique in that it provides rich intrahousehold information as well as a very comprehensive and complete family roster, comparable to the Panel Study of Income Dynamics (PSID) in the United States. Moreover, the CFPS collects specific questions on personal attitudes across various dimensions, and researchers can readily link personal responses with the actual household-level information. Specifically, I use the 2014 wave of the CFPS to measure attitudes toward several cultural factors and social norms. This wave has data available on personal attitudes regarding gender, fertility, and co-residence decisions. I group the questions into three categories: (i) filial piety; (ii) son preference; and (iii) gender ideology.[11] I standardize the answer for each question to be between 0 and 1 and compute the mean score across all questions in the same category.[12]

As shown in Panel A of Figure 1, both men and women conform to traditional filial piety, though to a lower degree for women. We can see that the degree of son preference in China is decreasing, as depicted in Panel B of Figure 1. However, men always hold a stronger son preference than women. The diverging pattern supports that there may be conflicts between couples within a household.

Furthermore, gender attitudes in China have changed across cohorts. Figure 2 presents the mean values of attitudes about gender in the public and private sphere by birth cohort and gender, respectively.[13] On average, both men and women express more egalitarian attitudes about gender in the public sphere across cohorts, but the increase in egalitarianism appears to be greater among women than among men. A comparison of the two measures suggests that

[10]CFPS is a nationally representative longitudinal survey of Chinese communities, families, and individuals, which was conducted in 2010 and implemented every two years thereafter by the Institute of Social Science Survey of Peking University (ISSS) (Xie and Hu, 2014).

[11]See Appendix B for questions for each category.

[12]The original answers range from 1 to 5, with 1 indicating complete disagreement, 3 meaning indifferent, and 5 complete agreement.

[13]Public sphere refers to gender attitudes in the labor market, while the private sphere points to within the family.

Chinese people hold more traditional attitudes about gender in the private sphere than in the public sphere. Figure C2 captures similar patterns when considering the public and private spheres as a whole.

I then study the correlation between the differences in the personal attitudes of husband and wife and living arrangement decisions. As depicted in Figure C3, only when both the husband and wife agree on "son living with elder parents after marriage," the young couple is the most likely to live with elder parents.[14] The likelihood of co-residence decreases once disagreement exists. This implies that the intrahousehold factor – the heterogeneous attitudes between husband and wife – also matters for the co-residence decision. To study intrahousehold resource allocations for multi-generational families, there is a need to extend the traditional collective household model to allow for inefficiency due to the conflicting opinions between household members.

3 The Collective Model for Multi-generational Households

In this section, I outline the framework and identification of the collective household model with endogenous living arrangement decisions. To account for potential efficiency loss, I apply the similar setting of the *conditional efficiency* model proposed by Lewbel and Pendakur (2022). The identification strategy of intrahousehold resource shares and scale economies allowing for inefficiency is discussed intensively in Lewbel and Pendakur (2022). Nevertheless, this paper extends their framework and establishes the identification method without requiring the observation of private assignable goods.

3.1 Set-up

The model extends the two-household-member setting in BCL to a large number of decision-makers. Assume a household consists of N members and that each member belongs to one of J categories (indexed by j), such as women, men, children, and the elderly. The number of household members of each category j is denoted by n_j so that $N = \sum_{j=1}^{J} n_j$.

Denote f as the co-residence decision, where f takes the value of 0 or 1, with 0 denoting not living with the elderly parents and 1 denoting the opposite. Following Lewbel and Pen-

[14] Figure C4 plots the correlation of attitudes and living arrangement decisions for broader categories of "norms."

dakur (2022), the collective household model with endogenous decision of co-residence can be written as:

$$\begin{aligned} &\max_{g_1,g_2,\ldots g_J} \textstyle\sum_{j=1}^{J} n_j \left(U_j\left(g_j\right)+u_j(f,v)\right)\mu_j(p,y,f) \\ &\text{s.t.}\quad p'g=y,\quad g=A_f\textstyle\sum_{j=1}^{J} n_j g_j, \end{aligned} \tag{1}$$

where y is household expenditure, g is the total consumption, p is vector prices of g, g_j is the private consumption by group j, μ_j is the so-called "Pareto Weights" of each member j measuring j's bargaining power. The term $u_j(f,v)$ is the additional utility member j directly obtains from living in a household with the co-residence decision given by f and v denotes observed variables that affect direct utility/disutility of f.[15] In (1), $g=A_f\sum_{j=1}^{J} n_j g_j$ is the "consumption technology function," which describes the extent to which each good is shared by the household members under different living arrangement settings. According to BCL, the square matrix A summarizes how much goods are shared.[16] Note that (1) is applicable to households with multiple categories of individuals, rather than only husband and wife ($j=2$).

In this setup, the co-residence decision is allowed to be endogenous and households can choose their cooperation level given by the matrix A_f. The conditional efficiency framework implies that each household is conditionally efficient, conditioning on f (Lewbel and Pendakur, 2022). Equivalently, each is conditionally efficient, conditioning on their household consumption technology matrix (either A_0 or A_1). The functional form of (1) has several features: (i) the endogenous choice variable f directly affects an individual's utility through the $u_j(\cdot)$ function, (ii) the choice variable f affects bargaining power $\mu_j(\cdot)$, (iii) the choice variable f affects resource allocations through the sharing rule square matrix A introduced in BCL, and (iv) household members belonging to the same category have identical preferences for consumption goods, suggesting the analysis will be conducted at the household member category level instead of the individual level.

Introducing the variable v is critical in solving the endogeneity of f. According to the model setting of (1), we can see that v only affects the utility of f but does not affect household

[15] In reality, $u_j(1,v)-u_j(0,v)$ could be negative, indicating that member j is experiencing disutility from expending the extra effort under different living arrangement settings. If member j gains pleasure or improves their well-being as a result of cooperating, $u_j(1,v)-u_j(0,v)$ may also be positive.

[16] Here is one example of the A matrix: Suppose a married couple without children rides together in a car (sharing the consumption of gasoline) for half of the time. Then, in terms of the total distance traveled by each person, it would be as if member 1 consumed a quantity g_1^1 of gasoline and member 2 consumed a quantity g_2^1 where $g^1=(3/4)\left(g_1^1+g_2^1\right)$. For instance, Person 1 drives 100 km and person 2 drives 100 km, the vehicle only drives 150 km since 50 km is driven jointly. In this example, the upper left corner of the matrix A that summarizes the extent to which gasoline is shared would be $3/4$.

demand functions for goods.[17] Therefore, v is a valid instrument for the endogenous choice f. More importantly, we do not need to explicitly model the decision of f. Instead, all we need is to observe some v. In my empirical application, I use the couples' agreement over the co-residence decision as the instrument for the propensity of co-residence.

To solve (1), we need to impose the following assumptions:

Assumption 1 (Conditional efficient behavior)**.** *Conditional on f, p, y, the household chooses consumption quantities, g, following (1).*

Assumption 2 (Regularity conditions)**.** *Each $\mu_j(f,p,y)$ function is differentiable and homogeneous of degree zero in price p and income y. Each $U_j\left(g_j\right)$ function is concave, strictly increasing, and twice continuously differentiable in g_j. For each f, the matrix A_f is non-singular with all non-negative elements and a strictly positive diagonal. The variable y and each element of p are all strictly positive, and the maximizing values of $g_1,\ldots g_J$ in Assumption 1 are all strictly positive.*

Lemma 1. *Let Assumptions 1 and 2 hold. Then there exist positive resource share functions $\eta_j(p,y,f)$ such that $\sum_{j=1}^{J} n_j\eta_j(p,y,f)=1$, and the household's demand functions for goods are given by each member j solving the following program:*

$$\begin{aligned} &\max_{g_1,g_2,\ldots g_J} \textstyle\sum_{j=1}^{J} n_j U_j\left(g_j\right) \\ &s.t. \quad p' A_f g = \textstyle\sum_{j=1}^{J} n_j \eta_j(p,y,f) y. \end{aligned}$$

Each η_j is the fraction of the household's total resources y that are claimed by member j. The proof follows Lewbel and Pendakur (2022) and BCL. The intuition is that due to the household being conditionally efficient conditioning on the consumption technology matrix A_f, the optimization problem of (1) yields an efficient allocation and has a decentralized representation conditioning on A_f. Therefore, solving the optimization problem is the same as solving a model where each member j chooses a consumption vector g_j to maximize their own utility function, subject to their own personal budget constraint with shadow price vector $A_f'p$ and shadow budget $\eta_j(p,y,f)y$.

[17] The reason is that in the setting, v only affects the u_j functions and not the utility from goods consumption U_j or Pareto weights μ_j.

3.2 Identification

With only household-level consumption data available and no private assignable goods, our main goal is to rely on the framework of (1) to identify intrahousehold resource shares η_j, economies of scale, and further, the *indifference scales* allowing for inefficiency. *Indifference scales* are welfare measures. They are defined as the fraction of household expenditure that puts an individual living alone on the same indifference curve that she would attain living in the household. Resource shares and indifference scales are two objects of interest for each individual in a household, and BCL shows that these objects are identifiable from data on household budgets and market prices. However, identification conditions of BCL require observing a great deal of market price variation, which is often challenging in data from developing countries, to overcome this limitation, Lewbel and Pendakur (2008) provide identification without price variation. In this section, I further extend Lewbel and Pendakur (2008) to establish the identification without observing the private assignable goods allowing for inefficiency and generalize it to be applicable to extended families.

Following the derivation in BCL, household members have preferences over K goods with log market prices $h = \log p = (h^1, \cdots, h^K)$. I then introduce the log Barten scales (Barten, 1964). Specifically, there exists a K vector of constants $\alpha_f = (\alpha_f^1, \cdots, \alpha_f^K)$, called log Barten scales, such that the total log quantity of a good k that is consumed by the household members under the condition of household behavior f equals the log quantity of the good purchased by the household minus α_f^k. BCL refers to the diagonal elements of A as Barten technology parameters, due to their equivalence to Barten scales. Similarly, for the conditional efficiency framework, diagonal elements of A_f also serve as Barten technology parameters. Let $x = \log y$ denote the log expenditure.

Denote $W_f^k(h, x, \alpha_f)$ the household-level budget share for good k as a function of log prices, log expenditure and Barten scales, and $w_{j,f}^k(h, x, \alpha_f)$ the individual-level budget share of each member of type j (that is, the budget share function of a household consisting just of one person of type j). Following BCL, the household-level budget shares take the Engel curve form:

$$W_f^k\left(h, x, \alpha_f\right) = \sum_j n_{j,f} \eta_{j,f}\left(h, x, \alpha_f\right) w_{j,f}^k\left(h + \alpha_f, x + \ln \eta_{j,f}\left(h, x, \alpha_f\right)\right). \tag{2}$$

Inefficient Indifference Scales. I introduce the concept of *inefficient indifference scales* based on Lewbel and Pendakur (2008) and Calvi et al. (2023). The objective of the scale is to compare the well-being of individual j living in families choosing $f=0$ versus families choosing $f=1$. Suppose a household choosing f has Barten scales α_f, and each person in that household has resource share $\eta_{j,f}$. The indifference scales $I_{j,1,0}$ for an individual of type j in a household of $f=0$ relative to a household of $f=1$ are solutions of:

$$V_j\left(\alpha_0+h, x+\ln\eta_{j,0}-\ln I_{j,1,0}\right)=V_j\left(\alpha_1+h, x+\ln\eta_{j,1}\right), \tag{3}$$

where $V_j(\cdot)$ denotes an ordinal indirect utility function describing the preferences of an individual of type j. The interpretation is that if a person in category j living in a non-coresident household were given an amount of income equal to $\eta_{j,0}e^x/I_{j,1,0}$, she would be able to buy a bundle of goods that lies on the same indifference curve as the bundle of goods she consumes as a member of a co-resident household with total expenditure e^x and resource share $\eta_{j,1}$. The indirect utility function $V_j(\cdot)$ implicitly defines the indifference curves of j over goods bundles. To formalize the identification arguments that do not have heavy data requirements, we need to make a number of simplifying assumptions:

Assumption 3 (Independence-of-Base assumption)**.** *For each household member j and household behavior f, there exists a scalar-values, differentiable function $d_{j,f}(\alpha_f,h)$ such that:*

$$V_j\left(\alpha_f+h,x\right)=V_j\left(h,x-\ln d_{j,f}\left(\alpha_f,h\right)\right). \tag{4}$$

This is the independence-of-base (IB) assumption introduced in Blundell et al. (1998) and applied in Lewbel and Pendakur (2008) to simplify the estimation of the BCL model. It serves as one of the key assumptions to identify resource shares without price variation. We can read $d_{j,f}(\alpha_f,h)$ as a measure of the cost-savings that person j experiences when she lives in a family rather than alone due to scale economies. This function is assumed to be independent of the base expenditure at which they are evaluated.

Once applying Roy's identity to (4), I obtain the individual-level budget share functions for good k in a household choosing f as follows:

$$w^k_{j,f}\left(\alpha_f+h,x\right)=\delta^k_{j,f}+w^k_{j,f}\left(h,x-\ln d_{j,f}\left(\alpha_f,h\right)\right), \tag{5}$$

where

$$\delta^k_{j,f}=\frac{\partial\ln d_{j,f}\left(\alpha_f,h\right)}{\partial h^k}$$

is the elasticity of $d_{j,f}$ with respect to the k'th price. The budget share of a person j for good k has the same shape when evaluated at logged market prices h or at logged shadow prices $\alpha_f + h$.

Assumption 4. *Resource shares $\eta_{j,f}(h,x,\alpha_f)$ do not depend on x, i.e., $\eta_{j,f}(h,x,\alpha_f) = \eta_{j,f}(h,\alpha_f)$.*

This assumption mirrors Assumption A of Lewbel and Pendakur (2008) to the inefficiency setting and is the other key assumption for identification without price variation. A number of studies have empirically tested the validity of this assumption and provided support from real-world data (Bargain et al., 2018; Cherchye et al., 2015; Menon et al., 2012). The implication of this assumption is that as $\eta_{j,f}(h,\alpha_f)$ and $d_{j,f}(h,\alpha_f)$ are both independent of expenditure x, the indifference scales of individuals j across households choosing $f = 0$ and those choosing $f = 1$ are also independent of expenditure. I hereby formally define indifference scales in the following Lemma:

Lemma 2. *Let Assumption 3 and 4 hold, the indifference scales for an individual of group j in a household choosing $f = 0$ relative to a household choosing $f = 1$ do not depend on log expenditure, x, and are given by:*

$$I_{j,1,0}(h,\alpha_0,\alpha_1) = \frac{\eta_{j,0}(h,\alpha_0)}{\eta_{j,1}(h,\alpha_1)} \frac{d_{j,1}(h,\alpha_1)}{d_{j,0}(h,\alpha_0)}.$$

Proof. See Appendix A.1. □

Lemma 2 implies that we can reach the identification of all the three objects of interest (resource shares, economies of scale, and indifference scales) as long as two of them are identified.

Substituting (5) into (2), I obtain the household-level budget share demand functions:

$$W_f^k(h,x,\alpha_f) = \sum_j n_{j,f}\eta_{j,f}(h,x,\alpha_f)\,[\delta_{j,f}^k + w_{j,f}^k(h,x+\ln\eta_{j,f}(h,x,\alpha_f) - \ln d_{j,f}(\alpha_f,h))]. \quad (6)$$

Equation (6) shows that household budget share equations are a simple function of individual budget share equations. Moreover, equation (6) shows that household budget shares are weighted averages of individual budget shares translated both in budget shares (vertically) and log-expenditure (horizontally). Lewbel and Pendakur (2008) show that when there is only one price regime, one can drop prices and rewrite (6) in Engel curve form. They further show that resource shares and scales of economies can be nonparametrically identified, as long as some of the goods have budget shares that are nonlinear and are sufficiently different across individuals. To extend their identification arguments to the inefficiency setting, we require the following additional technical assumptions:

Assumption 5 (Preference stability across f)**.** *Let $\omega_{j,f}^{k}(y)$ be the individual-level budget share equations for goods k as a function of total expenditure in one price regime. $\omega_{j,f}^{k}(y)$ are twice continuously differentiable with respect to y and, when evaluated at $y = 0$, are such that: $\nabla_y^2 \omega_{j,f}^k(0) = \nabla_y^2 \omega_j^k(0)$.*

This assumption says that the consumption preference only varies by the individual category j but does not vary across different living arrangements or marital statuses.[18] Equivalently, I assume singles and individuals in couples (no matter whether the couples live with elderly parents) have the same preferences.

This is the key assumption that allows us to achieve identification when no private assignable goods consumption is available. Intuitively, the consumption of singles would serve as a "proxy" for the private assignable goods consumption of individuals in adult couples and extended families in my exercise. This assumption requires household members to have identical preferences across household types defined by the value of f. This restriction mirrors the preference stability requirement proposed in Lewbel and Pendakur (2008). Individuals' preferences over goods are constrained to be the same whether they are single or in a couple (regardless of values of f), so that changes in consumption behavior between $f = 0$ and $f = 1$ can be attributed to joint consumption and resource sharing rather than changes in preferences.

Assumption 6 (Non-linearity condition)**.** *Following definition in Assumption 5, further assume that $\nabla_y^2 \omega_{j,f}^k(0) \neq 0$. Let $M(y)$ denote the K by J matrix where the element in the k'th row and j'th column is $\omega_j^k(y)$. Assume that the matrices $\partial M(y)/\partial y$ and $\partial^2 M(y)/\partial y^2$, evaluated at $y = 0$, exist and have rank J.*

This assumption imposes the non-linearity restriction on the behavior of Engel curves at the zero expenditure level, as in Lewbel and Pendakur (2008) and BCL. The nonlinearity is critical to separately identify intrahousehold allocation from the extent of joint consumption, as stated in the proof in Appendix A.2. Note that given the assumed smoothness (differentiability) of

[18] Another way of introducing the notation of f is to include those singles and allow $f = \{0, 1, 2\}$, where 0 denotes singles, 1 denotes adult couples, and 2 denotes couples with elderly parents. All the proofs and arguments will follow with subtle modifications.

Engel curves, Assumptions 5 and 6 do not formally require observing budget shares at zero expenditure levels, but rather depend on the limits of Engel curve derivatives in the neighborhood of zero, i.e., at small expenditure levels. Identification really just requires a certain degree of nonlinearity, which is most easily described at zero. Writing the restriction at y = 0 makes the proof more convenient.

Theorem 1. *Consider a population of households of $f = 0,1$. Let Assumptions 1-6 hold for all f. Then, the resource shares $\eta_{j,f}$ and economies of scale $d_{j,f}$ are identified for $j = 1,\cdots,J$, with household-level demand data under a single price regime.*

Proof. See Appendix A.2. □

Theorem 1 says that, under appropriate normalization, the structural components of the model, such as $\eta_{j,f}$ and $d_{j,f}$, are identified for all f and $j = 1,\cdots,J$. Following Lemma 2, the indifference scales for each family member across different household types are also identified. Note that this setting allows me to identify both $d_{j,0}$ and $d_{j,1}$. Those single-adult households serve as the reference household, and economies of scale for adult-couple ($f = 0$) and co-residence ($f = 1$) households are defined relative to these households. For many policy applications, such as establishing relative poverty thresholds, only recovering relative (as opposed to absolute) scale economies may be adequate. As stated in Calvi et al. (2023), it is also convenient to define indifference scales for individual j at a relative level, namely as the income adjustment needed for the individual living in non-reference households that would allow her to reach the same indifference curve as if she was living in the reference household. In my case, I set the single-adult households as the reference households. Thus, if indifference scales were less than one, then household income would then need to be scaled up by $1/I_{j,1,0}$ for the individual in the co-residence households to be just as well off as if they were living alone. On the contrary, if indifference scales were above one, household income would need to be scaled down by $1/I_{j,1,0}$. And similarly for the case of adult-couple households. Overall, indifference scales facilitate the quantification of the trade-off between consumption sharing and intrahousehold resource allocation for households under different living arrangement settings.

The identification strategy is closest to Lewbel and Pendakur (2008), Calvi et al. (2023), and Lewbel and Pendakur (2022). I summarize the identification conditions and results of related literature in Table 1. The conditional efficiency setting is similar to Lewbel and Pendakur (2022), which is absent in both Lewbel and Pendakur (2008) and Calvi et al. (2023). This study, on the other hand, extends Lewbel and Pendakur (2022) to identify both resource shares and economies of scale in consumption without requiring the observation of private assignable goods consumption and to generalize to extended families. Calvi et al. (2023) also formalizes the identification of the two objects in extended families, but similarly as Lewbel and Pendakur (2022), they require researchers to observe the consumption of private assignable goods as well. In contrast, the identification method of this paper only requires household-level consumption data, though as a trade-off, one needs to impose the additional preference stability restriction across types, as stated in Assumption 5.

4 Empirical Application

4.1 Description of the Estimation Sample

Consistent with Section 2, I use the 2014 wave of CFPS to estimate the Engel curve system (6). CFPS collects four types of household expenditures (recalled measures over the past 12 months): (1) consumption expenditure (nonproductive expenditures): food, clothing, housing, household appliance as well as daily used commodities and necessities, transportation and communication, entertainment and education, medical care and other consumption expenditure; (2) transfer expenditure: financial support to family and non-co-residing family members or friends, social donations and gifts and cash gifts in major family events; (3) insurance expenditure: expenditure on commercial insurance; (4) housing expenditure, including mortgage payment. I mainly focus on using consumption expenditure in my empirical analysis. I divide the eight categories of consumption expenditures into five new ones since expenditures of certain categories are extremely small for the majority of households. Specifically, I recalculate the household expenditures by removing consumption expenditures on other goods. I then combine clothing and daily necessities expenditures into a new category. I also combine expenditures on transportation and education into another new category.

In the main analysis, the elderly are defined as those who are 60 years old or above. To be consistent with the CFPS definition, I define children as aged between 0-15 for estimation and adults as those aged 16 and 59. I apply the following screens to ensure that only households who recorded their purchasing in 2014 are included. I exclude (1) households from the dataset when there is the presence of non-relative members or foreigners (e.g., nannies, drivers, etc.) living in the household, (2) households with missing data for any of the household characteristics (especially the attitudes questions) or relevant expenditures households, and (3) households with individuals reporting zero food consumption to avoid issues related to special events. Finally, to eliminate outliers, I exclude any household in the top or bottom one percent of total household expenditure,[19] and households with more than eight adults or eight children. I define *Adult couple* Households as a two-parent family (one adult female and one adult male) with or without children, and *Co-residence* Households as those nuclear families living with elderly parents.[20]

Tables 2 and 3 display the summary statistics for single-adult households and extended families. As can be seen from the tables, children are more likely to live with their mother than with their father. Moreover, extended families are more likely to live in rural areas, and individuals living in extended households are less educated, relative to single households. In all the five types of households, food consumption accounts for the largest budget share, 38-49% of total household expenditures. The other non-food categories account for roughly 6-20% of total expenditures, respectively. Health care and medical expenses account for a higher proportion of household expenditure in households with senior members.

4.2 Estimation

Lewbel and Pendakur (2008) show that an example of a general model of individual preferences satisfying Assumption 3 belongs to the Quadratic Almost Ideal Demand System (QUAIDS) of Banks et al. (1997). The QUAIDS demand system defines indirect utility as follows:

$$V_j(p,x) = \left(\frac{P_j^2(p)}{x - \ln P_j^1(p)} + P_j^3(p) \right)^{-1},$$

where the functions $P^1(\cdot), P^2(\cdot)$, and $P^3(\cdot)$ are defined so that the equation satisfies the property of the indirect utility function $V(\cdot)$.

Based on Roy's Identity, the individual-level budget share functions for goods k are rank

[19] The bottom one and top one percent households could have dramatically different consumption patterns that may be complicated to analyze.

[20] The reason for focusing on nuclear families with only one adult female and one adult male for estimation is to avoid confounding factors in the household decision-making process. However, the model can be easily applied to estimate the case of multiple adults in the households, assuming that resources are equally shared among individuals of the same category, as in Calvi et al. (2023).

three quadratic in log expenditure:

$$w_j^k(p,x) = -\frac{1}{P_j^1(p)}\frac{\partial P_j^1(p)}{\partial p} + \frac{\partial P_j^2(p)}{\partial p}\frac{\left(x - \ln P_j^1(p)\right)}{P_j^2(p)} + \frac{\partial P_j^3(p)}{\partial p}\frac{\left(x - \ln P_j^1(p)\right)^2}{P_j^2(p)}$$
$$= a_j(p) + b_j(p)x + c_j(p)x^2,$$

where for which p is the log of market price and x is the log of expenditure.

Substituting the derived individual budget share into (6), the household-level budget share for goods k for a household choosing f, with resource shares $\eta_{j,f}$ and scale economies $d_{j,f}$ is specified as:

$$W_f^k = \sum_j n_{j,f}\eta_{j,f}\left[a_{j,f}^k + \delta_{j,f}^k + b_j^k\left(x + \ln\eta_{j,f} - \ln d_{j,f}\right) + c_j^k\left(x + \ln\eta_{j,f} - \ln d_{j,f}\right)^2\right].$$

The households I consider include three groups of members: women, men, and the elderly. I index the members of the household by $j = w$, $j = m$, and $j = e$, so $J = 3$. Adding error terms ε, for $k = 1,\ldots,K$, I obtain the following system of equations:

$$\begin{aligned}
w_w^k &= w_w^k(x) + \varepsilon_w^k \\
w_m^k &= w_m^k(x) + \varepsilon_m^k \\
w_e^k &= w_e^k(x) + \varepsilon_e^k \\
W_f^k &= \sum_j n_{j,f}\eta_{j,f}\left[a_{j,f}^k + \delta_{j,f}^k + b_j^k\left(x + \ln\eta_{j,f} - \ln d_{j,f}\right) + c_j^k\left(x + \ln\eta_{j,f} - \ln d_{j,f}\right)^2\right] + \varepsilon_f^k.
\end{aligned} \tag{7}$$

Recall that f is endogenous and that v denotes potential instruments of choice f. I introduce a vector of demographic characteristics for each individual, z_j, and a vector of distribution factors z_h. Denote $z = \{z_w, z_m, z_e, z_h\}$. Following Lewbel and Pendakur (2022), I specify the conditional moment condition for the household budget share equation as:

$$\begin{aligned}
E(W_f^k - \sum_j n_{j,f}\eta_{j,f}(z)[a_{j,f}^k(z) + \delta_{j,f}^k(z) + b_j^k(z)(x + \ln\eta_{j,f}(z) - \ln d_{j,f}(z)) \\
+ c_j^k(z)(x + \ln\eta_{j,f}(z) - \ln d_{j,f}(z))^2]|v,z) = 0.
\end{aligned} \tag{8}$$

I rewrite the above conditional moment equation into an unconditional moment:

$$
\begin{aligned}
E[(W_f^k - \sum_j n_{j,f}\eta_{j,f}(z)[a_{j,f}^k(z) + \delta_{j,f}^k(z) + b_j^k(z)(x + \ln \eta_{j,f}(z) - \ln d_{j,f}(z)) \\
+ c_j^k(z)(x + \ln \eta_{j,f}(z) - \ln d_{j,f}(z))^2])\phi(v,z)] = 0.
\end{aligned} \tag{9}
$$

Equation (9) holds for any vector of bounded functions $\phi(v,z)$. I apply the Generalized Method of Moments (GMM) to construct an estimator for the parameter vector θ (Hansen, 1982).

Instruments. As discussed in Section 3, the co-residence decision f suffers from the endogeneity issue in the sense that there might be some unobserved factors affecting f, the co-residence decision, and at the same time, affect the household demand functions for goods.[21] To address the issue, in my case, I use the indicator of *Agree*, which takes the value of 1 when both husband and wife agree on the statement "*Son should live with parents after getting married*," and leave-one-out county level average value of f (leaving out household h) and its higher-order (squared, cubed, and quartic) terms as the instruments. Theoretically, these instruments are considered valid when they are correlated with the co-residence decision but do not impact utility over consumption goods. Empirically, the validity of using the indicator of *Agree* as the instrument is supported by the data evidence illustrated in Section 2. The idea of using the leave-one-out average is that variation in the local prevalence of co-residence families is likely to correlate with an individual's own decision to co-reside. The county-level average f (leaving out household h) is a valid instrument in the model if the choice of f in households other than household h is unrelated to the unobserved preference heterogeneity in member's co-residence decision in household h. To formally test the strength of the instruments, I ran the first-stage linear regressions. Table C1 provides evidence for the relevance of the instruments, with the first-stage F-statistics being greater than 100.[22]

Parametric Specifications. For single-member households j and for goods k, the error

[21] Considering the endogeneity of marriage decisions with the post-marriage living arrangement decisions is beyond the scope of the current analysis, which I will leave for future studies.

[22] I follow the equation below to test the validity:

$$
\begin{aligned}
\text{Co-residence}_{ic} = &\beta_0 + \beta_1 \overline{\text{Co-residence}}_c + \beta_f \text{ she yes / he no }_{ic} + \beta_m \text{ she no / he yes }_{ic} \\
&+ \beta_a \text{ Agree }_{ic} + \beta_3 X + \varepsilon_{ic},
\end{aligned}
$$

where $\overline{\text{Co-residence}}_c$ is the county-level leave-one-out average of the total number of co-residence households, the vector X denotes control variables including the number of children, mean age of women, mean age of men, the average level of educational attainment of all the women, and the average level of educational attainment of all the men within the household.

term used in GMM estimation is specified as:

$$\varepsilon_j^k = w_j^k - (a_j^{k0} + a_j^{k1}\mathbf{Z}_j + b_j^k x_j + c_j^k x_j^2), \tag{10}$$

where $j = \{w, m, e\}$, $\mathbf{Z}_j$ is the vector of an individual's demographic characteristics, including the variables listed in Table 2, such as age, education, household composition, and place of residence, and x_j is the log expenditure for the individual j. The parameters a_j^{k0}, b_j^k, and c_j^k are scalars, and a_j^k is a vector of parameters. The constraint that individual j's budget shares sum to one is imposed by adding up the restrictions $\sum_{k=1}^K a_j^{k0} = \mathbf{1}$, $\sum_{k=1}^K b_j^k = \mathbf{0}, \sum_{k=1}^k c_j^k = \mathbf{0}$, and $\sum_{k=1}^K a_j^{k1} = \mathbf{0}$, where $\mathbf{0}$ is a vector of zeros and $\mathbf{1}$ is a vector of ones. To account for the housing market condition, I additionally include the log of the housing price index at the province level[23] and interact with the ownership status (whether the house is owned by the adult couple or the elderly) to allow for heterogeneous impacts on household consumption preferences.

Plugging (10) in (7), I obtain the following equation for extended families h and for goods k. The error term from (9) is specified as:[24]

$$\begin{aligned}\varepsilon_{f,h}^k = W_{f,h}^k - \sum_j n_{j,f,h}\eta_{j,f}(\mathbf{Z}_h)[a_j^{k0} + a_j^{k1}\mathbf{Z}_h + \delta_{j,f}^k + b_j^k(x_{f,h} + \ln\eta_{j,f}(\mathbf{Z}_h) - \ln d_{j,f}(\mathbf{Z}_h)) \\ + c_j^k(x_{f,h} + \ln\eta_{j,f}(\mathbf{Z}_h) - \ln d_{j,f}(\mathbf{Z}_h))^2].\end{aligned} \tag{11}$$

I specify the resource sharing rule $\eta(\mathbf{Z})$ and economies of scale function $d(\mathbf{Z})$ as:[25]

$$\begin{aligned}\eta_{j,f}(\mathbf{Z}_h) &= k_{j,0} + k'_{j,f,1}\mathbf{Z}_h + k_{j,2}f_h \\ d_{j,f}(\mathbf{Z}_h) &= m_{j,f,0} + m'_{j,f,1}\mathbf{Z}_h,\end{aligned} \tag{12}$$

where f_h is the co-residence decision for the extended family h. Following the constraint that resource shares sum to one, I impose $\sum_{j\in\{w,m,e\}} k_{j,0} = 1$, $\sum_{j\in\{w,m,e\}} k_{j,f,1} = 0$, and $\sum_{j\in\{w,m,e\}} k_{j,2} = 0$.

Following Calvi et al. (2023), I make several simplifications to ensure convergence: First,

[23] The housing price index is obtained from the 2014 China Statistical Yearbook downloaded from http://www.stats.gov.cn/tjsj/ndsj/2014/zk/html/Z0506e.htm. I admit that housing price variation in China is at a finer level than the province level. However, the Statistical Yearbook data is the only publicly available data source containing housing price information of all regions in China.

[24] The vector of $\mathbf{Z}_h$ includes variables listed in Table 3, such as age, education, household composition, and place of residence.

[25] Specifically, when $f = 0$, i.e., in a non-coresidence family, j can only take the value of m or w. For the case of $f = 1$, i.e., in a coresidence-type family, j can then take the value of m, w, or e.

I assume that preferences for goods are similar across household member categories, i.e., $a_j^{k1} = a^{k1}$, $b_j^k = b^k$ and $c_j^k = c^k$. Second, I estimate a single scale economy parameter for each household type, i.e., $d_{j,f} = d_f$, which means that I assume any gains from joint consumption are equally shared among all household members. This assumption amounts to $m_{j,f,0} = m_{f,0}$ and $m_{j,f,1} = m_{f,1}$. Third, I specify $\eta_{j,f}$ and $d_{j,f}$ using an inverse logistic function that guarantees they are bounded between zero and one as specified in (13). To deal with the issue of multiple local minima and ease computation, I further scale age variables by dividing by 10. This gives

$$\begin{aligned} \eta_{j,f}(\mathbf{Z}_h) &= \frac{\exp(k_{j,0} + k'_{j,f,1}\mathbf{Z}_h + k_{j,2}f_h)}{n_{j,f}\sum_j \exp(k_{j,0} + k'_{j,f,1}\mathbf{Z}_h + k_{j,2}f_h)} \\ d_f(\mathbf{Z}_h) &= \frac{\exp(m_{f,0} + m'_{f,1}\mathbf{Z}_h)}{1 + \exp(m_{f,0} + m'_{f,1}\mathbf{Z}_h)} \end{aligned} \tag{13}$$

I then construct the vector of functions $\phi(v,z)$ in (9) as the cross products of the instruments with the vector of household characteristics following Lewbel and Pendakur (2022). Specifically, I specify $\phi(v,z) = (1, \mathbf{Z_h}) \times (1, \mathbf{v})$, where $\times$ indicates element-wise multiplication, deleting redundant elements.

I have a total of 255 parameters to estimate from 388 moments, giving a maximum degree of freedom of 133 of the most general model. I follow a two-stage GMM estimation procedure starting with an identity matrix and perform grid searches over a wide range of starting values.[26] I select the estimates corresponding to the minimum value of the GMM objective function.

Pre-estimation Tests. Following Assumption 6, one needs enough curvature between the budget share and the log expenditure for a particular household consumption goods. I conduct a pre-estimation test to check the validity of this assumption before fully estimating the collective household model. Specifically, I follow:

$$W_f^k = \alpha_0 + \left(X_f, X_f^\tau\right)'\alpha + \left(X_f, X_f^\tau\right)'\beta x_f + \left(X_f, X_f^\tau\right)'\gamma x_f^2 + \varepsilon_f, \tag{14}$$

where W_f^k is the household budget share of type f for goods k, X_f is a vector of socioeconomic characteristics of type f household, including age, education, and whether live in the urban region, X_f^τ is a vector of household composition variables of type f household, includ-

[26] Similarly as Browning et al. (2013), I adopt a one-step procedure by estimating the preference parameters of the singles jointly with the sharing rule and the economy of scales, which has been proven to be far more accurate than a two-step estimator, where I first estimate the preference parameters using singles and then plug them into (11) to estimate the economy of scales and sharing parameters.

ing number of men, number of women, number of children, and number of the elderly. One thing worth mentioning here is that though this model framework cannot separately identify children's resource shares from the data, I interpret the estimates as the resources controlled by the adults in the household without the need to recover individual-level resource shares for children. Table C2 shows the pre-estimation test results of (14). Food, housing, and clothing display the highest degree of curvature among the consumption goods. I also use a local polynomial approximation to visualize the curvature of the Engel curves for the five categories, as illustrated in Figure C5. The patterns from the graphs provide solid evidence for the existence of curvature, suggesting the validity of Assumption 6 with the CFPS data.

5 Results

5.1 Estimated Individual Resource Shares and Economies of Scale

Table 4 presents selected summary statistics for the estimated women's, men's, and elderly's resources shares as well as economies of scale. Recall that these are estimated conditional on a set of observable household characteristics and composition variables. The coefficients for each variable and the corresponding standard errors are presented in Appendix Tables C3 and C4.

The top panel of Table 4 reports the estimates for the adult couple households, while the bottom panel reports the results for extended families. In adult couple families, men tend to consume more than women. The same pattern is detected for extended families, where men consume more than women, and the resource share of the elderly ranks the lowest. Recall that resource shares, which are closely related to Pareto weights, are often interpreted as measures of the bargaining power of each household member. However, they are also determined by altruism (Dunbar et al., 2021). When living with the elderly, women's resource share drops far more than men, implying that women tend to be more altruistic towards the elderly in consumption sharing than men.

Regarding the estimated economies of scale, as described in Section 3, scale economies measure the cost-savings experienced by individuals from living in a household of a composition relative to living in a reference household (i.e., single-adult households), and lower values imply greater consumption sharing. From the estimates, co-residence indeed helps gain economies of scale compared to non-coresidence families. For adult couple households, there is a minimum efficiency gain relative to single adult households as the economy of scale is close to 1. In contrast, for extended families, the mean of the scale economy is smaller and estimated to be 0.732. The scale economy is larger than 0.5, suggesting that even after accounting for the housing market conditions, cultural factors may still outweigh economic factors for Chinese households. Formally speaking, the number means that, on average, the total household expenditure is scaled up by approximately 37.7 percent (1/0.732) relative to the single adult households. This implies that the cost of living faced by an individual in the average extended family household is 62.3 percent of what is faced by an individual living alone.

5.2 Post-estimation Analysis

5.2.1 Compare with Survey Measures

To fully utilize the richness of the CFPS data, in this section, I compare the estimated individual resource shares with the self-reported decision-making process exported from the survey measures. In CFPS, there is a household decision panel asking mainly about decision-makers regarding various aspects, including family expenditure.[27] As discussed in Jayachandran et al. (2021) and Calvi et al. (2022), this exercise can serve as a cross-check to the model-based measures of individual bargaining power indicated by individual resource shares.

Figure 3 shows the comparison results. It illustrates that the model-based measures of bargaining power are indeed valid and can represent the actual household decision-making process to some extent. Specifically, I plot the density distribution of the estimated resource shares for men (Panel A), women (Panel B), and the elderly (Panel C) separately. On top of each histogram, I also draw a solid red line representing the proportion of each type of individual (men/women/elderly) reported being the decision-maker on household expenditure, which is directly obtained from the survey responses. For all three categories of individuals, the mean of the estimated resource shares is close to the survey responses of that particular type of individual being the decision-maker on household expenditure.

5.2.2 Individual Resource Shares and Spousal Attitudes

In this section, I link the full sample estimates with spousal attitudes to explore the association between individual resource shares, particularly among the elderly, and individual responses to

[27]The question is formulated as “Who makes the decision regarding family expenditure?”

the survey questions as described in Section 2.

Figure 4 shows the pattern of the average elderly resource shares by spousal attitudes. Panel A depicts the pattern across the entire sample, regardless of living arrangement settings (i.e., whether with the husband's or wife's parents). Panel B shows the pattern for households that live with the husband's parents only.[28] We can see that, for both scenarios, elderly resource shares reach the highest value when the husband and wife both agree with the argument. There does not appear to be a significant difference between other groups. Men appear to have more bargaining power than women when it comes to deciding resource shares for the elderly because resource shares for the elderly are lowest when men do not agree. Figure 5 shows the pattern of elderly resource shares by living arrangement setting. As shown in Panel A, the husband's parents, on average, have a higher resource share than the wife's parents, which is consistent with the patriarchic culture in China. When focusing on families that live with the husband's parents, as shown in Panel B, we cannot detect a significant disparity in spousal attitude.

As discussed in Calvi et al. (2022), the resource share of the woman relative to her husband can be considered a measure of intra-household bargaining power. Thus, I further explore the pattern of *resource share ratio* by the presence of senior members in the household in Figure 6. We can see that living with elderly parents exacerbates the intra-household inequality between the adult couple, which is likely owing to the fact that the majority of co-residence families live with the husband's parents.

Motivated by Cherchye et al. (2012) and Lin (2019), I also investigate the heterogeneity of elderly resource shares by their status: widow or widower, as shown in Figure 7. Consistent with their findings, I find that, on average, a widower consumes more resources than a widow. This gender disparity again highlights the important role of bargaining power within households. I additionally look into the association between the elderly resource share and whether they are the house owner. Figure C6 shows that when the elderly own the house, they have a larger estimated resource share within the household.

[28] Because the survey questions only inquire about the agreement to live with the husband's parents, I hereby only show the results for those living with the husband's parents. Moreover, living with the husband's parents accounts for more than 85% of the co-residence family sample.

5.2.3 Poverty Analysis

Another advantage of this method is to recalculate poverty measures by taking intrahousehold allocation and economies of scale into account. Standard measures of poverty, e.g., per-capita metrics from the World Bank, disregard intrahousehold allocation and scale economies. Other approaches, such as OECD equivalence scales, deal with economies of scale in a largely atheoretical manner while ignoring intrahousehold inequality. Following Calvi et al. (2023), I proceed with conducting an individual-level poverty analysis using the structural estimates. I then compare poverty estimates based on different methods.

Table 5 summarizes the results for four different poverty measures. In Column (1), I report the poverty rates for men, women, children, and the elderly using the per-capita expenditure measure. I use the international poverty line recommended by the World Bank of 1.9 PPP dollars per day to calculate the poverty rates.[29] This approach implicitly assumes that everyone receives the same share of total household expenditure and that there is no consumption sharing. Due to its inability to account for intrahousehold inequality, one would always reach the conclusion that either everyone in a household lives below the poverty line or no one does, resulting in substantial biases when intrahousehold inequality is non-negligible. In Column (2), I report the equivalence scale-adjusted poverty rates. This measure adjusts household expenditure across household compositions using equivalence scales.[30] However, it still suffers from several drawbacks: (i) it avoids incorporating intrahousehold allocations, (ii) the assumptions that are used to construct equivalence scales tend to be *ad hoc* and are difficult to verify, and (iii) equivalence scales equate the utility of an individual to the utility of a household. However, theoretically, individuals, not households, have preferences. And hence, equivalence scales suffer from fundamental identification issues associated with interpersonal comparisons of utility. To construct this measure, I follow the OECD scale to divide household expenditure by $1+0.7\,(1-n_a)+0.5n_c$, where n_a represents the number of adults and n_c represents the number of children. Columns (3) and (4) report the model-based poverty rates. The poverty rates reported in Column (3) account for the estimated resource allocation among family members, but not economies of scale, whereas poverty rates in Column (4) account for both dimensions.

[29] An individual is classified as poor if their household per-capita expenditure is less than US$1.90/day. In practice, I use the PPP conversion factor published by the World Bank to transfer to the Chinese Yuan. See https://www.indexmundi.com/facts/china/ppp-conversion-factor.

[30] According to Chiappori (2016), an equivalence scale is defined as the household expenditure divided by the expenditure of a single person that enjoys the same standard of living (i.e., the same utility level) as in the household.

To calculate individual expenditure, I multiply total annual household expenditure by estimated individual resource shares. Individual consumption is obtained by dividing individual expenditure by the estimated scale economies.

As shown in Table 5, the poverty rate for the elderly is universally higher than for men and women, which is in line with Calvi (2020), who find that an individual's bargaining power declines with age. Comparing different poverty measures, the OECD equivalence scale delivers substantially lower poverty rates than individual consumption, suggesting that this scale may over-correct for economies of scale. Furthermore, poverty rates for women and the elderly are more likely to be underestimated by the international poverty line based on the conventional per-capita measure, but not for men. These findings suggest that intrahousehold inequality exists among Chinese households and that future poverty reduction policies should be better designed to target these underserved, for example, women and the elderly in the households.

Living Arrangements and Poverty of Elderly. I continue to explore patterns of poverty rates by living arrangements, with an emphasis on the elderly. Table 6 delivers a general pattern that living alone is associated with lower poverty rates for the elderly. It is likely that when the elderly prefer to live apart, their higher absolute income provides a greater likelihood that they can do so, which leads to lower poverty rates.[31] This finding is consistent with Guo et al. (2021), who find that empowering the elderly with pension payments reduces co-residence rates and increases the independence of the aging population. In contrast, those elderly who live with their adult children may have a higher chance of poor health status and bearing all sorts of disadvantages, thus resulting in higher poverty rates.

Taken together, the exercise of poverty measure recalculation reveals that more adult females and more elderly are underestimated by the international poverty line based on the conventional per-capita measure. The sharp discrepancy in poverty rates of the elderly by living arrangement settings, once taking into account resource sharing and economies of scale, again highlights the importance of measuring individual-level, not only household-level, welfare status. The insights into intrahousehold inequality call for more thoughtful policy decision-making, especially for this aging society.

[31] This is further confirmed from the raw data that those extended families indeed have lower overall incomes to start with.

6 Conclusion and Discussions

This study develops a new method to identify resource shares and scale economies without heavy data requirements — it only requires household-level consumption data, no private assignable goods consumption, and one price regime. I also establish the identification arguments in a conditional efficiency framework motivated by Lewbel and Pendakur (2022) relaxing the Pareto Optimality assumption of the traditional collective household models. Using data from a nationally representative household survey from China with detailed gender attitudes questions from both husband and wife, I further apply and empirically estimate the model to uncover intrahousehold resource allocation and the extent of joint consumption for households with different living arrangement settings.

The estimation results suggest that the elderly suffer a significant level of intrahousehold inequality, as they are allocated the least resource shares in household expenditures. Comparing different living arrangement settings, co-residence households indeed enjoy benefits in economies of scale compared to nuclear households. However, the estimated economies of scale suggest that economic efficiency gains may not be the whole story of why multi-generations live together in Chinese society and that social norm factors might still play a role in the living arrangement decisions. The reason why Chinese households choose to co-reside remains an open question and needs further investigation. Finally, I thoroughly explore the unique advantage of the individual-level estimates to correct measures of poverty rates by incorporating intrahousehold inequality and economies of scale in consumption.

The limitation of this paper is the absence of a model to capture the co-residence decision. The model assumes the elderly as pure "price takers." In other words, the current setup only allows the young couples to be the decision-maker, while the elderly are restricted to face *Take it or Leave it offers*. To relax this assumption, one may need to build a four-way bargaining model, which might be computationally challenging. Though emphasizing the welfare consequences of potential disagreement between the couples, this paper is limited in incorporating the possibility of getting divorced or other marriage dynamics at later stages. Instead, the model considers all actions as rather static. Extending to a dynamic procedure could be an intriguing exercise, but is out of the scope of current work.

Despite its limitations, this study advances our understanding of the causes and consequences of co-residence decisions by posing the issue from a unique intrahousehold perspective. Identification of individual-level resource shares is crucial in uncovering inequality within households. The lower level of consumption allocated to the elderly and women calls for more focused anti-poverty policies. For instance, future research could apply this method to quantify the pass-through of the 2009 China's New Rural Pension Scheme (NRPS).[32] The detailed breakdown of the pension received by senior members to the contribution of intrahousehold wealth inequality aids in better understanding the mechanisms of the pension program, providing insights for policy designs aimed at empowering the elderly. This study is also one of the first to systematically examine how economic and cultural factors interact to influence living arrangement decisions. The findings imply that in a developing country context, it is more likely that households will be constrained by persistent social norms when making decisions, resulting in efficiency loss. My study evaluating Chinese households is not a special case and may be easily applied to other societies, as households in the developing world are relatively larger in family sizes compared to developed countries and typically include several generations.

[32]The Chinese government launched a nationwide social pension program in 2009, the New Rural Pension Scheme (NRPS), to support the elderly in rural regions. According to Huang and Zhang (2021), the scheme significantly decreased the poverty rate in China and narrowed the rural-urban gap.

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Tables and Figures

Table 1: Comparison to Existing Literature

	Lewbel-Pendakur (2008)	Browning-Chiappori-Lewbel (2013)	Calvi et al (2023)	Lewbel-Pendakur (2022)	This Paper
Assumptions					
Conditional efficiency (A1 & A2)				✓	✓
BCL model (Pareto Efficient)	✓	✓	✓		
Preference Similarity Across Types (A5)	✓	✓	✓		✓
Preference Similarity Across People			✓	✓	
Non-linearity (A6)	✓	✓	✓		✓
Independence of Base (A3)	✓		✓		✓
Expenditure Invariance (A4)	✓		✓	✓	✓
Preference Stability Across Types (A5)	✓	✓			✓
Data Requirements					
Observability of Price Variation		✓			
Observability of Singles' Data	✓	✓			✓
Observability of Assignable Goods			✓	✓	
Identified Objects					
Resource Shares for Adults	✓	✓	✓	✓	✓
Scale Economies for Adults	✓	✓	✓		✓
Indifference Scales for Adults	✓	✓	✓		✓
Resource Shares for Children			✓	✓	
Scale Economies for Children			✓		
Indifference Scales for Children			✓		

Note: This table summarizes the identification conditions, data requirement, and results of the relevant literature, as well as the contribution of this paper to the literature. Similarity Across Types is a weaker version of Preference Stability Across Types. Any method requiring Preference Stability Across Types implicitly assumes Similarity Across Type (Calvi et al., 2023).

Table 2: Summary Statistics–Singles

	Single woman				Single man				Single elderly			
	Mean	Median	Std.Dev	N	Mean	Median	Std.Dev	N	Mean	Median	Std.Dev	N
Budget food	0.382	0.381	0.189	442	0.459	0.458	0.188	428	0.492	0.512	0.221	501
Budget housing	0.150	0.092	0.157	442	0.140	0.094	0.146	428	0.147	0.106	0.142	501
Budget health care and medical expense	0.093	0.036	0.150	442	0.061	0.018	0.123	428	0.180	0.095	0.207	501
Budget clothing	0.178	0.142	0.142	442	0.145	0.120	0.107	428	0.090	0.065	0.091	501
Budget recreation and education	0.197	0.148	0.162	442	0.195	0.151	0.148	428	0.090	0.047	0.126	501
# of women	1.000	1.000	0.000	442	.	.	.	428	.	.	.	501
# of men	.	.	.	442	1.000	1.000	0.000	428	.	.	.	501
# of elderly	.	.	.	442	.	.	.	428	1.000	1.000	0.000	501
# of children	0.495	0.000	0.766	442	0.131	0.000	0.418	428	0.090	0.000	0.360	501
Average age women	39.871	42.000	11.698	442	.	.	.	0	.	.	.	0
Average age men	.	.	.	0	38.252	38.000	12.549	428	.	.	.	0
Average age elderly	.	.	.	0	.	.	.	0	71.521	71.000	7.775	501
Average age children	9.266	9.500	3.473	155	8.919	8.500	4.035	43	9.995	10.000	3.026	34
Average educ women	2.520	2.000	1.907	442	.	.	.	0	.	.	.	0
Average educ men	.	.	.	0	2.962	3.000	1.554	428	.	.	.	0
Average educ elderly	.	.	.	0	.	.	.	0	2.808	2.000	2.644	501
$\mathbb{1}$(Urban)	0.468	0.000	0.500	442	0.533	1.000	0.500	428	0.475	0.000	0.500	501

Note: This table reports some descriptive statistics of the single-adult households used in estimation. Expenditure data based on annual recall. Individual education ranges from 1 (illiterate/semi-literate) to 8 (doctoral degree). Source: China Family Panel Studies (CFPS) 2014.

Table 3: Summary Statistics–Adult Couple and Extended Family

	Adult couple				Co-residence family			
	Mean	Median	Std.Dev	N	Mean	Median	Std.Dev	N
Budget food	0.404	0.401	0.186	1796	0.399	0.388	0.183	714
Budget housing	0.145	0.092	0.154	1796	0.132	0.079	0.152	714
Budget health care and medical expense	0.088	0.037	0.134	1796	0.118	0.062	0.148	714
Budget clothing	0.158	0.124	0.127	1796	0.148	0.118	0.122	714
Budget recreation and education	0.206	0.165	0.152	1796	0.202	0.178	0.133	714
# of women	1.000	1.000	0.000	1796	1.000	1.000	0.000	714
# of men	1.000	1.000	0.000	1796	1.000	1.000	0.000	714
# of elderly	.	.	.	1796	1.490	1.000	0.528	714
# of children	0.771	1.000	0.862	1796	1.134	1.000	0.845	714
Average age women	43.187	44.000	8.806	1796	39.255	38.000	8.558	714
Average age men	44.756	45.000	8.864	1796	39.543	39.000	7.780	714
Average age elderly	.	.	.	0	69.598	67.750	7.781	714
Average age children	9.347	9.500	3.618	976	9.142	9.500	3.482	539
Average educ women	1.134	1.000	0.775	1796	0.657	0.600	0.439	714
Average educ men	1.195	1.000	0.646	1796	0.690	0.600	0.363	714
Average educ elderly	.	.	.	0	0.850	0.600	0.755	714
$\mathbb{1}$(Urban)	0.507	1.000	0.500	1796	0.462	0.000	0.499	714

Note: This table reports some descriptive statistics of the adult-couple and co-residence households used in estimation. Adult-couple households are two-parent families with or without children. Co-residence households are those nuclear families living with elderly parents. Expenditure data based on annual recall. Individual education ranges from 1 (illiterate/semi-literate) to 8 (doctoral degree). Source: China Family Panel Studies (CFPS) 2014.

Table 4: Estimated Resource Shares and Scale Economies

	Obs.	Mean	Median	Std. Dev
Adult couple households				
Resource shares: η				
Men	1796	0.604	0.611	0.073
Women	1796	0.396	0.389	0.073
Scale economies: d	1796	0.962	0.963	0.020
Co-residence households				
Resource shares: η				
Men	714	0.680	0.724	0.182
Women	714	0.245	0.192	0.193
Elderly	714	0.052	0.024	0.082
Scale economies: d	714	0.732	0.746	0.125

Note: The table shows selected summary statistics for the estimated men's, women's, and elderly's resources shares as well as economies of scale. Estimates are conditional on a set of observable household characteristics and composition variables. Coefficients for each variable and the corresponding standard errors are presented in Appendix Tables C3 and C4. Source: China Family Panel Studies (CFPS) 2014.

Table 5: Poverty Rates by Measure

	Obs	Per-capita Expenditure	Equivalent Expenditure	Individual Expenditure	Invividual Consumption
Men	2938	0.026	0.013	0.009	0.007
Women	2952	0.026	0.013	0.064	0.047
Elderly	1565	0.043	0.022	0.288	0.259
Children	2515	0.044	0.018		

Note: The table presents the poverty rates for the estimation sample using four approaches: household per-capita expenditure, household expenditure adjusted using the OECD equivalence scale, model-based individual expenditure, and model-based individual consumption. Per-capita expenditure is obtained by dividing total household expenditure by the number of individuals in the household. Equivalent expenditure is calculated by dividing total household expenditure by $1+0.7*(n_m+n_w+n_e-1)+0.5*n_c$ where n_j gives the number of men, women, elderly, and children for $j=m,w,e,c$, respectively. Individual expenditure is obtained by multiplying total annual household expenditure by individual resource shares. Individual consumption is obtained by dividing individual expenditure by scale economies. Poverty rates are based on the US$1.90/day poverty line. Source: China Family Panel Studies (CFPS) 2014.

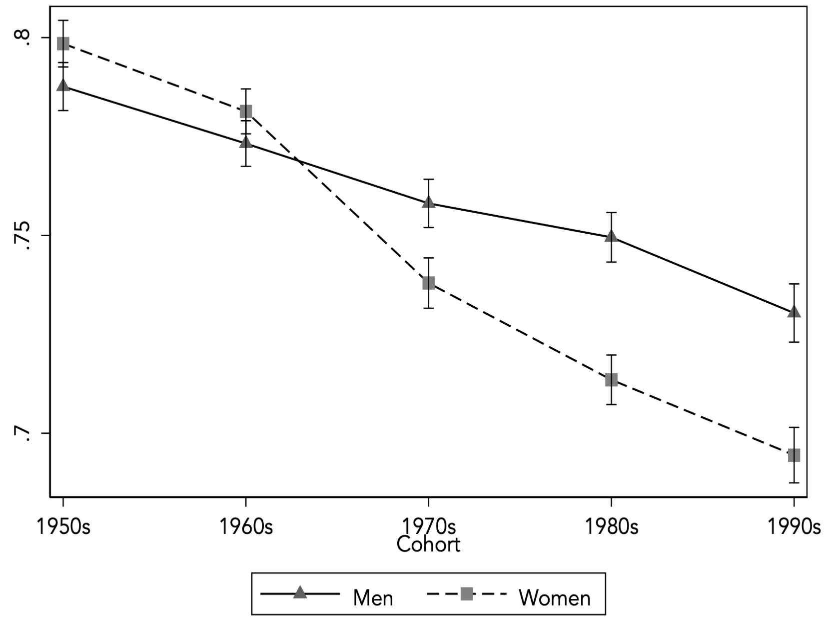
Table 6: Poverty Rates of the Elderly by Living Arrangements

	Obs	Per-capita Expenditure	Equivalent Expenditure	Individual Expenditure	Individual Consumption
Living alone	501	0.022	0.018	0.022	0.022
Co-residence	1064	0.054	0.024	0.413	0.370

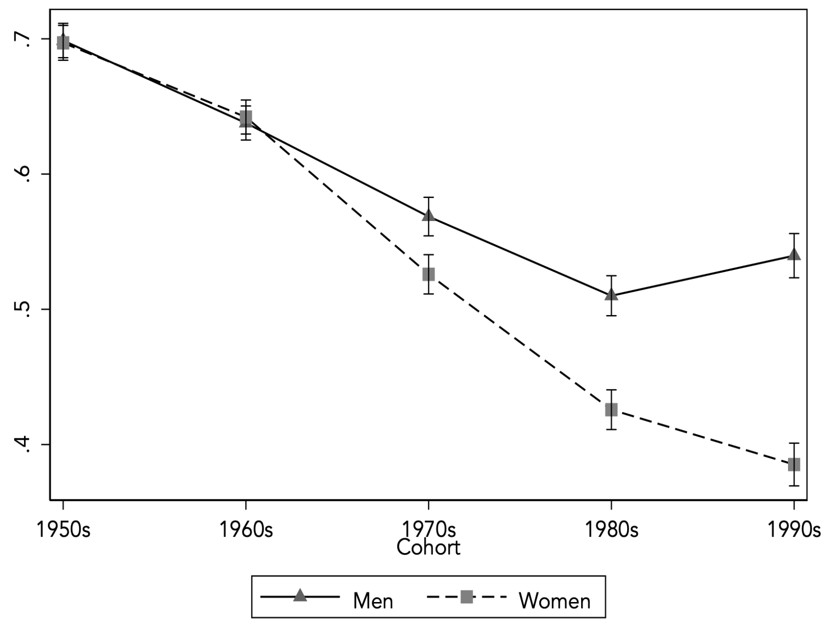
Note: The table presents the poverty rates of the elderly by living arrangements. The four measures are defined based on the same methods in Table 5. Poverty rates are based on the US$1.90/day poverty line. Source: China Family Panel Studies (CFPS) 2014.

Figure 1: Trend on Filial Piety and Son Preference

Panel A. Filial Piety

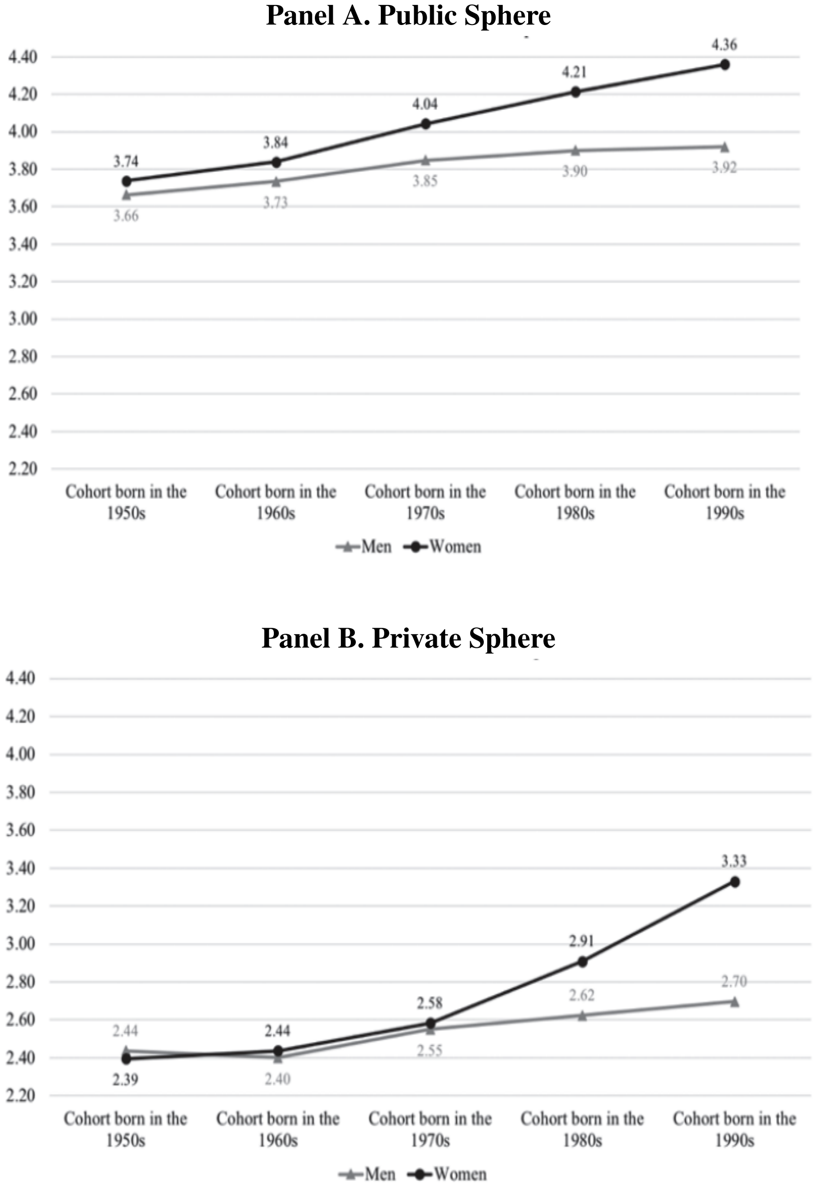


Panel B. Son Preference



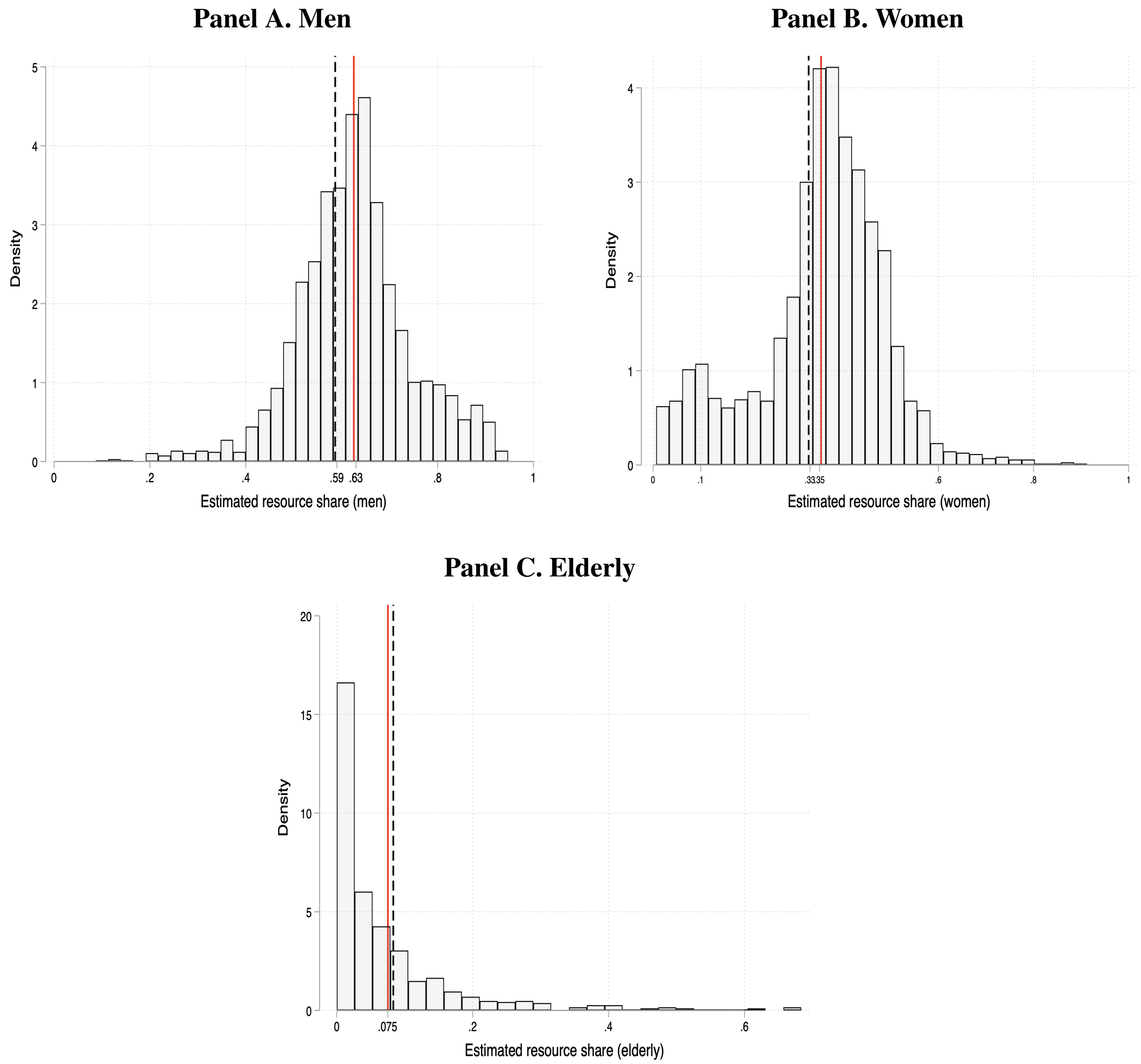
Note: Panel A describes the cohort trend of standardized filial piety separately for men and women. The number is the aggregate score from five questions listed in Appendix B. A higher number implies more obedience to traditional filial piety, while a lower number implies less obedience. Panel B describes the standardized son preference measures ranging from 0 to 1. A higher value implies a higher degree of son preference. Source: China Family Panel Studies (CFPS) 2014.

Figure 2: Gender Attitudes in the Public and Private Sphere



Note: This figure is from Qian and Li (2020). Panel A describes the gender ideology measures in the labor market (public sphere). The question is stated as "when the economy is bad, female employees should be fired first." The answers range from 1 to 5, with 1 indicating complete agreement with inegalitarian gender conditions, 3 meaning neutral, and 5 representing complete disagreement (and, therefore, indicating more gender egalitarianism). Panel B describes the gender ideology measures in the family (private sphere). Respondents were asked whether they agreed that "men should put career first, whereas women should put family first." The answers range from 1 to 5, with 1 indicating complete agreement with inegalitarian gender conditions, 3 meaning neutral, and 5 representing complete disagreement (and, therefore, indicating more gender egalitarianism). Source: Chinese General Social Survey (CGSS) data from 2010, 2012, 2013, and 2015.

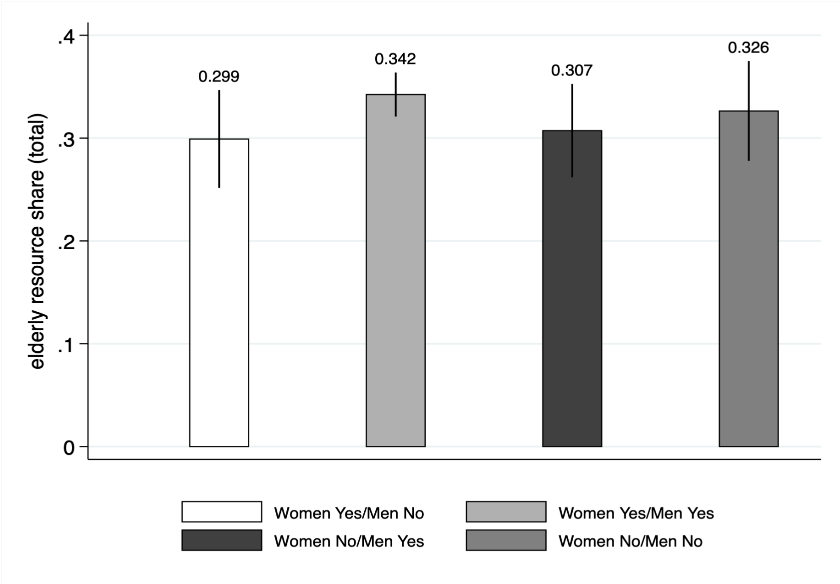
Figure 3: Compare with Survey Measures



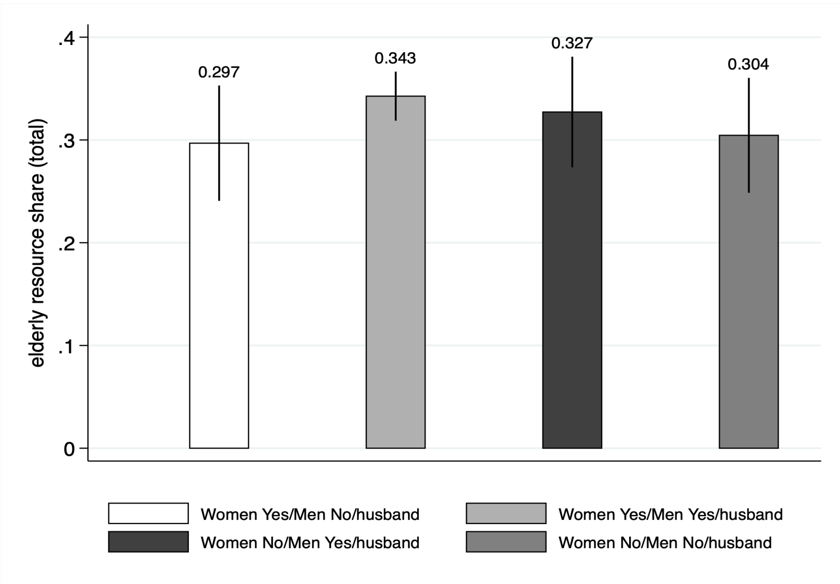
Note: This figure shows the results of comparing the model estimates of the individual resource shares with the survey responses from the CFPS Household Decision Panel. The histogram is the density distribution of the estimated resource shares. The red solid line is the mean of the estimated resource share. The black dashed line is the proportion of men/women/elderly being the decision maker in the study sample according to the survey responses. Source: China Family Panel Studies (CFPS) 2014.

Figure 4: Attitudes and Elderly Resource Shares

Panel A. by attitudes

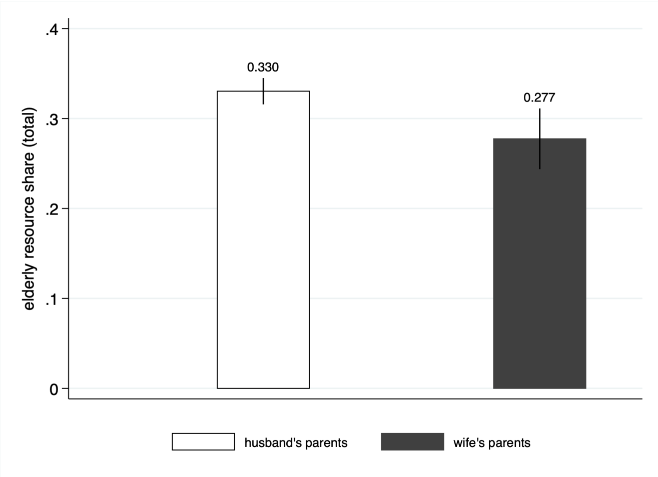


Panel B. by attitudes (live with husband's parents)

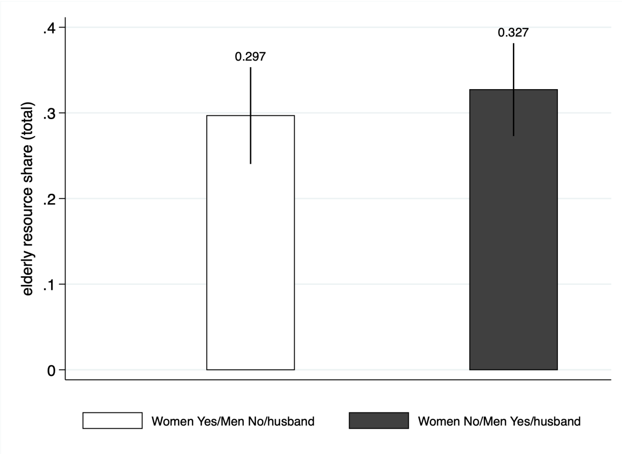


Note: This figure shows the mean elderly resource shares by spousal attitudes, i.e., their agreement on whether son should live with his parents after marriage. Panel A shows the pattern for the entire sample, regardless of the living arrangement setting. Panel B shows the pattern for the households that live with the husband's parents. The solid line on top of the histogram denotes the 95% confidence interval. Source: China Family Panel Studies (CFPS) 2014.

Figure 5: Living Arrangement and Elderly Resource Shares



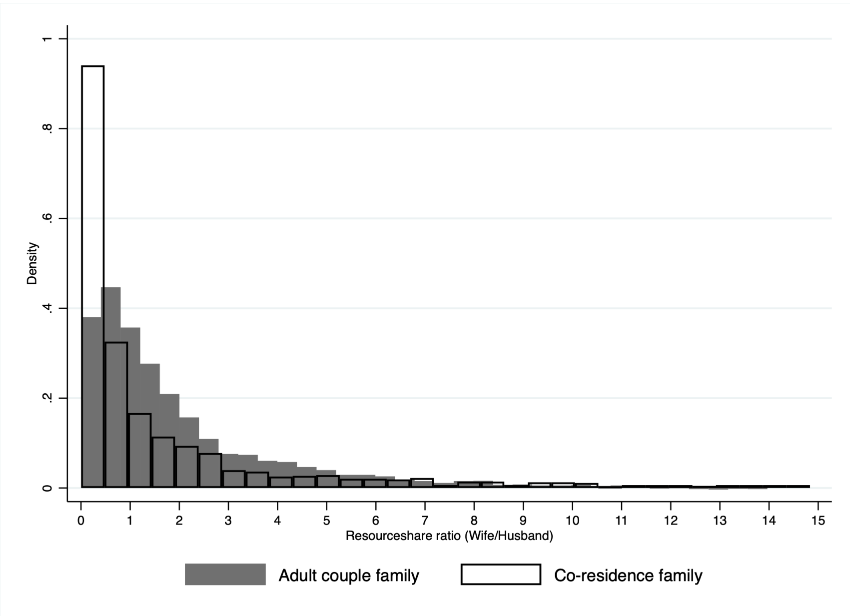
Panel A. by living arrangement



Panel B. by attitudes (live with husband's parents)

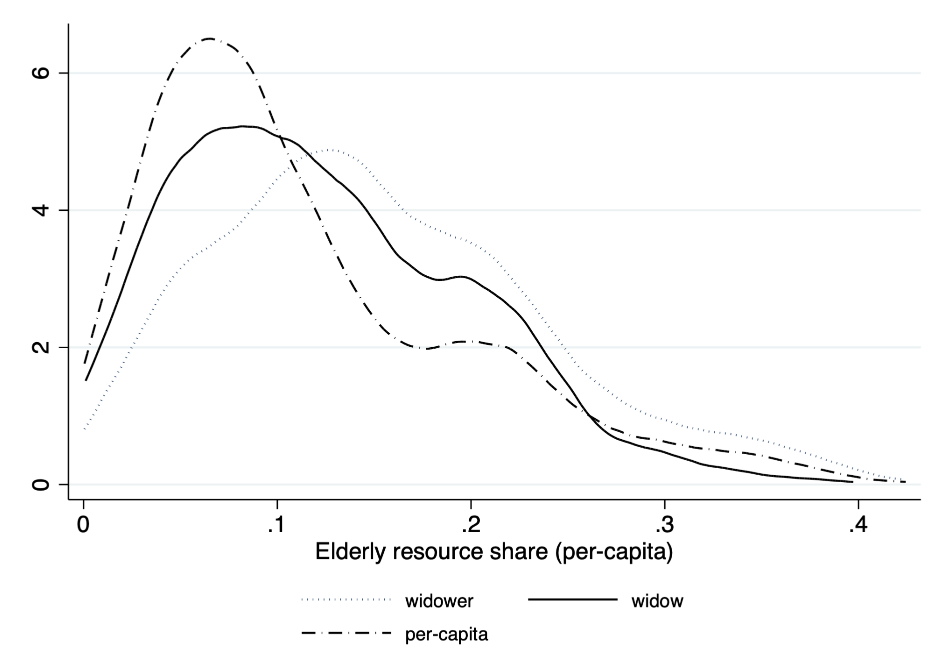
Note: This figure shows the mean elderly resource shares by detailed living arrangement settings. Panel A shows the pattern of living with the husband's or the wife's parents. Panel B further breaks down by spousal attitudes of those households who live with the husband's parents. The solid line on top of the histogram denotes the 95% confidence interval. Source: China Family Panel Studies (CFPS) 2014.

Figure 6: Living Arrangement and Resource Share Ratio (Wife/Husband)



Note: This figure shows the empirical distributions of the estimated resource share ratio by living arrangement settings. The numerator of the ratio is the wife's resource share, while the denominator of the ratio is the husband's resource share. Source: China Family Panel Studies (CFPS) 2014.

Figure 7: Resource Shares for Widow and Widower



Note: This figure plots the density distributions of resource shares for widow (solid line) and widower (short dashed line). I also plot the distribution of per-capita elderly resource shares (long dashed line) for comparison purposes. Source: China Family Panel Studies (CFPS) 2014.

APPENDIX

A Proofs

A.1 Proof of Lemma 2

Proof. According to the definition of indifference scales in (3),

$$V_j\left(\alpha_1+h,x+\ln\eta_{j,1}\right)=V_j\left(\alpha_0+h,x+\ln\eta_{j,0}-\ln I_{j,1,0}\right).$$

Following (4),

$$V_j\left(\alpha_1+h,x+\ln\eta_{j,1}\right)=V_j\left(\alpha_0+h,x+\ln\eta_{j,1}-\ln d_{j,1}+\ln d_{j,0}\right).$$

Therefore,

$$V_j\left(\alpha_0+h,x+\ln\eta_{j,1}-\ln d_{j,1}+\ln d_{j,0}\right)=V_j\left(\alpha_0+h,x+\ln\eta_{j,0}-\ln I_{j,1,0}\right),$$

which is equivalent to

$$\ln I_{j,1,0}=\ln\eta_{j,0}-\ln\eta_{j,1}+\ln d_{j,1}-\ln d_{j,0}.$$

□

A.2 Proof of Theorem 1

Proof. Let y be household expenditure with $x=\ln y$. Define $\Omega_f^k(y)=W_f^k(x)$, $\omega_{j,f}^k\left(y\eta_{j,f}/d_{j,f}\right)=w_{j,f}^k\left(x+\ln\eta_{j,f}-\ln d_{j,f}\right)$. Identification will come from the derivatives of the Engel curves, so let $v_{j,f}^k(y)=\nabla_y\omega_{j,f}^k(y)$ and $\zeta_{j,f}^k(y)=\nabla_y^2\omega_{j,f}^k(y)$.

I first begin with the case of $f=0$. Under a single price regime, Assumption 4, and (6), the household-level budget shares for goods k are given by:

$$\Omega_0^k(y)=\sum_j n_j\eta_{j,0}\left[\delta_{j,0}^k+\omega_{j,0}^k\left(\frac{\eta_{j,0}y}{d_{j,0}}\right)\right].\tag{15}$$

Differentiating (15) with respect to y and following Assumption 5 gives:

$$\nabla_y \Omega_0^k(y)\Big|_0 = \sum_j n_j \frac{\eta_{j,0}^2}{d_{j,0}} v_j^k(0).$$

Differentiating again produces:

$$\nabla_y^2 \Omega_0^k(y)\Big|_0 = \sum_j n_j \frac{\eta_{j,0}^3}{d_{j,0}^2} \zeta_j^k(0).$$

I then re-write these two equations in matrix form:

$$\begin{aligned}
\nabla_y \Omega_0^k(y)\big|_0 &= \left[\partial M(y)/\, \partial y|_{y=0}\right] \left[n_1 \frac{\eta_{1,0}^2}{d_{1,0}}, \ldots, n_J \frac{\eta_{J,0}^2}{d_{J,0}}\right]' \\
\nabla_y^2 \Omega_0^k(y)\big|_0 &= \left[\partial^2 M(y)/\, \partial y^2|_{y=0}\right] \left[n_1 \frac{\eta_{1,0}^3}{d_{1,0}^2}, \ldots, n_J \frac{\eta_{J,0}^3}{d_{J,0}^2}\right]',
\end{aligned}$$

where $M(y)$ denote the K by J matrix with the element in the $k'th$ row and $j'th$ column being $\omega_j^k(y)$. Both household-level budget shares $\Omega_0^k(y)$ and $\omega_j^k(y)$ can be observed from the data. Since the derivatives of $M(y)$ in these equations have full column rank following Assumption 6, these equations can be solved for the vectors $\left[n_1 \frac{\eta_{1,0}^2}{d_{1,0}}, \ldots, n_J \frac{\eta_{J,0}^2}{d_{J,0}}\right]$ and $\left[n_1 \frac{\eta_{1,0}^3}{d_{1,0}^2}, \ldots, n_J \frac{\eta_{J,0}^3}{d_{J,0}^2}\right]$, which are then be expressed entirely in terms of derivatives of the functions $\Omega_0^k(y)$ and $\omega_j^k(y)$ evaluated at $y = 0$ which are identified. Dividing each element in the second of these vectors by the corresponding element in the first yields the vector $[\frac{\eta_{1,0}}{d_{1,0}}, \ldots, \frac{\eta_{J,0}}{d_{J,0}}]$. Substitute the vector into the coefficient vector of the first-order derivative of $\Omega_0^k(y)$ gives $[\eta_{1,0}, \ldots, \eta_{J,0}]$, which further helps identity $[d_{1,0}, \ldots, d_{J,0}]$.

For households of $f = 1$, similarly, I can get:

$$\Omega_1^k(y) = \sum_j n_j \eta_{j,1} \left[\delta_{j,1}^k + \omega_{j,1}^k \left(\frac{\eta_{j,1} y}{d_{j,1}}\right)\right].$$

So the first and second derivatives with respect to y follow:

$$\nabla_y \Omega_1^k(y)\Big|_0 = \sum_j n_j \frac{\eta_{j,1}^2}{d_{j,1}} v_j^k(0),$$

and

$$\nabla_y^2 \Omega_1^k(y)\Big|_0 = \sum_j n_j \frac{\eta_{j,1}^3}{d_{j,1}^2} \zeta_j^k(0).$$

Similarly, I can re-write these two equations in matrix form:

$$\begin{aligned}\nabla_y \Omega_1^k(y)\big|_0 &= \left[\partial M(y)/\,\partial y|_{y=0}\right]\left[n_1\frac{\eta_{1,1}^2}{d_{1,1}},\dots,n_J\frac{\eta_{J,1}^2}{d_{J,1}}\right]' \\ \nabla_y^2 \Omega_1^k(y)\big|_0 &= \left[\partial^2 M(y)/\,\partial y^2|_{y=0}\right]\left[n_1\frac{\eta_{1,1}^3}{d_{1,1}^2},\dots,n_J\frac{\eta_{J,1}^3}{d_{J,1}^2}\right]'.\end{aligned} \tag{16}$$

Based on the same argument for the derivation for the case of $f = 0$, dividing each element in the second of these vectors by the corresponding element in the first yields the vector $[\frac{\eta_{1,1}}{d_{1,1}},\dots,\frac{\eta_{J,1}}{d_{J,1}}]$. Substitute the vector into the coefficient vector of the first equation in (16), $\left[n_1\frac{\eta_{1,1}^2}{d_{1,1}},\dots,n_J\frac{\eta_{J,1}^2}{d_{J,1}}\right]$, I thus identity $[\eta_{1,1},\dots,\eta_{J,1}]$ and $[d_{1,1},\dots,d_{J,1}]$.

□

B Questions in China Family Panel Studies (CFPS) 2014

Do you agree with the following statements? The answers range from 1 to 5, with 1 indicating complete disagreement, 3 meaning neutral, and 5 representing complete agreement.

- **Filial Piety**
  - "Children should respect parents however bad they are treated by parents"
  - "Children should regularly visit their parents even though working outside home"
  - "Children should fulfill their parents' dreams instead of their own"
  - "People should strive for achievements to glorify their family name"
  - "A man should live with his parents after marriage"
- **Son Preference**
  - "Women should give birth to at least one boy to continue family lineage"
- **Gender Ideology**
  - "Men should focus on career, while women should focus on family"
  - "Marrying well is more important for women than doing well"
  - "Women should have at least one child"
  - "Men should do half of the housework"

C Supplementary Tables and Figures

Table C1: IV Test – "First Stage"

	Co-residence	Co-residence
Instruments for the co-residence decision f		
county-level (leave-one-out) average value of f	0.40***	0.40***
	(0.045)	(0.045)
she yes/he no	0.00083	
	(0.021)	
she no/he yes	-0.040*	
	(0.021)	
agree	0.047***	0.051***
	(0.013)	(0.013)
Covariates		
$\mathbb{1}$(urban area)	0.051***	0.051***
	(0.012)	(0.012)
number of children	-0.036***	-0.036***
	(0.0086)	(0.0086)
average age women	0.0013	0.0013
	(0.00092)	(0.00092)
average age men	-0.012***	-0.012***
	(0.00085)	(0.00085)
average education women	-0.080***	-0.080***
	(0.0077)	(0.0077)
average education men	-0.22***	-0.22***
	(0.010)	(0.010)
Constant	0.93***	0.92***
	(0.042)	(0.042)
Observations	3474	3474
R-squared	0.196	0.196
F-stats	133	167

Note: The table shows the results of the first stage estimation results for the validity of instruments for f, the co-residence decision. The outcome variable is the indicator of being a co-residence household. I report the linear probability model estimates, with standard errors clustered at the household level (* p<0.10, ** p<0.05, *** p<0.01). Source: China Family Panel Studies (CFPS) 2014.

Table C2: Pre-estimation Test Result

	Slope			Curvature		
	|T-stat|	25 percentile	Median	|T-stat|	25 percentile	Median
Food	2.212	1.248	1.839	2.300	1.341	1.972
Housing	2.358	1.343	2.321	2.461	1.443	2.401
Health care and medical expense	0.509	0.224	0.454	0.503	0.215	0.445
Clothing	2.233	1.677	2.343	2.294	1.714	2.418
Recreation and education	1.496	0.672	1.438	1.537	0.681	1.464

Note: The table shows OLS estimates of slope coefficients and curvature parameters of the fully-interacted linear regression model (14). I also report the t-statistics of the slope coefficients and curvature parameters as well as the 25 percentile and median of the empirical distributions. The predicted values are obtained from a regression of the budget shares for a particular category on preference factors $\left(X_f, X_f^\tau\right)'$, $\left(X_f, X_f^\tau\right)' x_f$, and $\left(X_f, X_f^\tau\right)' x_f^2$. Source: China Family Panel Studies (CFPS) 2014.

Table C3: GMM Estimates of Resource Shares and Scale Economies – Adult Couple Households

	Adult couple			
	Resource Shares		Scale Economies	
	Women			
	Estimate	SE	Estimate	SE
Average educ women	0.101	(0.0007)	-0.160	(0.0003)
Average educ men	-0.254	(0.0007)	0.640	(0.0003)
Average educ elderly				
Average age women	0.394	(0.0017)	0.150	(0.0011)
Average age men	-0.150	(0.0017)	-0.096	(0.0011)
Average age elderly				
$\mathbb{1}$(Urban)	0.360	(0.0004)	0.077	(0.0001)
# of children	-0.035	(0.0010)	0.308	(0.0002)
# of elderly				
$\mathbb{1}$(Housing owned by the adult couple)	0.333	(0.0004)	-0.181	(0.0003)
Logged housing price (province level)	-0.355	(0.0018)	0.521	(0.0011)
$\mathbb{1}$(housing ownership) $\times$ logged housing price	-0.142	(0.0018)	-0.157	(0.0012)
Constant	0.435	(0.0004)	0.471	(0.0002)
N	1796			

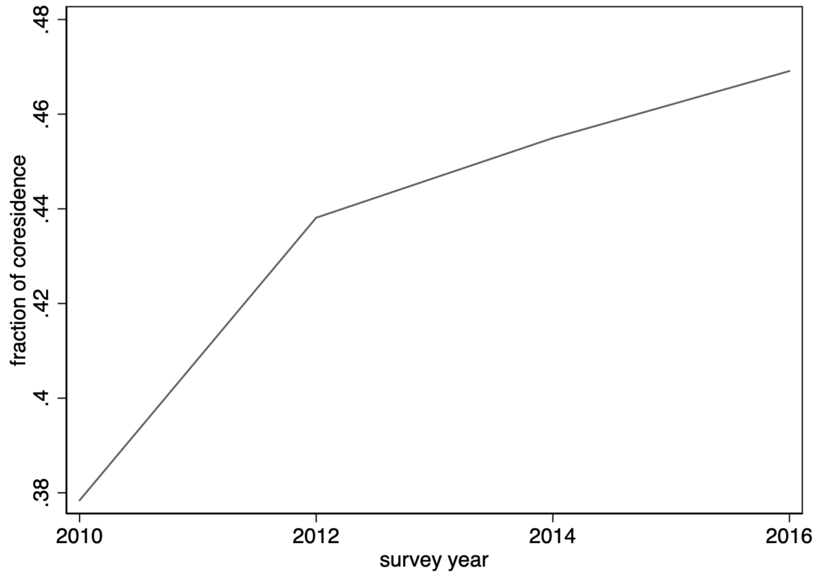
Note: The table reports the 2-step GMM estimates conditional on a set of observable household characteristics, household composition variables, and housing market conditions for the adult-couple households. The construction of moments is detailed in Section 4.2. I specify resource shares and scale economies using an inverse logistic function that guarantees that they are bounded between zero and one. The scale economies estimates are relative to single-adult families. Age variables are divided by 10 to ease computation. Source: China Family Panel Studies (CFPS) 2014.

Table C4: GMM Estimates of Resource Shares and Scale Economies – Co-residence Households

	Co-residence family					
	Resource Shares				Scale Economies	
	Women		Elderly			
	Estimate	SE	Estimate	SE	Estimate	SE
Average educ women	0.395	(0.0051)	-0.732	(0.0008)	0.396	(0.0017)
Average educ men	0.202	(0.0050)	-0.635	(0.0011)	0.462	(0.0012)
Average educ elderly	0.265	(0.0055)	0.871	(0.0052)	0.068	(0.0088)
Average age women	-0.347	(0.0051)	1.287	(0.0112)	-0.186	(0.0097)
Average age men	-0.378	(0.0044)	-0.225	(0.0104)	-0.488	(0.0102)
Average age elderly	0.485	(0.0058)	-1.106	(0.0182)	0.536	(0.0161)
$\mathbb{1}$(Urban)	-0.965	(0.0033)	1.432	(0.0011)	-0.040	(0.0015)
# of children	-0.962	(0.0024)	0.289	(0.0038)	0.558	(0.0010)
# of elderly	-0.819	(0.0049)	0.560	(0.0063)	0.198	(0.0034)
$\mathbb{1}$(Housing owned by the adult couple)	0.036	(0.0040)	0.649	(0.0006)	0.218	(0.0006)
Logged housing price (province level)	0.146	(0.0037)	-0.208	(0.0122)	-0.629	(0.0095)
$\mathbb{1}$(housing ownership) $\times$ logged housing price	0.053	(0.0184)	0.020	(0.0026)	0.128	(0.0026)
Constant	-0.514	(0.0008)	-0.567	(0.0026)	1.047	(0.0021)
N	714					

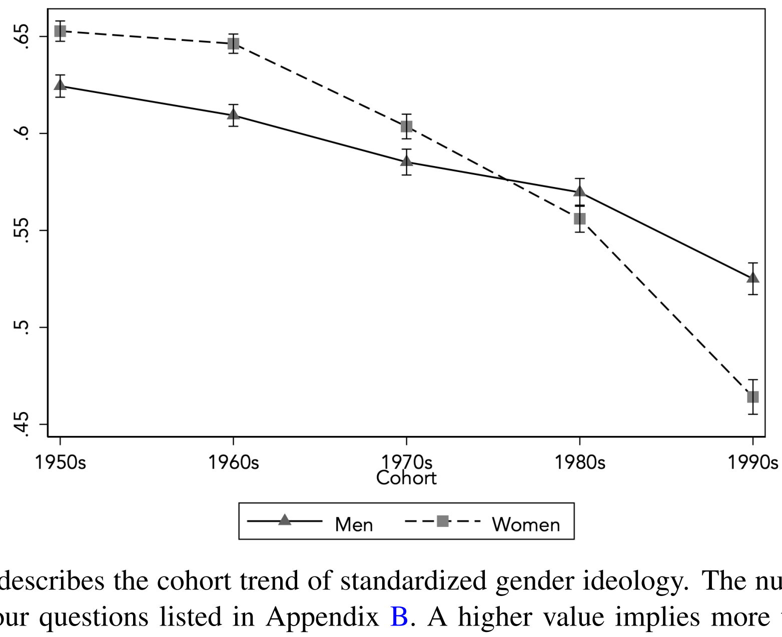
Note: The table reports the 2-step GMM estimates conditional on a set of observable household characteristics, household composition variables, and housing market conditions for the co-residence households. The construction of moments is detailed in Section 4.2. I specify resource shares and scale economies using an inverse logistic function that guarantees that they are bounded between zero and one. The scale economies estimates are relative to single-adult families. Age variables are divided by 10 to ease computation. Source: China Family Panel Studies (CFPS) 2014.

Figure C1: Trend of Co-residence



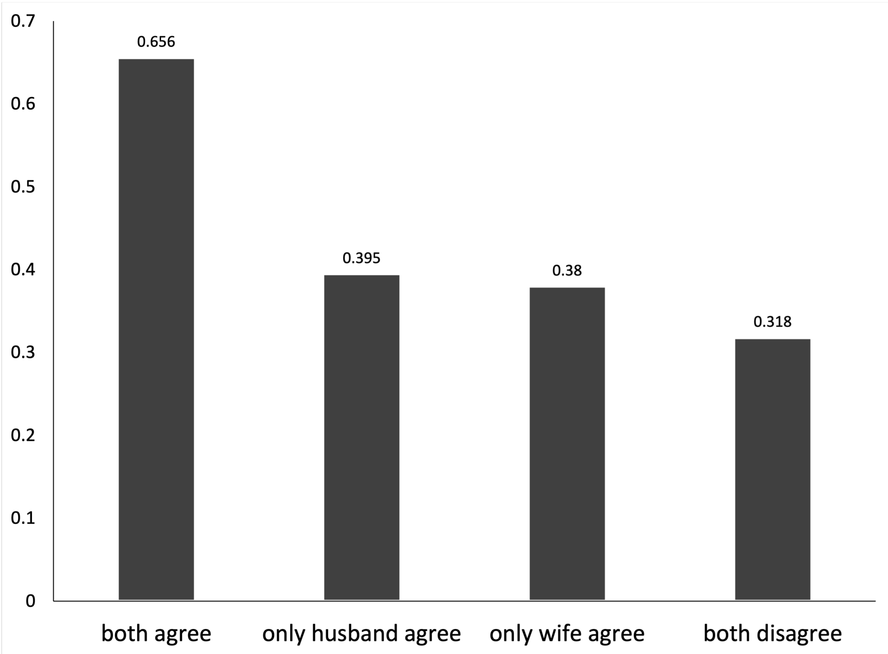
Note: Data are from the four waves of China Family Panel Studies (CFPS).

Figure C2: Trend on Gender Ideology



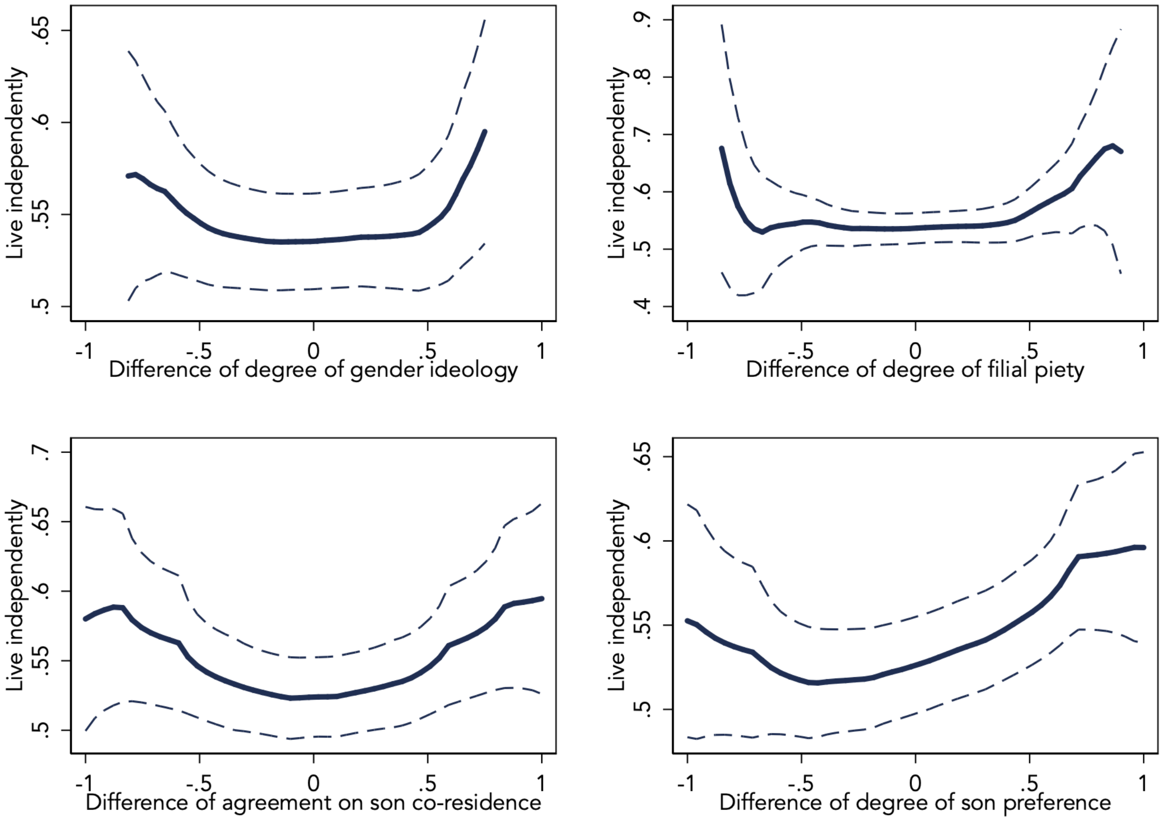
Note: This figure describes the cohort trend of standardized gender ideology. The number is an aggregation from the four questions listed in Appendix B. A higher value implies more traditional gender role attitudes, while a lower value means more egalitarian. Source: China Family Panel Studies (CFPS) 2014.

Figure C3: Intrahousehold Factor Matters for Co-residence Behavior



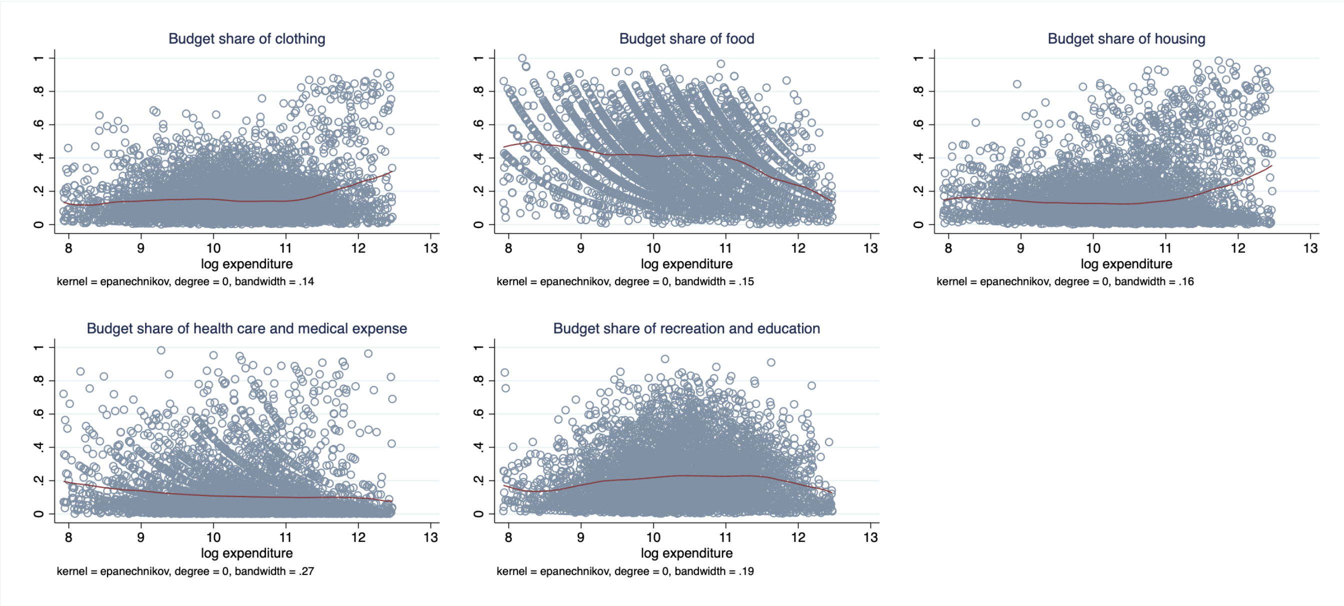
Note: This figure plots the distribution of the observed co-residence behavior by adult couple's agreement towards the argument "whether son should live with their parents after marriage." The numbers on the top of the histograms are the proportions of co-residence households for each type of adult couple agreement level. Source: China Family Panel Studies (CFPS) 2014.

Figure C4: Difference in Personal Attitudes and Living Independently



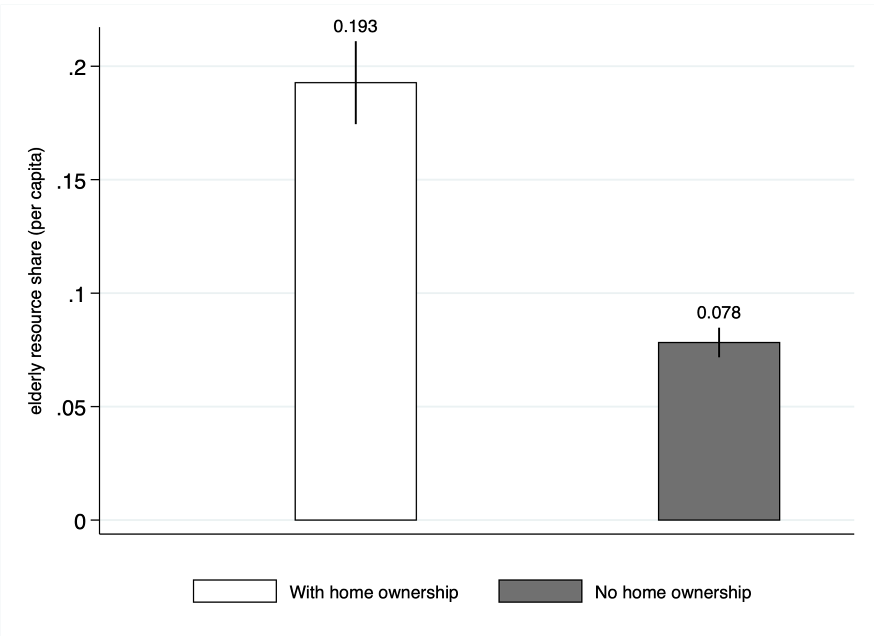
Note: This figure plots the correlation of differences in attitudes and the predicted decision on whether to live independently based on non-parametric approximation. The difference is measured as the husband's personal attitude value minus the wife's personal attitude value. The dashed lines denote the 95% confidence region. Source: China Family Panel Studies (CFPS) 2014.

Figure C5: Pre-estimation Test



Note: This figure plots the local polynomial smooth approximation of the correlation between budget shares of the five categories of goods and the log household expenditure. Source: China Family Panel Studies (CFPS) 2014.

Figure C6: Elderly Resource Share by Housing Ownership



Note: This figure shows the mean elderly resource share by housing ownership information, i.e., whether the house is owned by the elderly. The solid line on top of the histograms denotes the 95% confidence interval. Source: China Family Panel Studies (CFPS) 2014.