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This paper seeks to understand one important Chinese "savings puzzle" - the elevated savings rates of the young relative to the middle-aged. This was first documented in Chamon and Prasad (2010), who showed, using combined sets of annual Urban Household Surveys covering the period 1986-2005 for 10 provinces and correcting for period and cohort effects, that savings rates for 25-40 year-olds were as high as or higher than those for the middle-aged. This pattern is at odds with the standard life-cycle savings model, which implies that relative savings rates should be low for the young, whose incomes are expected to rise over the life-cycle (Japelli and Modigliani, 2005). The data on household savings used by Chamon and Prasad, and almost all other researchers examining Chinese savings at the micro level, however, do not actually represent the life-cycle pattern of savings for individuals or couples because of another important phenomenon - the high co-residence rates of the young with their parents. Co-residence of young adults and their parents is common and on the rise in many developing countries. And in urban China, among males aged 25-35, over 25% are still co-residing with at least one parent (2005 Chinese mini census).[1] Because of the aggregation of savings within households, household savings will reflect co-residence choices, which also have distinct age-patterns.

While there are no studies specifically addressing the factors determining the life-cycle patterns of savings or co-residence choices in China, three recent studies (Banerjee *et al.*, 2012; Choukhmane *et al.*, 2013; Wei and Zhang, 2011) that exploit micro data have focused on the high overall savings rate of the young in China that are relevant.[2] The first two explore the hypothesis that the elevated savings rates in China are due to the tradition of old-age support combined with lower fertility induced by the one child policy, which increases the expected support burden because there are fewer siblings to share support responsibility. Empirical analyses in these studies have also used urban survey data, and provide evidence suggesting that lower fertility does increase the household savings of parents directly. However, they provide no direct evidence of sibling effects on old-age support and no credible evidence of the importance

[1]Inter-generational co-residence is a common feature of rural populations in most countries of the world, but is becoming more common in urban areas of developing countries. The 2005 World Values Survey provides the answer to the question whether a respondent resided with his or her parents for combined rural and urban populations for 52 countries. Among men aged 25-39 in China, 41% reported they were living with their parents, but China only ranked 21st on the list. India, with a co-residence rate of 78% for the same age group had the highest rate. But even less urbanized countries such as Thailand and Taiwan have overall inter-generational co-residence rates higher than 60% in this age group. The rate in the United States for the same age group is 11%.

[2]Savings behavior also plays an important role in macro models seeking to explain China's growth patterns, e.g., Song *et al.* (2011).

of old-age support in contemporaneous urban China. Oliveira (2013) provides evidence using combined rural and urban data from China that total transfers to parents from children are higher when family size is larger but does not examine how the number of siblings affects transfers per sibling in China or look at the savings rates of the young. Wei and Zhang (2011) focus on marriage competition in both rural and urban China, which pushes up savings rates in households with young parents. This competition, and thus the elevated savings rates among the young, is exacerbated by the one-child policy, which has resulted in sex ratios at birth favoring males and thus intensifies competition for brides.

All of the prior studies of urban savings rates ignore inter-generational co-residence as a phenomenon affecting savings. There are two reasons, however, why consideration of co-residence is important for studying Chinese savings behavior. The first is that, as noted, the best available data on savings in urban China, the Urban Household Surveys (UHS) and the 2002 Chinese Household Income Project report total savings at the household level, including inter-generationally co-resident households, not for individuals or couples. The savings rate by "age" are actually the rates sorted by the ages of heads of households. Because of co-residence, few young people are household heads (only 7% of males 25-45 according to the China 2005 mini-Census), and who among the young are heads (residing in homes without parents) is highly selective, as we show below. This age-specific censoring of savings by individuals or couples due to co-residence raises the question of whether the reported age-pattern of savings in urban China is simply a data artifact and not a true departure from the standard life-cycle model for individuals.[3]

The second reason why an analysis of savings cannot ignore co-residence is that sharing the parental home is a potential mechanism for lowering consumption by the young and thus permits higher savings rates. If a young adult desires to save, subsidization of consumption via shared housing can facilitate savings. Given the cost advantages of shared housing for the young, it is potentially informative to consider savings and residence choice as joint decisions, taken by both the parents and the young children. Of course, this begs the question of why the young

[3]The problem of censoring due to co-residence for studying savings patterns in available data sets was recognized in the analyses of savings in Japan in the 1980's by Hayashi (1986), where age-specific savings patterns exhibit similar patterns to those in contemporaneous China and when rates of inter-generational co-residence were also similar. The similar historic age patterns of Japanese savings suggest that the one-child policy in China is not a necessary factor for elevated young savings rates.

would want to save. One reason is marital competition as suggested by Wei and Zhang (2011); another related reason is the high costs of housing, which would also make shared residence more desirable.[4] Just as urban Japan in the 1980's was characterized by high housing costs, the housing costs in China are also internationally high.[5] Rental markets in urban China are also thin, due to lack of both tenant and landlord protections, and this market failure combined with down-payment requirements for purchasing a house thus necessitates the accumulation of savings prior to leaving the parental home.[6]

Co-residence of parents and adult children in households headed by the old is not unique to urban China and is a rising phenomenon in many developing countries (Ruggles and Heggeness, 2008). Inter-generational co-residence, moreover, as documented by Ruggles and Heggeness, is increasingly reflective of the support by the old of the young, as indicated by headship patterns by age. They suggest that the reason for the rising trend of co-residence is increasing housing "shortages" in urban areas, where the phenomenon of inter-generational co-residence is most prevalent. In contemporary urban China too, as we show below, the old support of the young is substantially more important than old-age support by the young, which is economically small, and thus the latter is an unlikely motive for savings by the young no matter how many siblings they have. The absence of substantial old-age support and the subsidization by the old of the young is not surprising in urban China. Indeed, many of the current old own their homes, mostly acquired during the housing reforms at highly subsidized rates (Wang, 2011). The current young, however, face unsubsidized and high housing costs, and would have to wait many years to inherit their parent's home given the approximate 25-year age gap between parents and children. Many of the current urban old in China also have generous pensions, at replacement rates of up to 80%.

Despite the growing importance of co-residence internationally, there have been few studies of the phenomenon in the economics literature, and none links co-residence to savings

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[4]Wei and Zhang (2011) also argue that high housing costs are one of the mechanisms through which marital competition results in higher savings. Chamon and Prasad (2010) earlier conjecture about the importance of high housing costs for explaining the high savings rates in China.

[5]Wu *et al*. (2010) found that the average ratio of the price of housing to household income in eight major Chinese urban housing markets in 2002 ranged from 7 to 12 (Figure 12). Richards (2008) reports that a similarly-calculated ratio for the United States and the United Kingdom in 2002 was around 3 (Graph 7).

[6]The Chinese Household Income Project (2002) urban data indicate that less than 15% of Chinese households are renters.

patterns. Rosenzweig and Wolpin (1993) examine parental assistance to young adult children in the form of both shared residence and financial transfers in the United States, finding that shared residence is an important component of young-age support. Costa (1997) uses changes in Union army pensions to show that in the United States prior to 1940, rising income was a major factor in reducing co-residence, with lower housing costs after that period reducing the importance of income in determining co-residence. In urban China, the existence of high housing costs suggests that income may be an important factor in residence choice, which we test below. Hayashi (1997) models and studies co-residence as a choice in Japan, but the data he could work with lacked important information for such an inquiry, such as the characteristics of both parents and children when families live apart. We build on Hayashi's work in this paper by linking co-residence and savings.

In our study, we have unique data from our own survey of individuals (twins and non twins) from five Chinese cities, using a sampling frame similar to that of the UHS and an augmented UHS questionnaire, which enables us to identify individual (or joint married couple) savings and not just aggregated multi-generation savings rates at the household level. These data also provide financial transfers across generations and the characteristics of all respondents' siblings and parents that are not censored when family members choose to live apart. We show using these data that the age-selective censoring of individual savings due to co-residence accounts for a part of the life-cycle savings puzzle, but that individual savings rates are still elevated for the young.

To explain the individual patterns of life-cycle savings we construct a multi-generation life-cycle model in which the savings and co-residence of two generations in a family are jointly determined. There are two important features of the model: the inclusion of housing services costs and a preference for privacy by the young (residence sharing is a bad). A key implication of the model is that many of predictions with respect to the effects of family size and incomes on savings behavior become ambiguous when inter-generational co-residence is an important option for families as it is in China. We are able to generate a number of testable implications from the model for how variations in the number of siblings in the young generation affect savings rates, co-residence, and intergenerational financial transfers; how changes in housing prices affect savings and co-residence; and how changes in life-cycle incomes affect co-residence and savings.

In our empirical analysis in section one of the paper, we use data from the various UHS survey rounds, the 2002 Chinese Household Income Project, the 2005 Chinese mini Census, and our own 2002 survey data on twins and non-twins. We first document the age patterns of household-level savings by head's age, and earnings and co-residence by individual age for different years and data sources. We then show using the 2005 mini census that (i) who among the adult males in a household is the "head" depends on both relative age and relative income - it is selective and (ii) for the current generation of *urban* families in China, the assumption that old-age support is important is unsupported. The census data indicate that few old report receiving significant financial support from their adult children. To the contrary, the predominant form of inter-generational support is the old assisting the young via both financial transfers and through sharing residence in the house owned by the old. Our survey data are also consistent with the census data in the patterns of inter-generational support by age.

We test the model exploiting our twins survey data, using the twin-first methodology first suggested and used by Rosenzweig and Wolpin (1980) and within-twin pairs contrasts in earnings, co-residence and savings. The former method uses whether or not an individual came from a family in which the first-born among his or her siblings was a twin as an instrument for the individual's number of siblings (the relevant cohorts were all born before the one-child policy). In the data, this instrument is a powerful predictor of the number of siblings. We then show that an exogenous increase in the number of siblings reduces financial transfers from young to old, as assumed in the model and in prior studies, and that, consistent with the predictions of the model, an increase in the number of siblings increases the likelihood of co-residence. We show that the principal reason is that higher incomes lead to a higher likelihood of moving out of the parent's home, consistent with our model and the pre-1940 U.S. findings by Costa (1997), and that individuals with more siblings have lower incomes. We identify income effects on co-residence and savings using within-twin pairs estimates - finding that the lower income twin is the one most likely to co-reside. We also use the same methodology to estimate the effect of co-residence on savings, finding that, as implied by the model, savings rates are substantially higher when the young co-reside than when they do not (the co-residing twin, for given income, has a significantly higher savings rate than the non co-residing twin) but that savings are no higher among the old co-residing with their adult children. All of these results together provide support for the basic implication of the model, which is that the high cost of housing, and the willingness of parents to provide direct housing support, is a major factor causing the high savings rates of the young and their high rates of co-residence with parents in contemporaneous urban China, with the one-child policy and old-age support unimportant factors.

I. Life-Cycle Savings, Headship, Co-Residence, Inter-generational Support in Urban China

A. Household savings by age of head and inter-generational co-residence and headship by individual age

Figures 1 and 2 display average savings rates, and the rates Lowess-smoothed, by the ages of heads of households in the UHS for cities in six Chinese Provinces for the years 2002 and 2009.[7] The savings rate is conventionally defined as household disposable income net of taxes (DI) minus household consumption divided by household DI. As can be seen, savings rates are higher in households headed by the young compared with households headed by the middle-aged, contrary to the patterns predicted by standard life-cycle savings hypothesis when earnings trajectories are characterized by an inverted-U shape. The fact that the shapes of the curves are similar across the seven-year time span indicates that these figures depict life-cycle phenomena rather than idiosyncratic cohort and period effects, consistent with the findings in Chaman and Prasad (2010), who parsed cohort, age and period effects using a longer annual series of UHS surveys. We show the 2002 rates because the survey data we will use is from that year and it is important that the age patterns for that year are not atypical.

As noted, the patterns of China savings rates by household head's age are not dissimilar to those of Japan in the 1970's, but are dissimilar to those of the United States in that decade, which exhibit the conventional inverted U-shape, as shown in Figure 3 taken from tabulations reported in Hayashi (1997).

The Chinese urban savings pattern observed in Figures 1 and 2 are not due to any unusual shape to the male earnings trajectories by individual age, given in the bottom part of Figure 4 from the 2002 UHS, which exhibits the standard inverted U-shape. However, the household income of the same individuals by age do not exhibit this pattern. This is evidently the result of

[7] We use UHS data from six provinces that are broadly representative of China's rich regional variation, namely, Beijing, Liaoning, Zhejiang, Sichuan, Guangdong and Shaanxi. Beijing is a rapidly growing municipality in the north; Guangdong and Zhejiang are dynamic high-growth provinces in China's south coastal region; Liaoning is a heavy industrial province in the northeast; Sichuan and Shaanxi are relatively less developed provinces located in the southwest and northwest, respectively. The same six-provinces data have been used in a number of studies (e.g. Zhang *et al.*, 2005; Han *et al.*, 2012).

changing rates of co-residence by age. Figure 5 shows for urban males aged 25-65 in the 2002 UHS (i) age-specific rates of inter-generational co- residence, defined as the co-residence of the respondent with a parent, parent-in-law or an adult child aged 25 and over, and (ii) age-specific rates of headship. As can be seen, rates of co-residence for urban young men are high even for men aged 35 (26%) and decline from age 25 to age 40. The rates bottom out in the age range 40-50 after which they rise again. Thus, as young men age their own earnings rise but they also move out from their parent's home. The net effect of the increase in own earnings and the loss of parental income from home exit in the computation of household income is evidently responsible for the observed decline in household income with individual age to age 45 seen in Figure 4.

Figure 5 also shows that less than half of young men between the ages of 25 and 35 on average are heads of households. This means that the savings rates, depicted in Figures 1 and 2, for young heads is highly unrepresentative of all young men, a large fraction of whom are co-residing with their parents. Indeed, the 2005 Chinese mini census data indicate (not shown) that less than 5% of men aged 25-45 and residing with parents are considered household heads and that young heads, almost all of whom live without their parents, have higher earnings than young non-heads. To assess the selectivity of headship within co-resident households we also estimated the relationship between headship and a number of individual characteristics for men aged 25-65 who were co-residing with at least one other male aged 25 and over using the census data. The estimates, reported in Appendix Table 1a, indicate that there is no set rule for headship within an inter-generationally-extended household, which evidently depends on a person's age, relative age, earnings and relative earnings, and independence from family support.[8] Given that in co-resident households savings and incomes are aggregated across all household members, the patterns of savings rates by age of the household head in Figures 1 and 2 thus reflect the decline in co-residence rates by age, the rise in headship by age, and selection of headship by age within co-resident households in addition to any individual age profiles of savings rates.

B. Savings rates by age from the Chinese Twins and Non Twins Survey

Because standard models of savings are for individuals or couples and we are interested in the savings rates of individuals, we would like to have data that describe individual savings behavior uncensored by choice of residence. Our survey of twins and non-twins in five Chinese

[8]In contrast, in the Japanese savings data examined by Hayashi (1997), the household head is simply defined as the highest earning male.

cities in 2002 provides this information. The data that we use are from the Chinese Twins Survey (CTS) and the corresponding Chinese Non Twins Survey (CNTS), which was carried out by the Urban Survey Unit (USU) of the National Bureau of Statistics (NBS) in June and July 2002 in Chengdu, Chongqing, Harbin, Hefei, and Wuhan. The local Statistical Bureaus identified same-sex twins aged between 18 and 65 using various channels, including colleagues, friends, relatives, newspaper advertising, neighborhood notices, neighborhood management committees, and household records from the local public security bureau. Overall, these sources permitted a roughly equal probability of contacting all of the twins in these cities, and thus the twins sample that was obtained is approximately representative.[9] The UHS sampling frame was used to obtain a comparable sample of non-twins aged 25-60 in the same neighborhoods as the twins.

There are 4,683 respondents in the CTS who completed the questionnaire, of which 2,990 are in matched twin pairs. There are 1,665 respondents in the CNTS. Below we will describe the characteristics of these data in more detail. Here, we will use the data to describe the co-residence and savings rates of the individual males (and spouses if married) aged 25-60 by age in the combined samples. Reassuringly, inter-generational co-residence in both the twins and non-twins samples exhibit the same age patterns as seen in the more representative six-province 2002 UHS data, as shown in Figure 6 - falling from over 85% among males aged 25 to approximately 15% in the age range 40-50. These data also indicate that co-residence is generally higher among twins than among singletons, a result that we show below is consistent with our model.

Figure 7 depicts the savings rates by *individual* age for the men in the combined samples.[10] As can be seen, while the pattern of individual savings does not resemble the U-shaped savings pattern by *head's* age from the census data, individual-based savings rates for the young are still high relative to the middle-aged. While rates rise between the ages of 25 and 30, they remain high and then decline only after age 45. This again is certainly not the life-cycle

[9]These data have been used in a number of studies of China, including estimating the returns to Communist Party membership (Li *et al.*, 2007), identifying the mechanisms by which spousal education affects earnings (Huang *et al.*, 2009), studying family behavior during the Chinese send-down movement (Li *et al.*, 2010), and estimating the effects of birth weight on adult occupational choice, schooling and wages (Rosenzweig and Zhang, 2013).

[10]The savings question in the CTS and CNTS was "Last year, how much was the increase in your assets (including cash, bank deposit, various financial securities etc.)?" This is different from the method by which savings is calculated in the UHS, which subtracts total household consumption from total household disposable income. We compared the savings measures from the 2002 UHS and the savings measures from the CTS and CNTS for nuclear households, and thus not subject to the aggregation problem in the UHS, and found that the savings rates and levels were comparable.

pattern predicted by the standard life-cycle model, but it becomes more like the life-cycle pattern predicted by standard theory when we avoid the censoring problem due to co-residence in the UHS data.[11] However, we show below that the option of co-residence affects the life-cycle savings pattern.

C. How important is old-age support by the young in urban China?

Figure 7 indicates that there is a real China savings puzzle - why are the savings rates of the young so high relative to the middle aged, given the rising age profiles of earnings to middle age? Recent studies of savings in urban China (Banerjee *et al.*, 2012; Choukhmane *et al.*, 2013), as noted, assume that a primary motive for saving by the young is support of their elderly parents. This could account for the high savings rates of the young, if they must support their parents when they are middle-aged and have few or no siblings to share that burden. Descriptive statistics from the Chinese mini Census on the main sources of financial support and our CTS and CNTS survey data, which have information on financial transfers between parents and children, suggest, however, that old-age support by the young is not currently an important phenomenon in urban China. To the contrary, in contemporary urban China the predominant flow of support is from parents to adult children. And the high rates of shared parents' residence with young adults, seen in Figures 3 and 6, is only part of this.

The Chinese mini Census asks all adult respondents to provide their main source of financial support. Figure 8 displays the proportions of male respondents, by individual age, who reported that their main source of financial support was the family. As can be seen, family is reported to be the main source of support for less than 10 percent of men in urban China from age 27 to age 77. It is only above 10 percent for a few age groups, but these are both the young and the elderly - persons aged 25-27 and aged 77-80.

The CTS and CNTS provide direct information on the total amounts of financial assistance provided by the respondents to their parents and provided by the parents to the respondents in the year prior to the survey. This question is asked independent of the residence status of the parents. Figure 9 displays the annual net transfers from children to parents by the age of the children (respondents). In both surveys, below age 45 the children are net recipients of

[11]Savings for members of the household other than the respondent and his or her spouse were not collected, so it is not possible to compute household level savings. The respondents were also not asked to identify the "head" of the household.

financial transfers from parents; above age 45 there is old-age support. As can be seen, net financial transfers are almost perfectly symmetric so that over the life course there is no net support of the old by the young, excluding shared residence, which clearly favors the young, and direct expenditures on children associated with child-rearing and education. More importantly, above age 45, consistent with the information from the census, on average net transfers are quite small - at the highest average level (for respondents aged 60) mean transfers are only 450 RMB, which represents less than 5% of the annual earnings of 60-years olds in the sample. Transfers from the young to the old are thus not a major source of support for the old nor a major burden for the young. Old-age support is unlikely to be a major factor, though it may be a contributing factor, in urban China motivating high young savings rates, where pension replacement rates are high, the elderly are predominantly home-owners, and the young seek to acquire their own housing.

II. A Simple Inter-generational Model of Savings and Co-Residence

A. Co-residence and optimal savings.

To fix ideas about the relationship between fertility and savings in a regime with high housing costs and endogenous inter-generational co-residence we construct a simple multi-period two-generation model. Parents and children, when adults, jointly determine their optimal consumption paths and whether to share the parents' residence when the adult children are young. To highlight the multiple links between the number of children, savings and co-residence we make a number of simplifying assumptions. First, we treat the number of children N as exogenous and embed in the model two mechanisms that have been widely discussed in the literature - the negative effect of fertility on human capital investment, and thus adult earnings, and the reduction in the burden of old-age support for the young when there are more siblings. In the empirical section we will allow for fertility and sibling size to be endogenous and test for the existence of both of these mechanisms in urban China. Second, we initially assume that the children are identical and examine the behavior of the representative child. We consider how differences among children affect their respective savings and co-residence decisions below, and make use of these differences to identify some of the key relationships in the model. Third, we assume that parents and children consume a fixed amount of housing services h. Finally, we assume that credit and housing markets are perfect and that parents and children face a given housing services price π.[12]

There are three time periods and two generations (k=children, p=parents). In period 1, children are very young and we ignore their utility. In period 2, children are "young", parents are middle-aged and both participate in the labor market. The children and the parents may choose to co-reside in this period. Parents provide free housing services h for the children if they co-reside. Otherwise children pay π_k per-unit of housing. The utility of housing services, however, is discounted if there is co-residence, and housing services are thus a decreasing function of N (privacy is valued). Parents may provide financial transfers τ to children. In period 3, children leave the original household if they co-resided in the second period and parents are retired, earning pension income P and receiving total transfers from their children R to meet a fixed target retirement income. There are thus two regimes in the model, a regime of co-residence in the second period with parents paying housing costs and a regime of non-co-residence in which adult children always live apart and pay housing costs $\pi_k h$ in periods two and three.

The non co-residence regime program, ignoring discounting, is

$$\text{(1)} \qquad \max \qquad U = U^1(N,E,C_p^1) + U_p^2(C_p^2) + U_k^2(C_k^2,h) + U_p^3(C_p^3) + U_k^3(C_k^3,h)$$

subject to:

$$\text{(2)} \qquad N\tau + 3\pi_p h + C_p^1 + C_p^2 + C_p^3 + NEq = Y_p^1 + Y_p^2 + \overline{R}$$

$$\text{(3)} \qquad C_k^2 + C_k^3 + \frac{\overline{R} - P}{N} + 2\pi_k h = 2Ew + \tau$$

where the C_k^i, C_p^i = consumption for each generation in each period i. Note that unlike in Hayashi (2000), parents and children do not pool income, though there is the option of inter-generational support in the form of shared housing and financial transfers.[13] Constraint (2) for the parents embeds the parental costs of providing (equal) skill E at unit cost q to each child from parental income Y_p^i and constraint (3) reflects the fact that the children's earnings depend on their amount of skill and the market price of skill w. (3) also builds in, as noted, that the old-age

[12]The level of the housing price may reflect imperfections in the supply of housing. Restrictions on borrowing and down-payment requirements, as modeled by Hayashi and Slemrod (2000), and imperfections in or distaste for rental markets would reinforce the relationships we obtain in the model.

[13]Altonji *et al.* (2000) reject the pooling model in the United States.

support burden is lower the larger is N by fixing the maximum amount of familial old-age support at R - P.

Under the non-co-residence regime, the "young" savings function in period 2 is

$$S_k^2 = Ew + \tau - C_k^2 - \pi_k h. \tag{4}$$

The co-residence regime program is

$$\max \qquad U = U^1(N, E, C_p^1) + U_p^2(C_p^2) + U_k^2(C_k^2, \delta(N)h) + U_p^3(C_p^3) + U_k^3(C_k^3, h)$$

subject to

$$N\tau + 3\pi_p h + C_p^1 + C_p^2 + C_p^3 + NEq = Y_p^1 + Y_p^2 + \overline{R}, \tag{5}$$

$$C_k^2 + C_k^3 + \frac{\overline{R} - P}{N} + \pi_k h = 2Ew + \tau. \tag{6}$$

and under the co-residence regime, the savings function in period 2 is

$$S_k^2 = Ew + \tau - C_k^2. \tag{7}$$

The first implication of the model is that optimal "young" savings ($S^{2*}_{k,NC}$ and $S^{2*}_{k,C}$) is higher under co-residence (indexed by subscript C) than under non co-residence (NC), for the same lifetime income:

Proposition 1: *Savings are higher for the young under co-residence than under non-co-residence for the same lifetime income.*

(8) That is $$S_{k,NC}^{2*} < S_{k,C}^{2*}$$

as $$C_{k,NC}^{2*} \le C_{k,C}^{2*} \le C_{k,NC}^{2*} + \pi_k h \text{ and } C_{k,NC}^{2*} = C_{k,NC}^{3*}\ ,\ C_{k,C}^{2*} < C_{k,C}^{3*}.$$

Proof is in Appendix A.

B. Housing costs, co-residence and optimal savings.

Which regime a child is in is a choice, so that the effects on savings cannot be understood without also considering how the change in the housing services price or any other parameter in the model affects regime choice (co-residence). To assess how changes in the exogenous variables in the model affect regime choice we need to compute optimal consumption in both regimes. For changes in the cost of housing π_k, we get

Proposition 2: *An increase in housing costs increases co-residence*.

Proof: Defining optimized utility as V^{C} and V^{NC}, respectively, in each regime, we have for the non-co-residence regime

(9) $$\frac{\partial V^{NC}}{\partial \pi_k} = \frac{\partial L}{\partial \pi_k}\bigg|\mathbf{C}_{NC}^{*} = -2\lambda_2 h\big|\mathbf{C}_{Nc}^{*} = -2U_{k1}^{2}h\big|\mathbf{C}_{NC}^{*} = -\,2U_{k1}^{3}h\big|\mathbf{C}_{NC}^{*} < 0,$$

where $\mathbf{C}_{NC}^{*}$ denotes the vector of the optimized consumption level for parents and kids within the non-co-residence regime. Similarly, for the co-residence regime

(10) $$\frac{\partial V^{C}}{\partial \pi_k} = \frac{\partial L}{\partial \pi_k}\bigg|\mathbf{C}_{C}^{*} = -\lambda_2 h\big|\mathbf{C}_{C}^{*} = -U_{k1}^{2}h\big|\mathbf{C}_{C}^{*} = -\,U_{k1}^{3}h\big|\mathbf{C}_{C}^{*} < 0,$$

where $\mathbf{C}_{C}^{*}$ denotes the vector of the optimized consumption level for parents and kids under the co-residence regime and L is the relevant Lagrangian of the programming problem. An increase in the cost of housing decreases utility in both regimes, but as can be seen from (9) and (10) :

$$\left|\frac{\partial V^{C}}{\partial \pi_k}\right| < \left|\frac{\partial V^{NC}}{\partial \pi_k}\right|.$$

Thus, for the family just indifferent between co-residence and non-co-residence, an increase in the cost of housing services leads to the choice of co-residence. A setting in which housing prices are high, even if capital markets are perfect, is likely to have high levels of inter-generational co-residence.

What about the effect of the housing price on savings? In this model with perfect capital markets, it is straightforward to show that a change in housing costs would have no effect on savings in the absence of co-residence, because for the non-co-resident children optimal consumption declines equally in all periods, by $h\pi_k$. However, for co-resident young adult children the higher housing cost increases savings, as the higher housing price in the third period lowers consumption in period 3 but not period two (the proof is in Appendix B). We then get

Proposition 3: *Higher housing costs increase the young's savings when co-residence with parents is an option.*

Proof: An increase in π_k induces more young to co-reside (Proposition 2), where savings are higher (Proposition 1), and increases savings for the co-resident young but has no effect on the non co-resident young.

C. Number of siblings, savings and co-residence.

Although the model delivers the result that higher housing costs increase co-residence and young savings, in part via the induced shift to inter-generational co-residence, it is not possible to test this implication empirically as we do not have a source of plausibly exogenous variation in π_k. But we can examine empirically the implications of the model for how changes in sibling size (N) and wages (w) affect savings as well as co-residence.[14] The effects of exogenous variation in N on savings is ambiguous in the model, and this ambiguity arises in part due to the option of co-residence. The effect of sibling size on co-residence is also ambiguous. To see why, it is useful first to look at wage effects, making use of the assumption consistent with much of the existing literature, and to be tested below, that a larger number of children affects children's schooling negatively and thus lowers their lifetime earnings (quality/quantity trade-off). We can show that

Proposition 4: *Higher-income young are less likely to co-reside with parents.*

Proof: An increase in lifetime income, with no change in the temporal pattern of income, increases optimized utility V in both regimes. But, because $\mathbf{C}^*_{k,NC} \le \mathbf{C}^*_{k,C}$, the increase in optimized utility V^{NC} is larger than the increase in V^{C} (details of proof in Appendix C).

Proposition 4 implies that if there is a trade-off between fertility and human capital investment so that a larger number of siblings reduces income for each child and if having a larger family increases the privacy costs of co-residing ($h\delta'(N)<0$), as assumed in the model, the effect of changes in the number of children N on adult co-residence is ambiguous. In a society such as China in which joint residence has low psychic costs and housing prices are high therefore relaxing constraints on fertility (which would reduce the incomes of the young and raise the price of housing in general-equilibrium) could increase inter-generational co-residence. High co-

[14] We can also test the assumption that the number of siblings lowers *per-child* transfers to parents (the key assumption for the old age support mechanism).

residence rates are thus not likely due to the one-child policy.

The effect of variation in the number of siblings N on savings is also ambiguous, and this is due in part to parental co-residence being an important option. Indeed, if there were no option of co-residence in the model, an increase in N unambiguously decreases "young" savings solely due to the decreased burden of old-age support that is assumed in the literature. This is because in the non co-residence regime, while increasing N lowers earnings (q/q), as noted a permanent change in wages (no change in the age-profile) has no effect on savings.[15] However, lowering the old-age support burden decreases the marginal utility of consumption in the third period and thus savings in the second period, as

(11) $$dS^{2*}_{k,NC} = 2Ew'(N)dN - dC^{2*}_{k,NC} = -\frac{\overline{R}-P}{2N^2}dN < 0$$

In the <u>co-residence regime</u>, however, the effect of an increases in N on young savings is given by[16]:

(12) $$dS^{2*}_{k,C} = Ew'(N) - \frac{2Ew'(N) + \frac{\overline{R}-P}{N^2} - \frac{U^2_{k12}}{U^3_{k11}} h\delta''(N)}{1 + \frac{U^2_{k11}}{U^3_{k11}}} dN \, .$$

Although the old-age support burden still tends to shift consumption towards the "young" period, the effect of the wage rate change on savings in this regime is ambiguous[17] and relationship (12) depends as well on whether consumption and housing services are substitutes or complements (U^2_{k12}). Thus, once one takes into account the effect of family size on a child's behavior in a setting with high housing prices (where the returns to co-residence are high) it is

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[15]However, it is easy to show that an increase only in second-period wages for the young, holding fixed third-period wages, would increase savings.

[16]The derivation of (12) is given in Appendix D.

[17]To see this, consider a unit change in the rental rate of human capital w over both periods of the child's working life, which increases lifetime earnings therefore by $2E$. The increase in the optimal consumption at periods 2 and 3, denoted as ΔC_2 and ΔC_3, must satisfy $\Delta C_2 + \Delta C_3 = 2E$, and $C_2^* + \Delta C_2 \le C_3^* + \Delta C_3$. For the co-resident children C_2 may be less than C_3 unlike for non co-resident children. However, it is not clear whether C_2 increases by more than E, which depends on the specific function form of the utility function.

not clear how changing rules of fertility affect savings for the young.

D. Parental income, young savings and inter-generational co-residence.

An important implication of the model is that parents' *pre-retirement* or contemporaneous income matters for the savings behavior of the young net of both the young's income and the parents' pension income, again because of the option of co-residence. In the absence of co-residence there is no effect of parental pre-retirement income on the behavior of the young in the model. The sign of the effect of parent's income on savings by their young children in the presence of co-residence can also be informative about whether consumption and housing services are complements or substitutes, which as shown in (12) affects how the number of siblings affects the young's savings. First, for given earnings of the young, we can show

Proposition 5: *An increase in parental pre-retirement or pension income increases inter-generational co-residence.*

Proof: Higher parents' income at either period 1 or 2 always leads to higher parents' consumption levels, and hence higher V^C and V^{NC}. It can be shown that

$$\Delta DV = \Delta V^{NC} - \Delta V^{C} \quad = U_{p1}^{2}\Big|\mathbf{C}_{p,NC}^{*} - \left[U_{p1}^{2} + U_{k2}^{2} h \delta_2(N, Y_p)\right]\Big|\mathbf{C}_{p,k,C}^{*}$$

$= -U_{k2}^{2} h \delta_2(N, Y_p)\Big|\mathbf{C}_{k,C}^{*} < 0$, since $U_{p1}^{2}\Big|\mathbf{C}_{p,NC}^{*} = U_{p1}^{2}\Big|\mathbf{C}_{p,k,C}^{*}$, where $\mathbf{C}_{p,k}^{*}$ indicates the vector of the optimal consumption goods by the parents and kids.[18]

The effect of parental income on young savings depends on whether the consumption good and housing services are complements or substitutes.

Proposition 6: *If housing services and consumption are substitutes an increase in parental pre-retirement income unambiguously increases the young's savings.*

Proof: The disutility of shared housing services decreases with parental income, so for co-resident children consumption declines and savings increases (decreases) when housing services and consumption are substitutes (complements). For non-co-resident children, parent's income has no direct effect on their consumption. As Proposition 5 indicates, co-residence increases with parental income and savings is higher under co-residence (Proposition 1). Thus,

[18] Proof details are in Appendix E.

savings for the young will increase regardless of residence regime when parental income is higher.[19]

In sum, the model indicates that in a setting where housing costs are high and parents are relatively well off relative to their young children, co-residence is likely to be high and savings rates by the young also high, facilitated by shared residence. In this environment, an increase in the income of the young generation relative to the old decrease co-residence and thus has ambiguous effects on savings, which would otherwise rise in a regime without co-residence. Similarly, increases in the number of siblings (family) size would unambiguously lower young savings, by lowering income and reducing old-age support, in a setting with no co-residence option but the effect of fertility (sibling size) on savings is ambiguous when co-residence is an important option.

III. Heterogeneous Children

In the model so far we have assumed that each child is identical. We now relax that assumption. We do this because in the empirical section we will estimate how changes in wage rates affect savings and co-residence using differences across siblings (twins). The advantage of such estimates is that they eliminate the influence of unmeasured or imperfectly measured common family variables, for example, contemporaneous parental income or preferences, which the model indicates affect both decisions. The issue then is how the differenced estimates correspond to the comparative statics for the representative child derived under the assumption of identical children. The key additional consideration is that changes in the earnings of one sibling can directly affect the behavior of the other sibling(s) because of co-residence and the privacy (crowding) externality.

Consider a family with two initially identical children (siblings) that is just indifferent between the co-residence or non-co-residence of the children. There is an exogenous increase in the earnings of one sibling, say sibling 1. We want to know what happens to the difference in the utilities of co-residing and non-co-residing between the two siblings. That is we want to know what happens to the difference in the changes in the utilities associated with the residence regimes across the siblings

(13) $$\Delta DV = (\Delta V_1^{NC} - \Delta V_1^{C}) - (\Delta V_2^{NC} - \Delta V_2^{C}),$$

[19]It is easy to show that in contrast an increase in parents' pension income always decreases the savings by the young due to the lower support burden.

when the lifetime earnings of sibling 1 increases.

From Proposition 4 we know that for sibling 1, $\Delta V_1^{NC} - \Delta V_1^{C} > 0$ when the lifetime earnings of sibling 1 increases and sibling 1 will move to non-co-residence if indifferent initially. For sibling 2 there is no change in the utility associated with non-co-residence. However, if sibling 1 chooses non-co-residence the gain from the co-residence regime increases for sibling 2, even though sibling 2 experiences no income change, because there will be less crowding (more privacy) if she chooses to co-reside with parents. The effect of a rise in sibling 1's wages on the difference in co-residence choice utilities is thus

(14) $$\Delta DV = (\Delta V_1^{NC} - \Delta V_1^{C}) - (\Delta V_2^{C}) > 0,$$

when the lifetime earnings of sibling 1 increases and is thus the same sign as the effect on sibling 1's own behavior, with the cross-sibling effect reinforcing the difference in residence choices. Similarly, it can be easily shown that the sign of the effect of differences in earnings across siblings on the difference in their savings is the same as that in the comparative static for the representative child.

IV. Reduced-Form Estimates of Number of Siblings

In this section we test two assumptions and two propositions from the model with respect to the effects of variation in the number of siblings N and parental resources on the schooling attainment, financial assistance of parents, inter-generational co-residence, and savings of the young. With respect to the assumptions, we look at the effects of variation in N on the schooling attainment of the young E and on transfers to parents from the young $((R - P)/N)$, which we have assumed to be negative in deriving some of the predictions of the model. We also look at the reduced-form effects of N and parental occupation (a proxy for their income) on co-residence and on young savings S_2^k. The linearized reduced-form estimating equation from the model for an adult child i in family j is:

(15) $$Z_{ij}^k = \beta_1 N_j + \beta_2 Y_{pj} + \varepsilon_{ij},$$

where $Z_{ij}^k = E_{ij}, (R_j - P_j)/N_j, C_{ij}^k, S_{ij}^k$. Propositions 5 and 6 imply that $\beta_2>0$ for both co-residence and young savings (the latter if housing services and consumption are not complements), while the assumption of reduced support burden and the quantity-quality trade-off imply that $\beta_1<0$ for both schooling attainment and parental transfers.

Although in the model we have assumed for simplicity that the number of children in the family is exogenous, the empirical challenge is that the number of siblings depends on parental fertility choices and thus may reflect parental preferences (e.g., altruism, preference for children's schooling, aversion to privacy loss), which may be inter-generationally correlated. To obtain causal effects of sibling size that do not reflect preference correlations we use the combined CTS and CNTS data to implement an instrumental-variables procedure, exploiting the fact that twinning on the first birth is random net of the mother's age at first birth (Rosenzweig and Wolpin, 1980). Choukhmane *et al.* (2013) used the presence of any twins in the UHS data sets as an instrument for fertility of younger couples. In those data, all of the children were born during the regime of the one-child policy, and there is evidence that twinning may reflect, given available technology, attempts by parents to circumvent fertility restrictions (Huang *et. al*, 2013). Thus, twinning (at any birth order) in contemporaneous China is unlikely to be a fully random outcome. In contrast, all of the respondents in the CTS and CNTS were born prior to the implementation of the one-child policy and before the widespread availability of fertility drugs. This means that for any pregnancy the event of a twin, conditional on mother's age, is random. However, the presence of twins in any family will reflect fertility preferences, as families with more pregnancies will be more likely to have a twin birth. Restricting the sample of twins to those born at the first birth, controlling for mother's age at first birth, eliminates the correlation between a family's family size (and other) preferences and twinning.

The first-stage estimating equation we use is thus:

$$N_j = \alpha_1 TFB_{ij} + \alpha_2 Y_{pj} + \alpha_3 AFB_k + u_k, \tag{16}$$

where TFB_{ij}=twinning on the first birth and AFB_k=mother's age at first birth.[20] Oliveira (2013) also used twinning on the first birth to estimate, using Chinese rural and urban data, the effect of number of children on the total transfers received by older mothers and, using Indonesia data, the effects of number of siblings on transfers per sibling, finding a positive relationship for the first and a negative relationship for the second, consistent with the assumption of our model.

To estimate (15) and (16) we use first-birth male twins aged 25-45 with at least one living parent from the CTS as the randomized treatment group and male singletons in the same age range and also with at least one living parent from the CNTS as the control group. Both data

[20]Rosenzweig and Wolpin show that even if the mother's age at first birth is endogenous (correlated with u in (16)), the estimate of the effect of twinning on the first birth (α_1) is unbiased.

sets provide information on all of the siblings of the respondents and the occupation of the parents, in six categories. We use an indicator variable for whether or not the mother or the father are in a skill category, defined as professional or managerial, to proxy for parental resources.

There is one additional issue in estimating (15) and (16). Twins have substantially lower birthweight than singletons and birthweight has been shown to have long-term effects on adult outcomes. However, for schooling, for example, the relationship is only important for females (Behrman and Rosenzweig, 2004; Rosenzweig and Zhang, 2013). Because the CTS and NTCS have birthweight information, we can check whether birthweight differences between twins for our male sample matter for the outcomes we examine. Table 1 provides descriptive statistics for three sub-samples - all twins, first-birth twins, and singletons in the age group 25-45. Of interest is that average birthweight is indeed significantly lower in the samples of twins than for singleton births. However, the differences in parental occupation across the sample categories is not statistically significant.

Table 2 provides the estimates of the first-stage sibling equation (16) using all twins and only first-birth twins as the treatment sample in columns one and two, respectively. In both samples, twinning has a statistically significant positive effect on the total number of siblings. As expected, however, use of any twins born to the parents results in a much larger sibling coefficient, as the presence of twins is, as noted, mechanically related to the (chosen) number of births. The causal estimate from the first-birth twin treatment sample, which eliminates this relationship, indicates that any person born in a family with twins on the first birth will have on average .43 more siblings.

Table 3 displays the OLS and IV estimates of the reduced-form equation (15) based on the first-stage estimates (16) for schooling attainment, testing an assumption of the model that the young with more siblings have less human capital. Both estimates are supportive of this assumption; the IV estimate indicates adding one additional sibling reduces schooling attainment by almost one full year (8.2%). To assess if this difference is negatively biased due to the lower birthweight of twins, we tested whether the birthweight differences between male twins affected differences in their schooling attainment. As shown in Appendix Table 2a we find using the same specification as in (16) that, as expected, the male twins have on average a statistically significant .63-.64 kilograms less birthweight than singletons. However, the within-twins estimates, reported in Appendix Table 3a, indicate that birthweight for this male sample is not a statistically significant determinant of schooling.[21]

In the first two columns of Table 4 we report reduced-form estimates that permit a test of another assumption of our model, and assumed but not tested in other the prior studies of fertility effects on savings, that having more siblings lowers the old-age support burden. Because, as seen in Table 1, the fraction of the respondents providing any financial assistance to parents is only 6%, we look specifically at how the number of siblings affects the probability of parental financial assistance, using probit and IV-probit. The Wald test statistic indicates rejection of the hypothesis that the number of siblings is orthogonal to the error term in the transfer equation. The statistically-preferred IV-estimate in column two indicates support for the assumption that having more siblings lowers the support burden. However, the point estimate, while statistically significant, suggests the effect on the probability of providing support is small, because the incidence of old-age support is small.

Columns three and four of Table 4 report, respectively, the probit and IV-probit estimates of the reduced-form effect of number of siblings and parental occupation on the probability that the (young) respondent co-resides with a parent. Our finding that additional siblings lowers human capital, reported in Table 2, and thus earnings, and the prediction of the model (Proposition 4) that higher-income for the young leads to less co-residence,[22] implies that respondents with more siblings may be more likely to stay with their parents, even though having more siblings leads to less privacy if they co-reside. The statistically-preferred (Wald test) IV probit reduced-form estimates in column 4 confirm this - in families with more children, the children are more likely to co-reside with parents. The point estimate indicates that a reduction in the number of siblings by one decreases co-residence by 45%. This implies that relaxation of the one-child policy will further increase inter-generational co-residence. The estimates in column 4 also confirm Proposition 5, that co-residence will be more likely the higher the incomes of the parents. The estimates indicate that in families in which the father is in

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[21]Birthweight differences within a twin pair are large but are orthogonal to the preferences or constraints of parents. Using the same within-twins method on the CTS sample for women yields a statistically significant relationship between birthweight and schooling, so the test has power (Rosenzweig and Zhang, 2013). As noted, this difference by gender in birthweight effects is consistent with other findings in the literature and has a biological and behavioral basis, as discussed in Pitt *et al.* (2012).

[22]We test Proposition 4 directly in the next section.

a professional or managerial occupation, his child is statistically significantly more likely to be co-residing with him (mother's occupation does not matter, however). This finding suggests, consistent with the model, that a policy of decreasing pensions for the elderly will lower the proportion of inter-generationally-extended households.

The last two columns of Table 4 report the reduced-form estimates of the effects of N and parental occupation on the savings rate of the young using OLS and IV. The model provides no prediction for the sibling effect - more siblings reduce the old-age support burden (Table 4, column 2) and human capital (Table 3), which would lower savings, but an increase in the number of siblings also induces co-residence (Table 4, column 4), which facilitates higher savings (Proposition 1).[23] The net effect of these mechanisms, to be directly tested below, is that changes in the number of siblings induced by a change in fertility policy would evidently have no effect on savings. Both the OLS and IV estimates (which are statistically identical) indicate that we cannot reject the hypothesis that the number of siblings has no effect on the savings rate in the reduced-form. However, there is mild support for Proposition 6 (with C^k and h_k not strong complements) that higher parental resources are associated with higher young savings, as both parental occupation coefficients are positive. Although neither parental occupation coefficient is statistically significant, they are jointly statistically significant at the 10% level.

V. Income, Savings and Co-Residence

A. Young income effects on co-residence and savings

In this section we test two additional propositions of the model - Proposition 4 that increasing incomes for the young reduces the likelihood of co-residence with parents and Proposition 1, central to the model, that co-residence facilitates the young's savings. We also estimate how income affects savings. Both co-residence and wages are endogenous in the model so we need to employ an empirical strategy that reduces endogeneity bias. In particular, we will exploit differences between the twins in a twin pairing. The "within-twin" methodology requires more stringent assumptions than are needed for the twin-first method to obtain credibly causal estimates. The key advantage of the within-twin method is that differences across twins in a family are orthogonal to any unmeasured or unobservable family-level characteristics such as preferences (e.g. for savings, human capital investments, and privacy) or constraints (parental

[23] We implement a test of Proposition 1 below.

income). Any endogeneity bias due to omitted common family-level factors is thus eliminated. This is a particularly important advantage for testing hypotheses derived from a framework in which two generations jointly make family decisions, as is consistent with the finding that father's occupation affects his children's co-residence (Table 4). Importantly, as we have shown in Section III, heterogeneity between siblings identifies the key relationships in the model.

A principal assumption of the within-twin method is that observed differences, in wages and co-residence, across twins within a pair are purely random net of the family-level factors. There are two issues. First, as is well-known, within-estimates are more sensitive to any measurement error in regressors, leading to an estimate that is biased to zero if there is a single regressor, or a more complex set of biases when there are multiple regressors. We will discuss the measurement-error issue, and a method for eliminating measurement-error bias, in more detail below. The second issue is that the underlying source of variation across twins, net of measurement error, is unknown. For example, it is not clear why one genetically-identical twin has higher earnings than another. However, to the extent that the source of this variation is due to differences in unobserved earnings endowments or ability (such as caused by heterogeneous birthweight or other womb-based determinants), as long as these are unrelated to the outcomes other than through income effects there is no bias.[24] It is unlikely that earnings endowment or ability bias would be a problem in estimating how wages affect savings. More troubling would be if differences in earnings (at the same age) were due to differences in discount rates, which led to differences in human capital investment, and which might directly affect savings (positive bias). It will never be possible to rule out all conjectured sources of cross-twin differences. It is even possible that the within-estimates are more biased than OLS estimates in some cases. We will test, however, how robust the estimates are to the use of different estimation methods and samples.

The first four columns of Table 5 report logit and within-twin conditional logit (within-twin) estimates of the effects of wages on the probability of providing a financial transfer to parents and the probability of co-residing with any parent for young respondent men aged 25-45 with at least one living parent. The last two columns of the table report OLS and within-twin

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[24]This would be more troubling for looking at how differences in schooling affect earnings, as earnings are likely to be directly affected by ability differences.

estimates of wages on the savings rate. Given that we have only one regressor, any measurement error in the wages will bias the wage coefficient to zero. This will make our test of the significance of these effects conservative and leave our conclusion about the sign of the direction of the wage effects unbiased. With respect to hypothesis tests, the results in all columns are robust to estimation procedure. The estimates indicate that while we cannot reject the hypothesis that wages have no effect on parental transfers, we can say with at least 95% confidence that an exogenous increase in income for the young lowers the probability of co-residing with parents, consistent with Proposition 4 of the model. Finally, in the last two columns of Table 5 we see that an increase in the wages of the young is associated with a higher savings rate, despite the fact that higher-income young are less likely to co-reside with parents, which permits higher savings.

B. Co-residence and young and old savings

A key implication of the model, Proposition 1, is that co-residence facilitates higher savings for the young. To test this we exploit the fact that within a large fraction of the twin pairs only one of the twins is co-residing with a parent. Since we have seen in Table 5 that variation in wages also affects differences in both the choice to co-reside and savings, we need also to control for differences in the earnings of the twins. That is, we wish to know across twins whether the one co-residing, for given own income, has higher savings. However, earnings are likely measured with error, which, as noted, will contaminate the estimate of the co-residence effect.[25] The CTS contains cross-reports on twin earnings. Each twin was asked to report both their own annual earnings and that of their co-twin. As in Ashenfelter and Krueger (1994), we can use the cross report as an instrument, in this case for own earnings, to eliminate measurement bias, as long as the measurement error in the cross and own-reports are uncorrelated net of a family fixed effect.

We can also carry out another test, making use of the older twins (46-60) in the CTS to further test a key assumption of our model - that the co-residence of the young and old represents a subsidy to the consumption of the young by the old. If that is the case then, in contrast to the sample of young, among the co-residing parents (old) savings should not be higher for the parent

[25]It is unlikely that the report by each twin on whether he is co-residing with a parent is erroneous. We do not have information on whether the siblings co-reside with each other that would enable a cross-check.

living with his adult son compared with his twin who has a son that is not co-resident, for given own income. We thus use the same specification and estimation methods for the older sample of twins each of whom has at least one child aged over 20.[26]

Table 6 reports the within-twin and IV within-twin estimates for the two samples. For the young sample, use of the cross-reports substantially increases the positive earnings effect on savings, consistent with the presence of measurement error, as well as the coefficient on co-residence. Both sets of estimates indicate non-rejection of Proposition 1 - the co-residing twin has significantly higher savings, almost double that of the non-co-residing twin, controlling for differences in income. On the other hand, while for the older twin parents the earnings effects on savings are similar to those for the young (regardless of estimation procedure), there is no statistically significant positive relationship between their co-residence with an adult child and their savings, and the point estimate is small. These sets of results are consistent with inter-generational co-residence reflecting the support of the young by the old.

VI. Conclusion

In this paper we have used unique data characterizing urban China to examine why the savings rates of the young are elevated relative to the middle-aged, despite rising individual incomes over the life-cycle. We show that to understand life-cycle savings behavior, particularly in a context of high housings costs, it is necessary to take into account inter-generational co-residence. Our paper is the first to link, both theoretically and empirically, these two phenomena.

The data we exploit are unique in providing savings information at the individual level as well as information on parents and siblings for all respondents. These features enabled us to study savings behavior in an inter-generational family context in a setting in which the sharing of residence by two or more generations, as in urban China, is common. We show that the aggregation of savings at the household level in standard data sets, given high rates of inter-generational co-residence that change over the life-cycle, distorts the true picture of life-cycle savings. More importantly, we show, within the context of a theoretical model in which two generations jointly choose their consumption paths, the amounts of inter-generational financial assistance, and whether to share the parental residence, that the option of co-residence facilitates

[26]The restriction of having an eligible adult child for both older twins in the pair reduces the sample of older twins by about one-third. While this sample is not therefore fully representative of all twins in the age group 46-60, there is no obvious reason why this sample selection should bias the within-twin estimate of the co-residence effect.

high savings rates for the young.

To test a number of assumptions embedded in the model and some of its predictions, we exploited another feature of our data, the presence of adult twin pairs. Using a variety of standard methods that exploit twins data, we obtained estimates that indicated support for the model, including that individuals born into larger families provide less financial support to parents, have lower human capital, and are more likely to co-reside with parents when young. Consistent with these effects of family size, we found no effect of the number of siblings on the savings rates of the young. We also found, consistent with the model, that inter-generational co-residence is lower the higher the incomes of the young but higher when the parents have higher incomes and that inter-generational co-residence, net of income, is associated with higher savings for the young but not higher savings for the old.

All of these results, in addition to the direct evidence we adduce on the magnitudes of financial transfers across generations, suggest that in urban China neither old-age support by the young nor the one-child policy are major factors underlying the relatively high savings rates of the urban young. Rather, currently high housing costs and the prevalence of inter-generational shared housing, which itself is made more attractive when the price of housing services is high, are key reasons for the higher savings rates for the urban young in China. Indeed, our results suggest that if relaxing constraints on fertility increases family size, this will increase the amount of inter-generational co-residence and may further raise the relatively high savings rates of the urban young to the extent that the resulting population growth further increases housing costs.

While we have used data from China to explore the interrelationships between the joint residence of two generations and life-cycle patterns of savings, our findings may have relevance for many developing countries, many of which are experiencing both rising rates of inter-generational co-residence and rising urban housing costs. The linkage between savings and co-residence also suggests that there may be value in moving from the traditional unit for the collection of survey data - the household - towards an approach that focuses on individuals and families, and in which therefore a household roster is only one of many endogenous characteristics of a family.

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Figure 1. Savings Rate, by Head's Age
(Source: Urban Household Survey 2002)

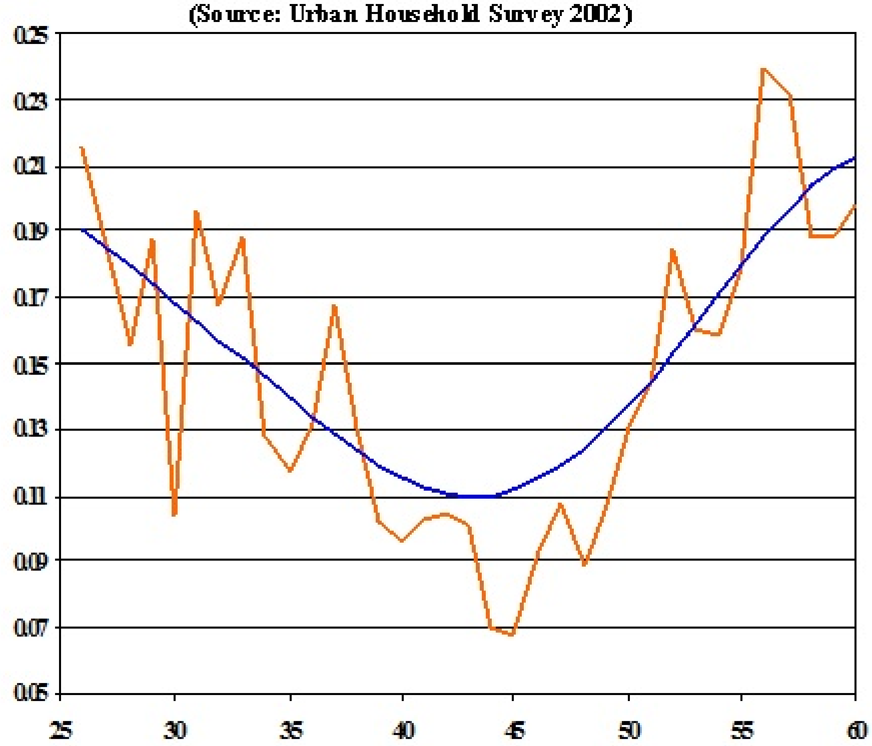

Figure 2. Savings Rate, by Head's Age
(Source: Urban Household Survey 2009)

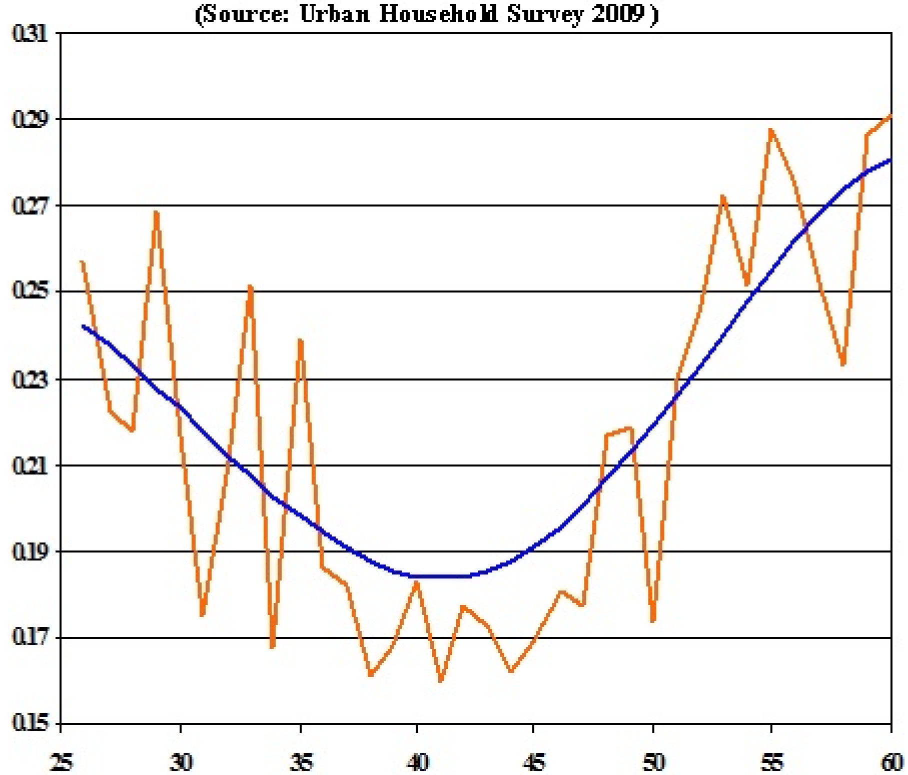

Figure 3. % Saving Rate by Head's Age in Japan (1974) and the United States (1972-73) (Source: Hayashi, 1997)

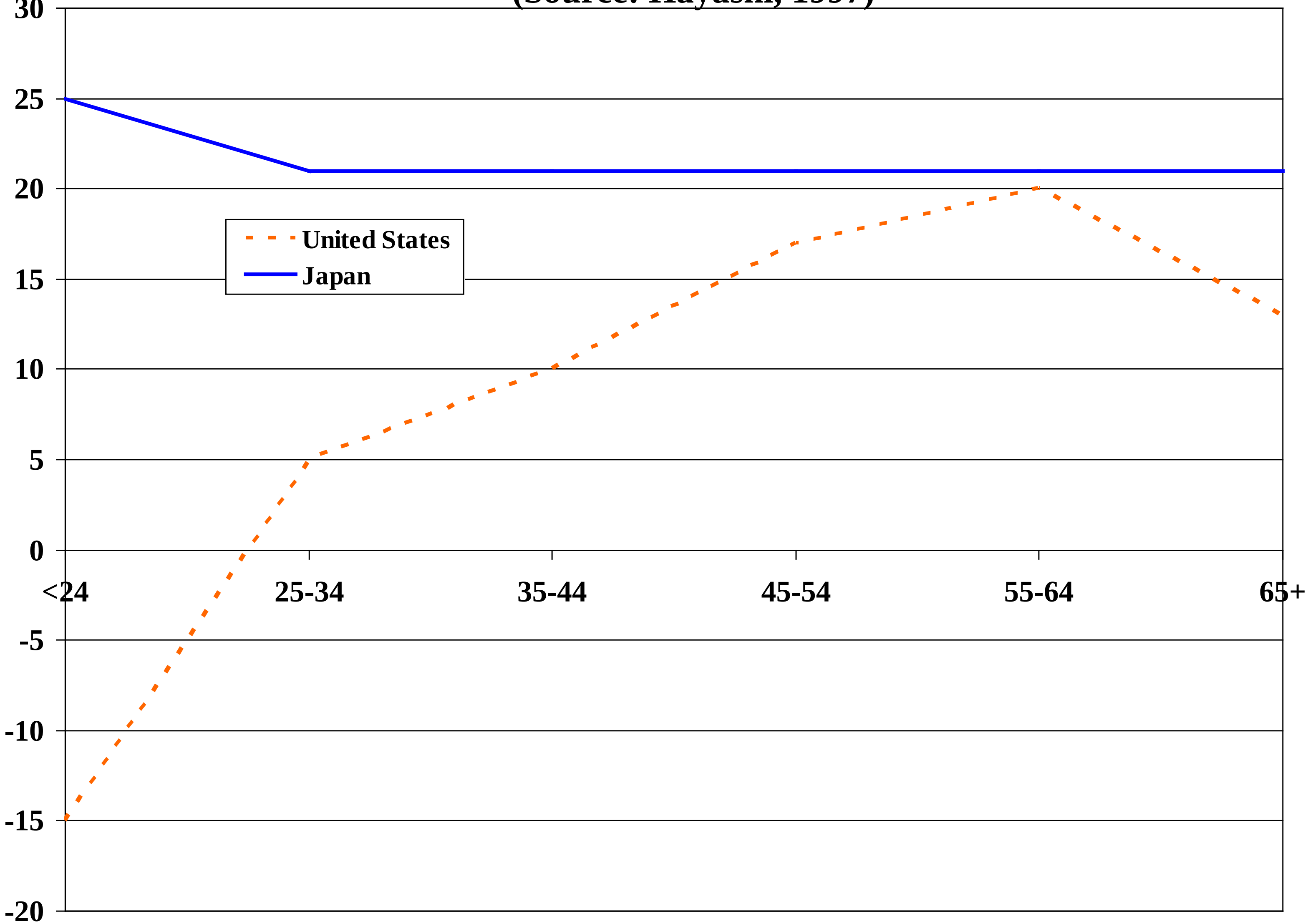

Figure 4. Total Household Income and Individual Income, by Age of Respondent (Source: 2002 China Urban Household Survey)

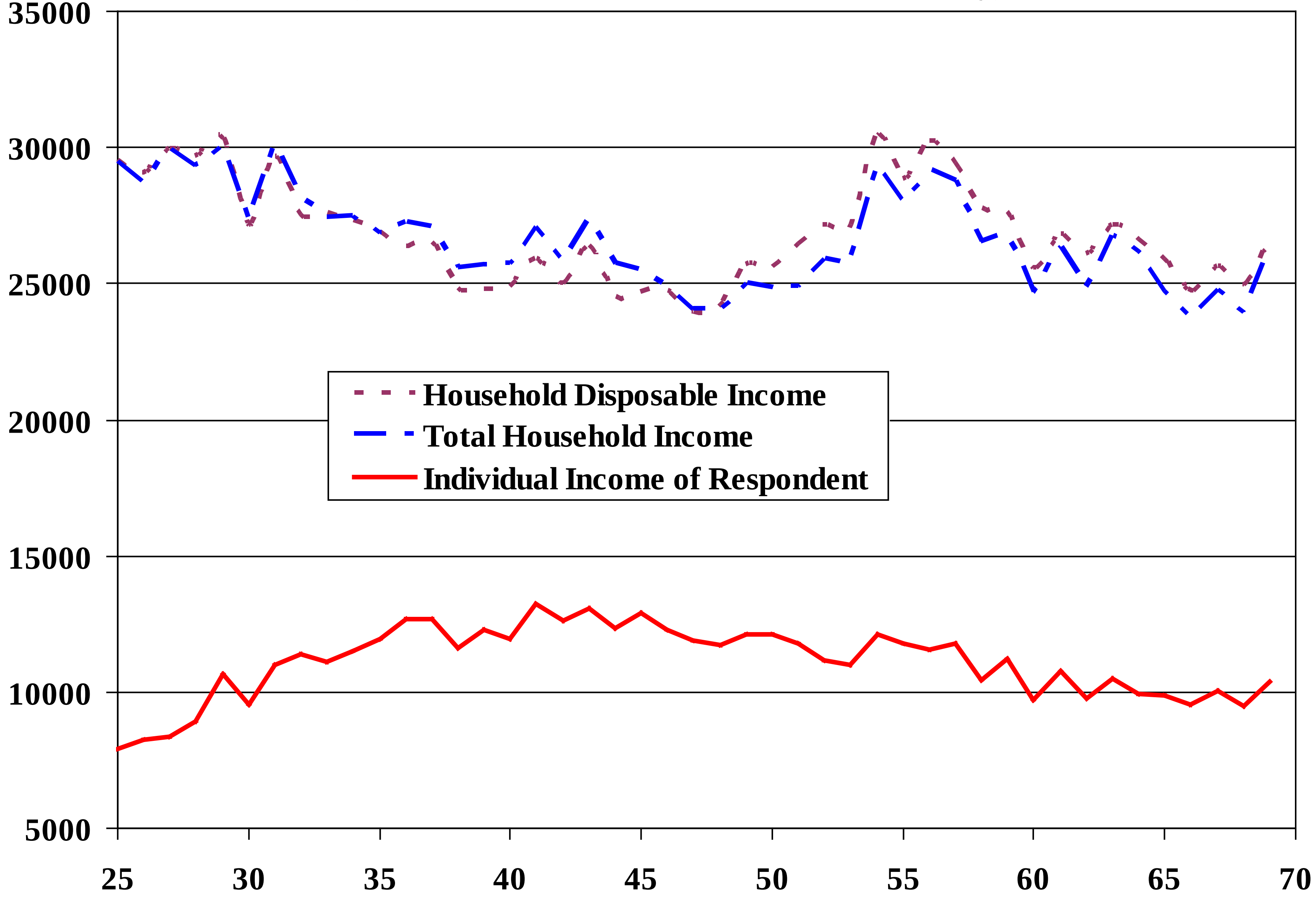

Figure 5. Fraction of Males Co-residing with Parents or In-Laws and Who are Heads of Households, by Individual Age (Source: 2002 UHS)

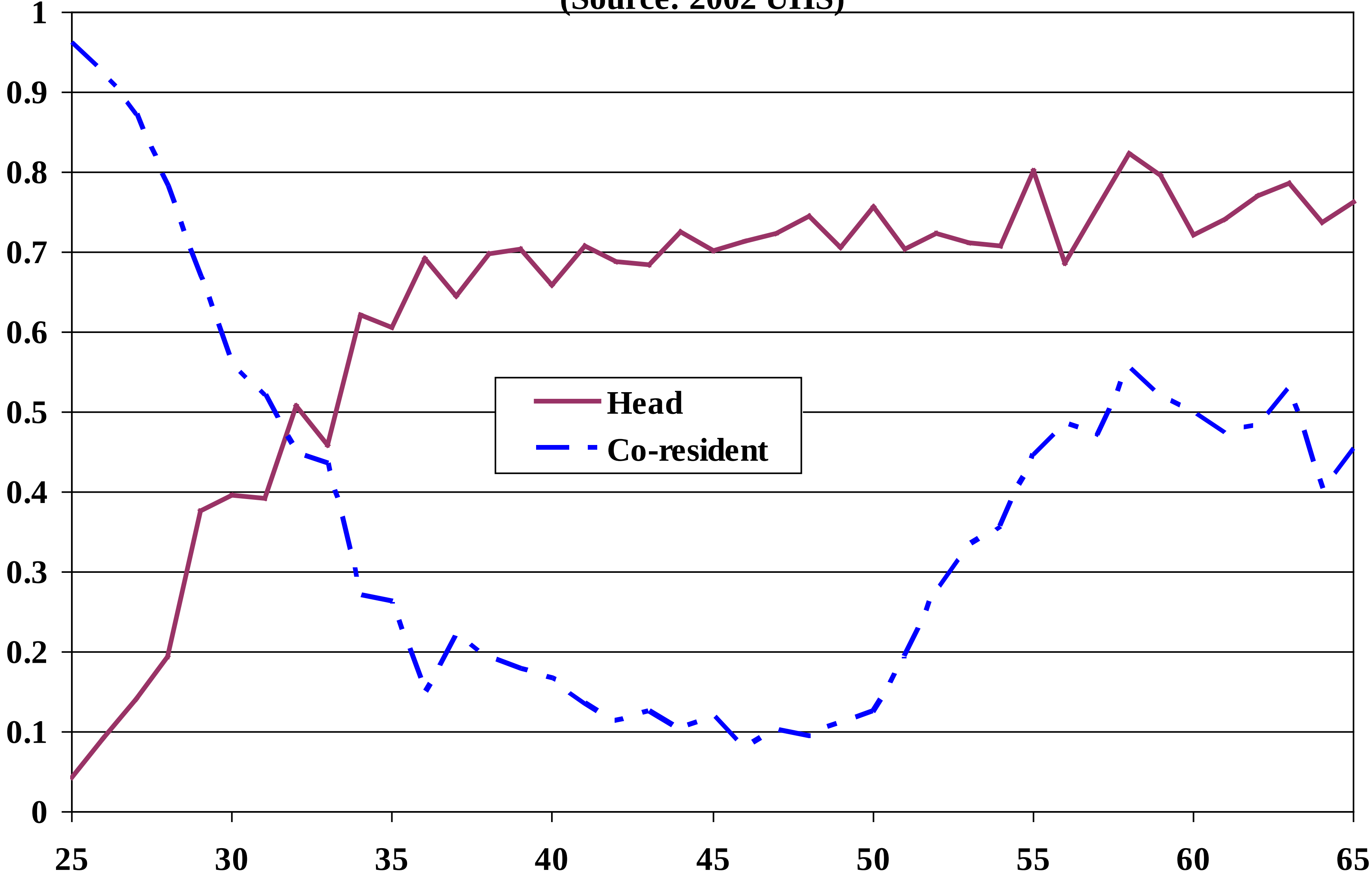

Figure 6. Fraction of Males Co-residing with Parents or In-Laws , by Age and Sample (Source: 2002 China Twin and Non-twin Surveys)

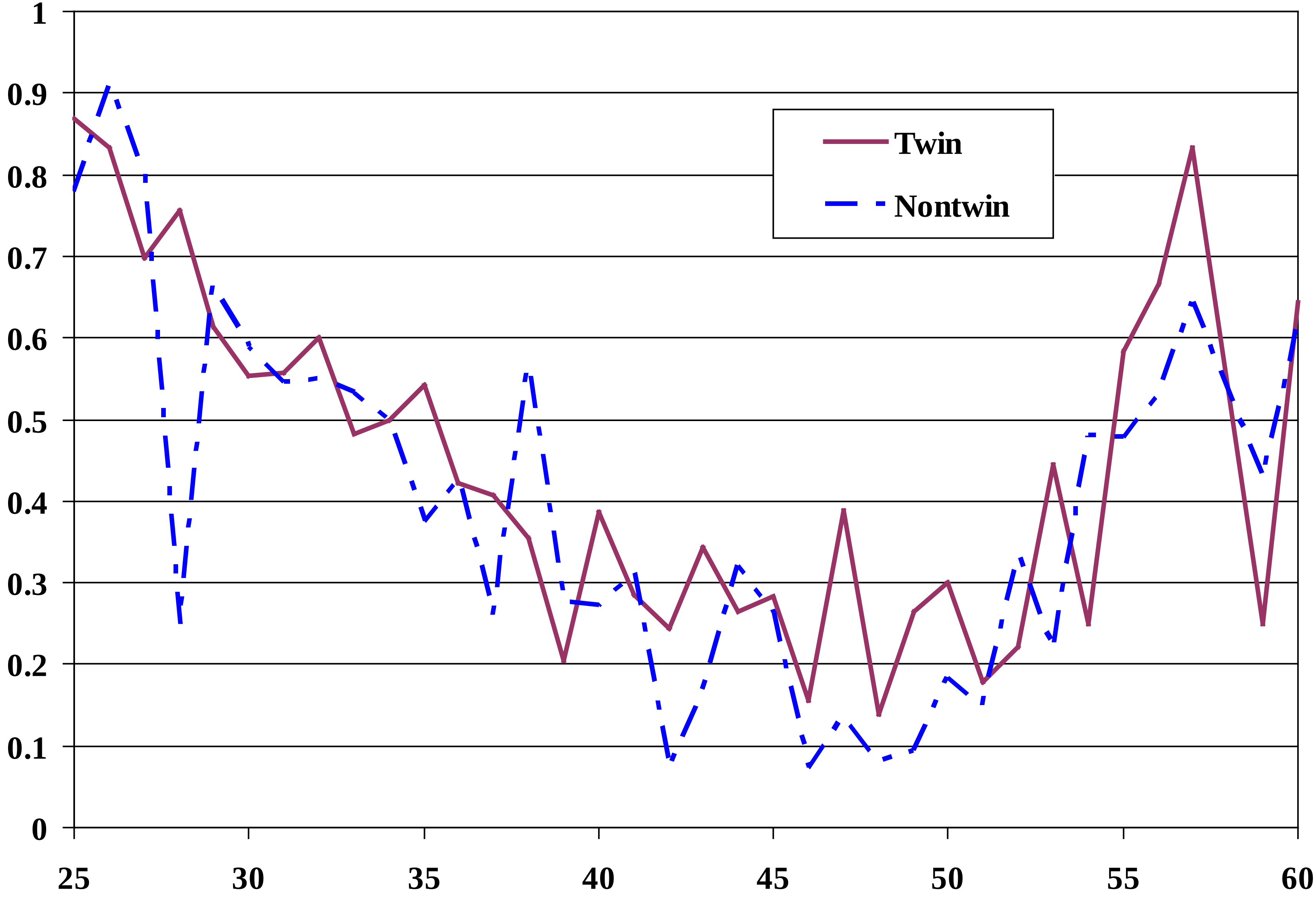

Figure 7. Savings Rate, Men 25-60, by Age
(Source: Adult Twins and Non-Twins Data)

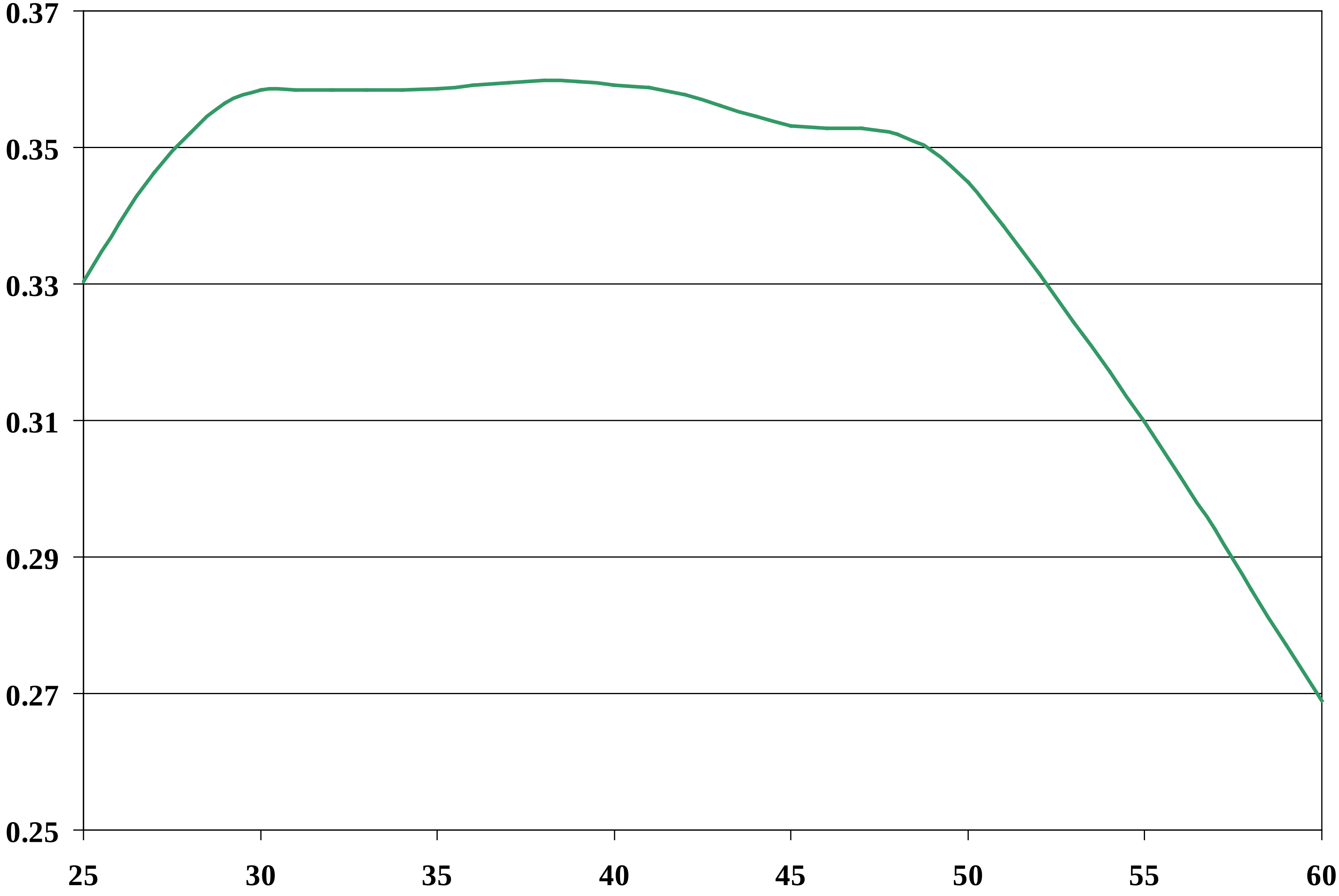

Figure 8. Fraction of Males Relying Mainly on Family Financial Support, by Age
(Source: 2005 Chinese Mini Census)

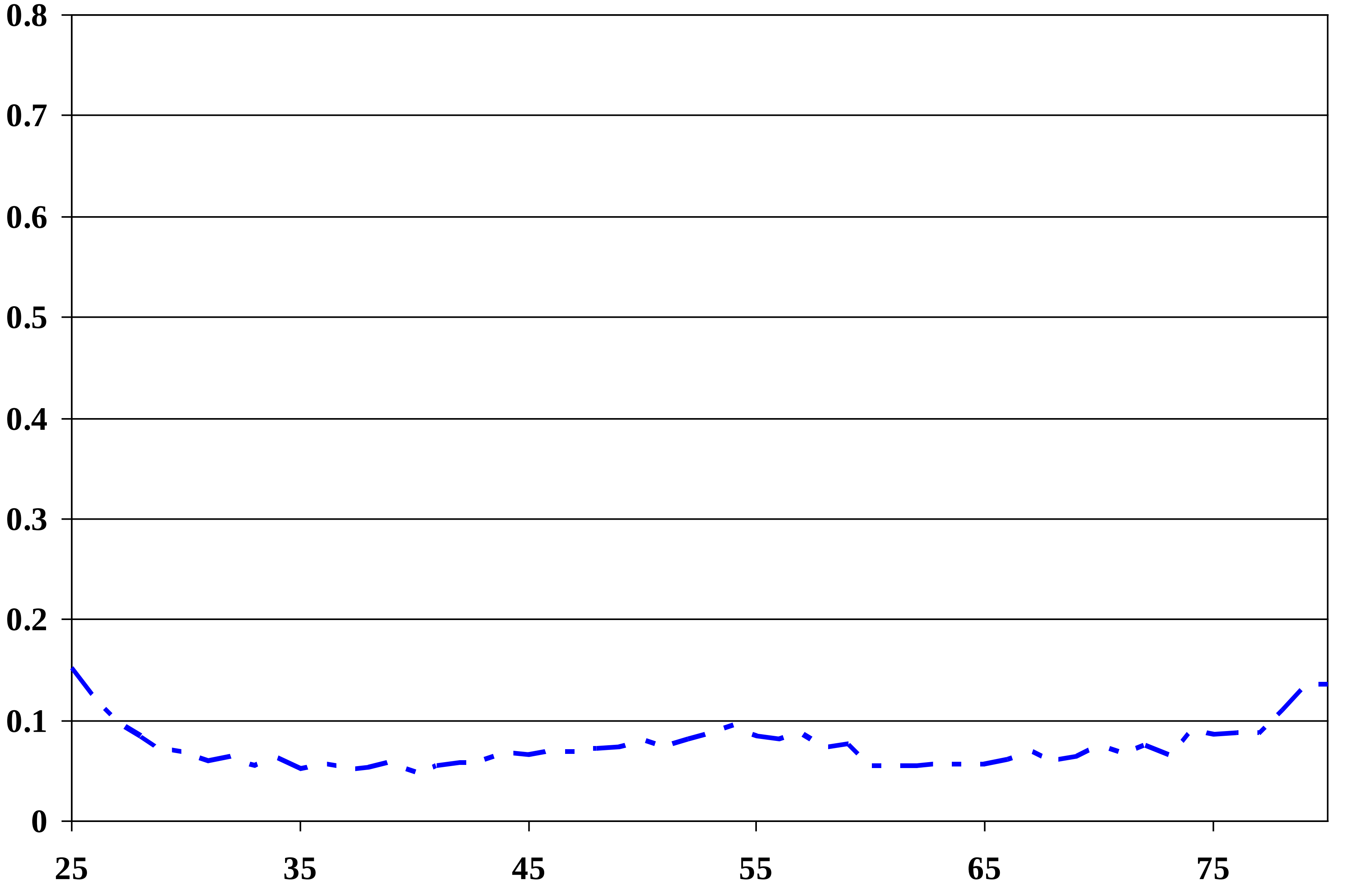

Figure 9. Mean Annual Net Transfer to Parents (Lowess-smoothed), by Age and Sample (Source: 2002 China Twin and Non-twin Surveys)

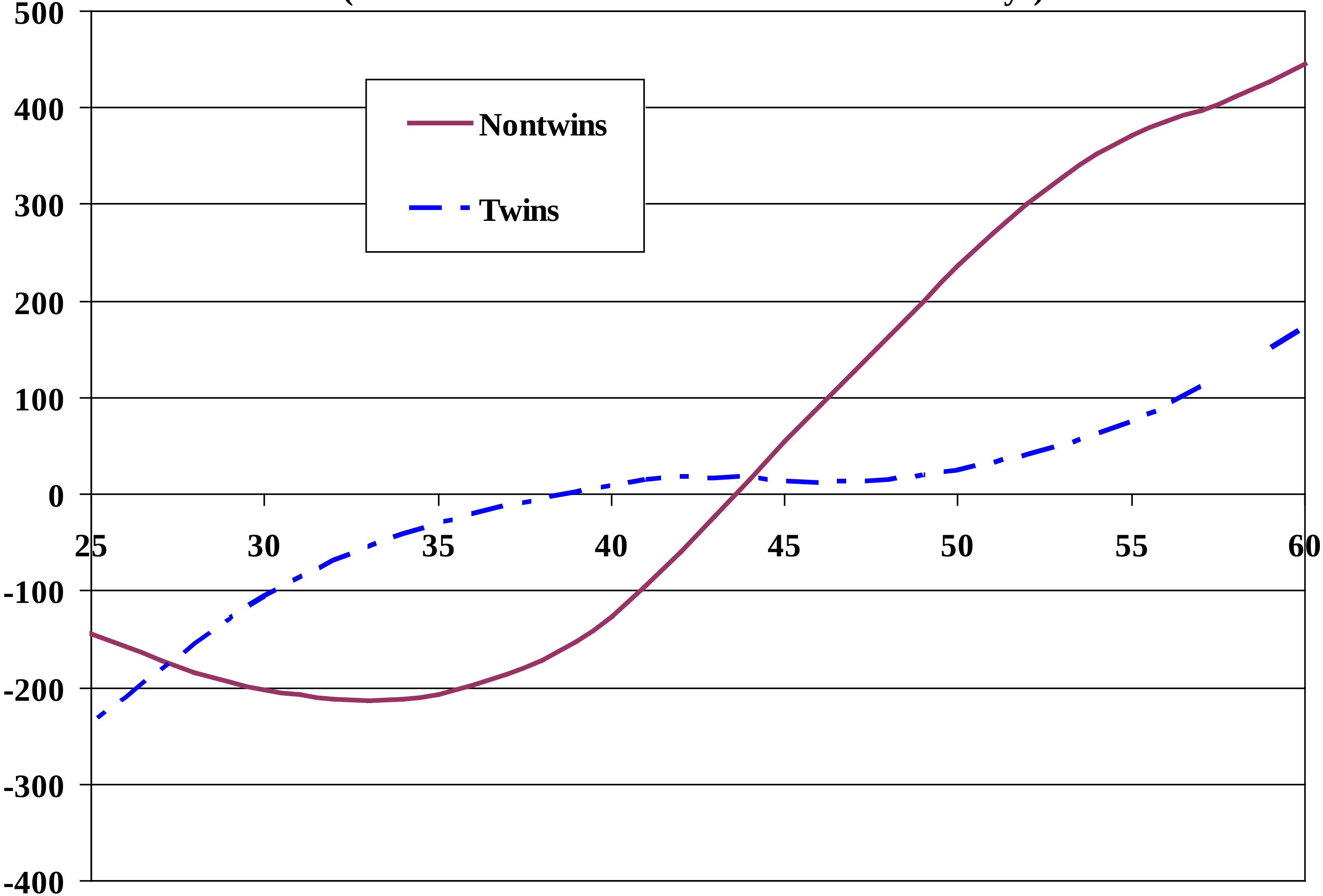

Table 1
Variable Means (Standard Deviations), by Sample: Males Aged 25-45

Variable	All Twins	First-birth Twins	All Singletons
Total siblings	2.57	2.38	1.84
	(1.42)	(1.68)	(1.23)
Schooling (years)	11.5	12.2	11.8
	(3.17)	(3.07)	(3.15)
Birthweight	2.53	2.50	3.19
	(0.64)	(0.62)	(0.54)
Mother's age at birth	28.1	25.9	28.2
	(4.97)	(4.01)	(5.64)
Father in skill occupation	.515	.563	.439
	(.500)	(.497)	(.497)
Mother in skill occupation	.284	.362	.239
	(.451)	(.481)	(.427)
Age	33.9	32.2	37.2
	(6.20)	(5.90)	(5.74)
Co-resident with parent	.487	.563	.364
	(.500)	(.497)	(.482)
Any transfers to parent	.061	.084	.139
	(.241)	(.277)	(.347)
Saving rate	.357	.350	.358
	(.333)	(.383)	(.367)
Monthly wage	42.2	42.4	40.9
	(29.3)	(29.1)	(23.1)
N	1124	422	364

Table 2
OLS Estimates of the Effects of Twinning on Number of Siblings, by Sample:
Male Respondents Aged 25-45

Sample	Singletons + All Households with Twins	Singletons + Households with First-birth Twins
Twin birth in household	.911 (10.6)	.437 (5.01)
Mother's age at birth of twin	.0932 (9.11)	-.0292 (3.32)
Father skill occupation	.0307 (0.34)	-.118 (1.51)
Mother skill occupation	-.477 (5.07)	-.108 (1.60)
N	1,311	517

Absolute values of *t*-ratios clustered at the household level in parentheses.

Table 3
OLS and IV (Twins-First) Estimates of the Effects of Number of Siblings on Schooling Attainment (Years): First-born Respondents Aged 25-45

Estimation procedure	OLS	IV (Twins-First)
Number of siblings	-.271	-.996
	(1.92)	(2.06)
Father skill occupation	.868	.877
	(3.22)	(3.24)
Mother skill occupation	.154	.0861
	(0.60)	(0.32)
N	960	960

All specifications include the respondent's sex, age and age squared. IV specification also includes the mother's age at first birth. Absolute values of *t*-ratios clustered at the household level in parentheses.

Table 4
Single-equation and IV (Twins-First) Estimates of the Effects of Number of Siblings on Transfers to Parents, Co-Residence with Parents and Savings Rate: First-Born Males Aged 25-45 with at Least One Parent Alive

Variable	Transfers to Parents		Co-Reside with Parents		Savings Rate	
Estimation procedure	Probit	IV-Probit	Probit	IV-Probit	OLS	IV
Number of siblings	.0508 (0.45)	-.684 (2.05)	-.152 (1.52)	.648 (2.38)	.0121 (0.63)	.0801 (1.06)
Father in skill occupation	.162 (0.89)	.0608 (0.33)	.180 (1.25)	.288 (2.05)	.0476 (1.38)	.0378 (1.08)
Mother in skill occupation	.00677 (0.04)	-.0937 (0.58)	-.0182 (0.12)	-.00226 (0.02)	.0218 (0.60)	.0469 (1.29)
N	521	521	540	540	531	531
Wald test of exogeneity ($\chi^2(1)$,[p])	3.98 [0.046]		6.31 [0.012]		-	
Durbin-Wu F [p]	-		-		1.28 [0.37]	

All specifications include the respondent's age and age squared. IV specifications also include the mother's age at first birth. Absolute values of *t*-ratios clustered at the household level in parentheses.

Table 5
Estimates of the Effect of the Monthly Wage on Transfers to Parents, Co-Residence with Parents and Savings Rate, by Estimation Procedure:
Male Twins Aged 25-45 with at Least One Parent Alive

Variable	Transfers to Parents		Co-Reside with Parents		Savings Rate	
Estimation procedure	Logit	Conditional Logit	Logit	Conditional Logit	OLS	Within-Twin
Daily wage	- .00109 (0.28)	-.00115 (0.15)	-.0122 (3.45)	-.0227 (2.03)	.000953 (2.12)	.000950 (2.04)
N	622	622	650	650	636	636

All OLS specifications include the respondent's age and age squared and parent occupation variables. Absolute values of *t*-ratios clustered at the household level in parentheses.

Table 6
Within-Twin and Within-Twin IV Estimates of the Effect of Co-Residence and Respondent Income on Respondent Savings, by Generation: Male Twins Aged 25-45 and 46-60

Age group	25-45		46-60	
Estimation procedure	Within-Twin	Within-Twin IV	Within-Twin	Within-Twin IV
Co-resident	1265.2 (1.65)	2960.5 (2.86)	316.5 (0.13)	316.3 (0.13)
Respondent Income	.0219 (2.04)	.226 (5.78)	.232 (7.00)	.257 (2.93)
N	1094	1094	322	322

The instrument for the within-twin IV estimates is the cross-twin report of annual earnings of the respondent. Absolute values of *t*-ratios clustered at the household level in parentheses.

Appendix Tables

Table 1a
OLS Estimates of the Probaility of Being the Household Head:
Male respondents Aged 25+ in Households with 2+ Adult Males
(2005 Chinese Mini-Census)

Variable	Coefficient
Age	.00529 (6.81)
Oldest adult male	.373 (17.1)
Annual earnings	.000063 (7.95)
Highest-earning male	.0536 (4.70)
Family financial support is main income source	-.238 (14.4)
Any non-earnings income	.0676 (4.03)
N	55,771

Absolute values of *t*-ratios clustered at the household level in parentheses.

Table 2a
OLS Estimates of the Effects of Twinning on Own Birthweight, by Sample:
Male Respondents Aged 25-45

Sample	All Births	First-births
Twin birth	-.638	-.633
	(16.4)	(10.4)
Mother's age at birth of twin	.00591	.0119
	(1.37)	(1.33)
Father skill occupation	.0389	.0460
	(0.86)	(0.56)
Mother skill occupation	-.101	-.0360
	(0.20)	(0.45)
N	1,311	517

Absolute values of *t*-ratios clustered at the household level in parentheses.

Table 3a
OLS and Within-twin Estimates of the Effects of Birthweight on Schooling Attainment (Years):
Male Twins Aged 25-45

Estimation procedure	OLS	Within-twin
Birthweight	0.0212	.0875
	(0.16)	(0.45)
Father skill occupation	.906	-
	(4.22)	
Mother skill occupation	1.55	-
	(7.59)	
N	1,119	1,119

Absolute values of *t*-ratios clustered at the household level in parentheses.

Appendix A

Proof of Proposition 1 that $S_{k,NC}^{2*} < S_{k,C}^{2*}$.

For this to be true the following must also be true:

$$C_{k,NC}^{2*} \le C_{k,C}^{2*} \le C_{k,NC}^{2*} + \pi_k h.$$

Proof of the first inequality:

Given the assumed constant income stream for the young, it must be true that optimized consumption is equal across periods for the non co-resident $C_{k,NC}^{2*} = C_{k,NC}^{3*}$. Moreover, for the co-resident young in period 2 $C_{k,C}^{2*} < C_{k,C}^{3*}$ because of the disutility of co-residence.

The second inequality can be proved as follows:

Assume that $C_{k,C}^{2*} > C_{k,NC}^{2*} + \pi_k h$, then we have

$$C_{k,C}^{3*} > C_{k,C}^{2*} > C_{k,NC}^{2*} + \pi_k h,$$

from the first inequality. Thus it follows that

$$C_{k,C}^{2*} + C_{k,C}^{3*} > 2C_{k,NC}^{2*} + 2\pi_k h,$$

Note that the disposable income, denoted as W_d, under either regime is labor income ($2Ew(N)$) plus transfer (τ) minus old-age support to parents ($\frac{\overline{R}-P}{N}$). And the disposable income is used for consumption and housing services. Under the non-co-residence regime, $C_{k,NC}^{2*} + C_{k,NC}^{3*} + 2\pi_k h = W_d$. Because housing services are purchased in both periods 2 and 3 in the non co-residence regime, it must hold that $W_d = C_{k,NC}^{2*} + C_{k,NC}^{3*} + 2\pi_k h = 2C_{k,NC}^{2*} + 2\pi_k h = W_d$, which in turn implies that $C_{k,C}^{2*} + C_{k,C}^{3*} + \pi_k h > C_{k,C}^{2*} + C_{k,C}^{3*} > W_d$. This is a contradiction.

Thus $C_{k,C}^{2*} < C_{k,NC}^{2*} + \pi_k h$, which leads to $S_{k,C}^{2*} > S_{k,NC}^{2*}$. That is, the optimal savings at period 2 under the co-residence regime is larger than that under the non-co-residence regime.

Appendix B

Proof that an increase in the cost of housing services increases young savings in the co-residence regime but not in the non-co-residence regime.

Optimal savings in the non-co-resident and co-resident regimes are given by

$$S_{k,NC}^{2*} = Ew(N) + \tau - C_{k,NC}^{2*} - \pi_k h,$$

$$S_{k,C}^{2*} = Ew(N) + \tau - C_{k,C}^{2*}.$$

To understand the impact of higher housing cost on young savings in period 2, we derive the partial derivative of optimized consumption C_k^{2*} with respect to π_k.

For the non-co-residence regime $C_{k,NC}^{2*}$ and $C_{k,NC}^{3*}$ are determined using

$$U_{k1,NC}^{2*} = U_{k1,NC}^{3*},$$

$$C_{k,NC}^{2*} + C_{k,NC}^{3*} + \frac{\overline{R} - P}{N} + 2\pi_k h = 2Ew(N) + \tau.$$

so that $C_{k,NC}^{2*} = C_{k,NC}^{3*} = \mathbf{C}_{k,NC}^{*}$ and $2dC_{k,NC}^{*} + 2hd\pi_k = 0,$ which in turn yields

$$\frac{\partial C_{k,NC}^{*}}{\partial \pi_k} = -h,$$

$$\frac{\partial S_{k,NC}^{2*}}{\partial \pi_k} = 0.$$

Housing costs have no impact on the optimal savings in period 2 for the young in the non-co-residence regime. This is because housing costs and consumption are equal across periods. In the co-residence regime, however, a rise in the housing cost does not affect disposable income $Ew(N) + \tau$ in period 2 but decreases resources available for consumption in the third period. Savings must therefore increase in period 2 to maintain the equality of marginal utilities across periods.

Appendix C

Proof that a permanent increase in the wage rate of the young reduces the relative utility of co-residence.

The impact of a permanent increase in the child's wage on optimized utility in either regime is always positive, and given by

$$\frac{\partial V^{NC}}{\partial w} = \frac{\partial L}{\partial w}\bigg|\mathbf{C}_{NC}^{*} = 2E\lambda_2\big|\mathbf{C}_{NC}^{*} = 2EU_{k1}^{3}\big|\mathbf{C}_{NC}^{*}$$

for the co-residence regime, and

$$\frac{\partial V^{C}}{\partial w} = \frac{\partial L}{\partial w}\bigg|\mathbf{C}_{C}^{*} = 2E\lambda_2\big|\mathbf{C}_{C}^{*} = 2EU_{k1}^{3}\big|\mathbf{C}_{C}^{*}.$$

for the non-co-residence regime, where λ_2 is the Lagrangian associated with the income constraint of the representative child.

Because, as shown, $\mathbf{C}_{k,NC}^{*} \le \mathbf{C}_{k,C}^{*}$, the increase in V^{NC} is larger than that in V^{C} when there is a wage increase, so that $\Delta DV = \Delta V^{NC} - \Delta V^{C} > 0$, where $DV = V^{NC} - V^{C}$. This implies that for the family indifferent between the two regimes, a wage increase will induce a shift to non-co-residence.

Appendix D

Derivation of the relationship between the number of siblings and second-period savings in the co-residence regime.

Under the co-residence regime, substituting into the budget constraint optimized consumption in periods 2 and 3, we have

$$dC_{k,C}^{2*} + dC_{k,C}^{3*} = 2Ew'(N)dN + \frac{\overline{R} - P}{N^2} dN \, .$$

Given the equality of marginal utilities across periods, we also have the following relationship for $dC_{k,C}^{2*}$ and $dC_{k,C}^{3*}$:

$$U_{k11}^2 dC_{k,C}^{2*} + h\delta_1(N,Y_p)U_{k12}^2 dN = U_{k11}^3 dC_{k,C}^{3*},$$

where U_{k11}^2 is the partial derivative of $U_{k1}^2(C_k^2, \delta(N,Y_p)h)$ with respect to the first argument, that is, the second partial derivative of U_k^2 with respect to consumption. This is negative by assumption. Similarly, U_{k12}^2 is positive and U_{k11}^3 is negative. From the last equation we can solve $dC_{k,C}^{2*}$ in terms of $dC_{k,C}^{3*}$. Furthermore, given second-period optimal savings, defined from the period-2 savings function $S_k^2 = Ew(N) + \tau - C_k^2$ we get

$$dS_{k,C}^{2*} = Ew'(N)dN - dC_{k,C}^{2*}.$$

Combining the above, we thus have

$$dS_{k,C}^{2*} = Ew'(N)dN - \left[\frac{2Ew'(N) + \frac{\overline{R}-P}{N^2} - \frac{U_{k12}^2}{U_{k11}^3} h\delta_1(N,Y_p)}{1 + \frac{U_{k11}^2}{U_{k11}^3}} \right] dN \, .$$

Appendix E

Proof that an increase in parents' income increases the relative utility of co-residence.

The marginal impact of parents' income, either in period 1 or 2, on family utility V is λ_1, the Lagrangian associated with the parent income constraint. It is easy to show that $\lambda_1 = U_3^1 = U_{p1}^2 = U_{p1}^3$. Under the non-co-residence regime we have

$$\frac{\partial V^{NC}}{\partial Y_p} = \lambda_1 \Big| \mathbf{C}_{p,NC}^* = U_{p1}^2 \Big| \mathbf{C}_{p,NC}^* = U_{p1}^3 \Big| \mathbf{C}_{p,NC}^* \, .$$

Similarly, under the co-residence regime

$$\begin{aligned}
\frac{\partial V^C}{\partial Y_p} &= \left[\lambda_1 + U_{k2}^2 h\delta_2(N,Y_p) \right] \Big| \mathbf{C}_{p,k,C}^* \\
&= \left[U_{p1}^2 + U_{k2}^2 h\delta_2(N,Y_p) \right] \Big| \mathbf{C}_{p,k,C}^* \\
&= \left[U_{p1}^3 + U_{k2}^2 h\delta_2(N,Y_p) \right] \Big| \mathbf{C}_{p,k,C}^*
\end{aligned}$$

where $\mathbf{C}_{p,k}^*$ indicates the vector of the optimal consumption levels of the parents and kids. Then

$$\begin{aligned}
\Delta DV &= \Delta V^{NC} - \Delta V^C \\
&= U_{p1}^2 \Big| \mathbf{C}_{p,NC}^* - \left[U_{p1}^2 + U_{k2}^2 h\delta_2(N,Y_p) \right] \Big| \mathbf{C}_{p,k,C}^*
\end{aligned}$$

$$= -U_{k2}^{2} h \delta_2(N, Y_p) \Big| \mathbf{C}_{k,C}^{*} > 0 \,,$$

since $U_{p1}^{2} \Big| \mathbf{C}_{p,NC}^{*} = U_{p1}^{2} \Big| \ \mathbf{C}_{p,k,C}^{*}$. Thus, if the family is indifferent between regimes, an increase in parental income would lead to the choice of co-residence.