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Filial piety matters: A study of intergenerational supports and parental health

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ABSTRACT

Eldercare has become a major challenge in China. As intergenerational support from children remains the primary source of caregiving, this paper investigates the impact of such support on parents' health outcomes. Exploiting data from the China Health and Retirement Longitudinal Study (CHARLS), we adopt the Heckman selection model and ordered probit model with instrumental variables, the firstborn son and firstborn daughter, to control for the potential endogeneity existing between intergenerational support and parents' health outcomes. Our results suggest that intergenerational support, including emotional and financial support, is effective in improving parental health status, including physical and psychological well-being and performance of activities of daily living (ADL) and instrumental activities of daily living (IADL). Emotional support also improves parental cognition. Children have trade-offs between emotional and financial support. Our findings provide insight into more efficient healthcare for the elderly.

1. Introduction

China has an aging society and continues to age more rapidly than any other countries. According to the Seventh National Population Census, the country had 260 million elderly people in 2020, accounting for 18.70 percent of the total population. The proportion of the population aged 60 and over increased by 5.44 percentage point from 2010 to 2020. The aging of the baby boomers, coupled with an increase in life expectancy, has created challenging social problems in China, including a growing need for eldercare and economic support for the elderly (Smith et al., 2014) (see Fig. 1).

Historically, China has not supplied formal, comprehensive long-term care for the elderly (Feng et al., 2012). Due to the important role played by the family in caring for elderly relatives, transfers from family members, especially children, remain central to the economic well-being of most elders in China. Intergenerational support from children, which commonly take the forms of co-residence, time, and money, are fundamental aspects of the social fabric (Biddlecom et al., 2002). Therefore, it is imperative that decision makers understand the effects of intergenerational care when implementing new policies relating to social services for the elderly.

The primary objective of this paper is to investigate the impact of intergenerational support on parental health outcomes. Children, as the dominant source of care for older people in China, provide support for their parents through co-living, transfer payments, and contacts. Exploiting data from China Health and Retirement Longitudinal Study (CHARLS), we explore how emotional and financial intergenerational support affects parental health. Specifically, we use an ordered probit model to estimate the effect of emotional and financial support. To account for the endogeneity induced by reverse causality (parental health status also affects children's behavior), we use instrumental variables: whether a child is the firstborn son or firstborn daughter or neither. Furthermore, we use a Heckman (1979)'s selection model to adjust for self-selection bias.

We find that both emotional and financial support are effective in improving parental health. Filial support improves parental self-reported health, where a 1% increase in money transfer is equivalent to additional 0.16–0.3 days accompanied. In other words, doubling the transferred money has a similar effect of accompanying parents with 16–30 days on their health status. In addition, such support significantly decreases the probability of being diagnosed as depression of parents. Emotional and financial support also improve parental ability to

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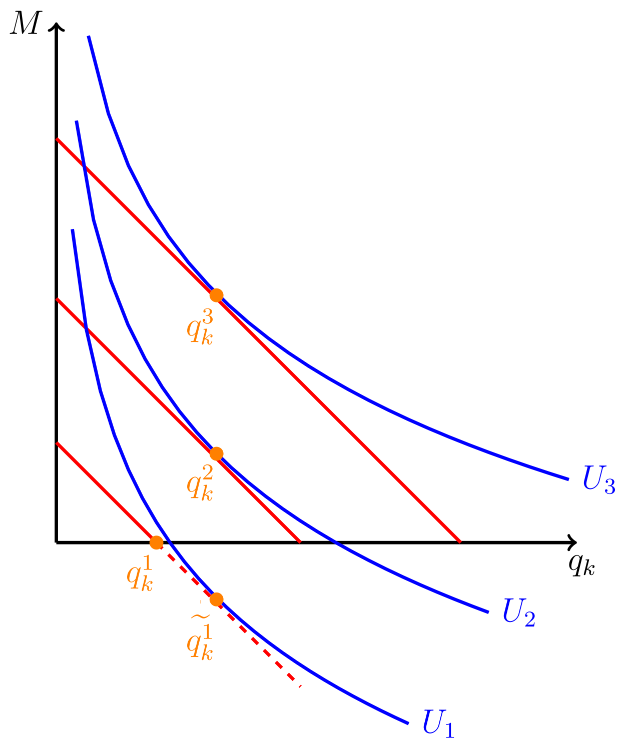

Fig. 1. Utility Maximization with Quasi-linear Utility
Note: This figure presents the consumer's utility maximization problem with a quasi-linear utility function. The blue curves represent indifference curves such that $U_1 < U_2 < U_3$. The red lines are the budget constraints for the same price but different income levels. The orange plots q_k^1, q_k^2, and q_k^3 represent the optimal consumption bundle in each case. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

perform activities of daily living (ADL) and instrumental activities of daily living (IADL). In contrast, only emotional support improves cognitive status; financial support has comparably less effect, especially for the mother.

Our study investigates the effects and channels of intergenerational support on parental well-being. This research is crucial for several reasons. First, intergenerational support is increasingly important in countries with ageing populations. As an inevitable result of the decline in fertility rate and increase in life expectancy in China, intergenerational support from family members, especially adult children, plays a key mediating role between societal-level changes and the physical and psychological well-being of the elderly. Second, family transfers have social and economic consequences that can directly impinge on the design and effectiveness of public insurance programs for long-term care. Given the growing older population and lack of long-term care services, it is particularly critical to explore the degree to which family support is or will continue to be sufficient for the needs of the elderly in China. Healthy aging can potentially reduce both familial and societal burdens by reducing or delaying the need for economic support and eldercare.

This paper contributes to several areas of scholarship. First, it enriches the literature that has evaluated intergenerational support (Peng et al., 2019; Jia & Ye, 2019; Vecchio et al., 2018; Yang & Wen, 2021). Scholars have examined the behavioral dimensions of intergenerational support, such as emotional and instrumental support (Cong & Silverstein, 2008; Djundeva et al., 2015; Jia & Ye, 2019). However, few have assessed the mixed effects of different measures of intergenerational support. Our study attempts to fill this gap by exploring how the interplay of filial emotional and financial support affects older parents' well-being. We calculate the trade-off between emotional and financial support—a trade-off that has economic implications for policymakers. Second, our paper provides a theoretical model to explain the mechanisms of our findings. The mechanisms of the effects of intergenerational support on health outcomes have rarely been discussed in empirical studies set in China. Third, our discussion of causality is more rigorous than similar discussions in prior studies. We adopt the Heckman selection model and instrumental variables to tackle the sample selection and endogeneity issues, respectively. CHARLS only records information about intergenerational support from non-coresident children. This may affect our sample selection as the decision to reside with parents is usually not exogenously determined (Cheng, 2019; Li & Huang, 2017). Additionally, there may exist reverse causality: the provision of informal care by children is driven by demands from elderly parents because elders in poor health are more likely to receive support and care from children. Furthermore, children's birth order and gender can affect their likelihood of providing end-of-life care to elderly parents. The filial norm is that the eldest son and eldest daughter are expected to provide most of the eldercare for their parents (Zuo et al., 2013). The birth-order variation in filial support should be orthogonal to factors that affect parents' health status. We thus adopt a set of instrumental variables—whether the child is the eldest son or eldest daughter—to control for the potential endogeneity problem. To this extent, our result is plausibly identified and indicates a positive effect of both emotional and financial support. Such identification allows us to estimate the marginal effect of corresponding counterfactual policies.

Finally, we contribute to the literature by exploring both physical and psychological health outcomes in evaluating the effects of intergenerational care. Although existing studies have focused on either physical or mental health status among older parents (Barnay & Juin, 2016; Shu et al., 2021; Wang & Li, 2012; Yang & Wen, 2021), health is multidimensional; using a single index of health may result in measurement errors (Giles & Mu, 2007). Therefore, we used several measures of health, including self-reported health (SRH), activities of daily living (ADL), instrumental activities of daily living (IADL), mental health (CESD), and cognition to ensure robust results.

The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the theoretical model. Section 4 discusses the data and descriptive statistics. Section 5 presents the empirical framework. Section 6 reports the results and their implications. Section 7 is the conclusion.

2. Literature review

The aging of the population has prompted research into the effects of intergenerational support on parental health. Theoretical models in this domain tend to focus on the family-decision making process and health promotion (Bolin et al., 2001; Byrne et al., 2009; Grossman, 2017; Van Houtven & Norton, 2004). For instance (Lee et al., 1995), studied intergenerational financial support and coresidence of adult children and their parents in Taiwan. They discussed three theoretical models of intergenerational relations: the power/bargaining, mutual aid, and altruism/corporate-group models (Bolin et al., 2001). assumed that each family member acts as a producer not only of his own health but also of the health status of other family members, with behaviors within a family interacting strategically.

Empirical research regarding intergenerational support has had mixed results. Some studies suggest that intergenerational support is strongly associated with improved health, especially mental health, in the elderly (Cong & Silverstein, 2008; Barnay & Juin, 2016; Shu et al., 2021). As a kind of informal care, intergenerational support, especially emotional support, can positively impact health by reducing the stresses of old age. Compared with formal care, intergenerational support has been found to reduce the risk of depression among the elderly and produce a long-term reduction in depression rates among elders (Barnay & Juin, 2016). However, a few studies have suggested that support, especially excessive support, received from family members may worsen an elderly parent's mental health by inducing dependence and placing a burden on caregivers (Dunham, 1995; Lee et al., 1995; Silverstein et al., 1996). Peng et al. (2019) found that elders experience higher levels of self-esteem and independence when providing financial support to their children than when receiving it. This results in improved well-being.

Studies conducted in China show that receiving intergenerational support from children, including monetary (Guo et al., 2017; Wu, 2021) and emotional support (Liu et al., 1995; Ping et al., 2017; Wu, 2021), has positive effects on psychological well-being in the elderly. For instance, Liu et al. (1995) observed that mental health improved in the elderly when their children contacted them to provide emotional support. Wu (2021) suggested that higher parental life satisfaction is attributable to exchanging financial and emotional support with children. An important related study by Yang and Wen (2021) examined the effect of filial piety of children on parental depressive symptoms. They focus on children in a rural county of northern China. Consistent with our findings, their results also reveal a significant and negative relationship between adult children's filial piety levels and older parents' depressive symptoms. Filial piety is beneficial to improving mental health of older parents. Our analysis differs from these studies of elder health in China in the following ways. First, most previous studies have focused on parental psychological well-being. Other dimensions of health, including physical, functional, and cognitive indicators, have rarely been discussed. Second, the combined effects of emotional and financial support have often been ignored. Finally, few studies have controlled for endogeneity, which may lead to biased results.

To account for the endogeneity of intergenerational support, previous studies have employed family characteristics as instruments, such as the number of children (Van Houtven & Norton, 2004; Charles & Sevak, 2005), the distance to the nearest child and proportion of female children (Bonsang, 2009), or the sex of the children (Wolf et al., 1997; Van Houtven & Norton, 2004). Following this approach, we adopt two variables—whether the child is the eldest son or eldest daughter—as suitable instruments in a Chinese context. The care system in China is based on Confucian beliefs of filial piety and family support. This culture places the responsibility for providing care on the family (Wenyi, 2019). For reasons of birth order and gender, the eldest son and eldest daughter are likely to take a leading role among their siblings in providing parental support, including eldercare (Hansson et al., 1978; Zuo et al., 2013).

3. Theoretical model

In this part, we construct a theoretical model to describe a utility function that measures health trade-offs in the elderly. Consider a quasi-linear utility function:

$$u(q, M) = \sum_{k=1}^{K} \beta_k \varphi^k(q_k) + M \tag{1}$$

where q is a vector of health status, k represents the k'th type of health metric (i.e. physical health, mental health, daily living activities, cognition, etc.). M is the numeraire (i.e. money available). We assume that the function $\varphi^k(\cdot)$ is concave (and thus the marginal utility of health is diminishing) so that the utility function performs as a common quasi-linear one.

Such a utility function characterizes how an elder values trade-offs between health and money. A useful property of the quasi-linear utility function is that as budget constraints increase, the goods with non-linear utility end up at some optimal level, and the rest of the budget is employed for purposes with linear utility. This property makes the model plausible: in the real world, people do not infinitely pursue consumption on health.

Figure D1 presents our theoretical model of a one-dimensional health metric q_k and the numeraire M. The dot q_k^1 suggests that, when the budget is low enough, the consumer prefers to use all of the money for health, i.e. $M = 0$. The dot $\widetilde{q_k^1}$ reflects the ideal optimal consumption bundle, but in the real world, this must compromise with the non-negative consumption set.

The path $q_k^1 \rightarrow q_k^2 \rightarrow q_k^3$ represents the income effect. Since both health and the numeraire are normal goods, the income effect should be non-negative. From q_k^1 to q_k^2, the consumer has additional funds to spend to achieve a higher health level and, at the same time, the numeraire becomes positive. In contrast, from q_k^2 to q_k^3, once health consumption reaches an optimal level (where the marginal utility of health is less than that of the numeraire), the health consumption remains constant despite the availability of additional funds, i.e. $q_k^2 = q_k^3$.

Given this property, it is meaningful to see whether there is a positive income effect on the elder's health condition. If the health condition significantly improves when more money is available, we conclude that this elder currently consumes healthcare at an inefficient level. In contrast, if the health status does not change when additional money is budgeted, the elder's healthcare consumption is efficient.

Although the transfer of money from adult children is the major source of additional funds that can be budgeted, children may also spend time with parents. We define the former as financial support and the latter as emotional support. The effect of financial support is shown in the model above as the income effect. We use a production function, $q_k = f_k(X, t)$, to describe the effect of emotional care, where X is a vector of the elder's demographic characteristics and t is the time that a child spends with the elder. We assume $\frac{\partial f_k}{\partial t} \geq 0$.

A child could choose to provide emotional or financial support or both for the elder. Admittedly, the child's choice is endogenous with his/her maximization process, but we do not model that here. Instead, we focus only on the effect of support on the elder's health status. Specifically, for an optimal consumption vector $q^* = (q_1^*, q_2^*, \ldots, q_K^*)$ with a given budget level I, time spent with the elder t, and demographic characteristics X, $q_k^* = q_k^*(I, t, X)$, $k = 1, 2, \ldots, K$:

- If $\frac{\partial q_k^*}{\partial t} > 0$, $\frac{\partial q_k^*}{\partial I} > 0$, both the emotional and financial support are effective, and the current health consumption is inefficient.
- If $\frac{\partial q_k^*}{\partial t} = 0$, $\frac{\partial q_k^*}{\partial I} > 0$, only the financial support is effective, and the health consumption is inefficient.
- If $\frac{\partial q_k^*}{\partial t} > 0$, $\frac{\partial q_k^*}{\partial I} = 0$, only the emotional support is effective, and the health consumption is efficient.
- If $\frac{\partial q_k^*}{\partial t} = 0$, $\frac{\partial q_k^*}{\partial I} = 0$, neither the financial nor the emotional support are effective, and the health consumption is efficient.

In the following empirical investigation, we focus on estimating such $\frac{\partial q_k^*}{\partial t}$ and $\frac{\partial q_k^*}{\partial I}$ to investigate which of the previous four situations is representative of the real world and identify the true effects of emotional and financial supports. These results could be helpful to policy makers for the development of counterfactual simulations.

4. Data

Our data are from the China Health and Retirement Longitudinal Study (CHARLS), conducted by the China Center for Economic Research at Peking University. CHARLS is a high quality, nationally representative sample of residents ages 45 and older in China, including about 10,000 households and 17,500 individuals. To be selected for our analysis, respondents had to be 60 years of age or older and have at least one child. We discarded observations with missing values for the variables of interest and the other explanatory variable.

4.1. Key dependent variables

CHARLS contains a variety of information relating to intergenerational support, including both emotional and financial support, provided by children to their parents. Emotional support is measured by the frequency of contact with parents, and financial support is measured by financial transfers to parents, including monetary and in-kind support.

4.2. Key independent variables

We select a rich set of variables on health status and functioning from those available in CHARLS. First, self-reported health (SRH) is adopted to measure the overall health condition of elderly parents. As SRH is a subjective indicator for health, we use some alternative health measures to control potential measurement errors in SRH. To measure mental health, we employ the Center for Epidemiologic Studies Depression Scale (CESD), which has been used successfully across wide age ranges (Lewinsohn et al., 1997). The CESD is a 10-item measure that asks respondents to rate how often they experienced symptoms associated with depression (e.g., restless sleep, fearfulness, and loneliness) over the past week. Scores range from 0 to 30, with high scores indicating greater depressive symptoms. We also use two functional indicators of health: the parent's ability to perform ADL and IADL. Compromised abilities to perform ADL and IADL may increase accident risk. Finally, we use parental memory, measured by the number of words that the elder can memorize, as an indicator of cognition (more details on these health variables are supplied in Appendix A).

4.3. Summary statistics

Table 1 illustrates the summary statistics for the key variables. The first panel shows the key dependent variables for both parents, including self-reported health, depression level, ADL and IADL scores, and cognition. Self-reported health status is scored based on the elder's response to the question "Would you say your health is excellent, very good, good, fair, or poor?" (scored from 0 for poor to 4 for excellent). The mean self-reported health score is 1.38 for fathers and 1.22 for mothers, suggesting both parents generally have fair to good health. Mothers, who have an average CESD score of 10.84, have a greater likelihood of suffering from symptoms of depression than fathers (average score of 8.76). The ADL and IADL scores indicate the level of difficulty experienced by the parents in completing daily activities and instrumental activities. Fathers have lower ADL and IADL scores than mothers, suggesting that they are healthier. Fathers also score higher on cognitive ability than mothers (average cognitive scores of 2.59 and 2.44, respectively).

The second and third panels report the key independent and instrumental variables. We adopt frequency of contact with parents to measure the children's emotional support. The average contact frequency is 62.32 days per year. The financial support provided by children to parents is measured by the logarithm of money transfer, with an average value of 2.72.

The last panel shows the control variables, including results for both parents and children. The education levels of parents and children are category variables that take values from 1 to 11, with 1 representing illiterate and 11 representing possession of a doctoral degree. Children's income is also a category variable, with 1 representing no income and 11 representing an income greater than 300,000 yuan.

Table 1
Summary statistics.

Variable	Definition	Mean	SD	Min	Max
Key dependent variables					
- Father					
SRH	Father's self-reported health	1.38	0.96	0	4
CESD	Father's depression level	8.76	5.73	1	28
ADL	Father's ADL score	0.50	1.17	0	6
IADL	Father's IADL score	0.56	1.18	0	5
COGN	Father's cognitive ability	2.59	1.78	0	9
- Mother					
SRH	Mother's self-reported health	1.22	0.98	0	4
CESD	Mother's depression level	10.84	6.39	1	29
ADL	Mother's ADL score	0.60	1.24	0	6
IADL	Mother's IADL score	0.79	1.33	0	5
COGN	Mother's cognitive ability	2.44	1.84	0	10
Key independent variables					
Emotional Support	Contact frequency (days)	62.32	103.76	0	360
Financial Support	Logarithm of money transfer (yuan)	2.72	3.26	0	12
Instruments					
Eldest Son	The eldest son	0.27	0.45	0	1
Eldest Daughter	The eldest daughter	0.28	0.45	0	1
Control variables					
- Parents' information					
AgeF	Father's age	68.11	5.42	49	80
AgeM	Mother's age	65.25	5.65	48	80
EducationF	Father's education level	3.45	1.79	1	10
EducationM	Mother's education level	2.15	1.60	1	10
Household Income	Logarithm of household income	5.42	3.64	0	12
Insurance	whether parents have any insurance	0.95	0.22	0	1
Urban	if survey area is urban (=1)	0.18	0.38	0	1
# of Children	Number of children	3.62	1.50	1	9
- Children's information					
Age	Age of children	39.15	6.48	16	61
Sex	Sex (1 = female)	0.51	0.50	0	1
Married	if child is married (=1)	1.00	0.07	0	1
Education	Education level	4.55	1.90	1	11
Income	Income level (1–11)	5.12	1.41	1	11

Note: The statistics come from the China Health and Retirement Longitudinal Study in 2011. Parental depression level is measured by the Center for Epidemiologic Studies Depression Scale (CESD). ADL represents the degree of difficulty experienced in performing activities of daily living and IADL represents the degree of difficulty experienced in performing instrumental activities of daily living. Parental education level is given a value between 1 and 11, with 1 representing illiterate and 11 representing possession of a doctoral degree. Children's income is a category variable, with 1 representing no income and 11 representing an income greater than 300,000 yuan.

5. Empirical strategy

5.1. Heckman selection model

Due to the sampling design, information on emotional and financial support were only collected from non-coresident children. We do not have data that can identify care provided by children living with parents. This might affect our results as the household living arrangement may not be exogenously determined. Hence, we adopt the Heckman two-step model to overcome the sample-selection issue. In the Heckman correction, we consider the indicator "living separately" endogenous and use the inverse Mill's ratio to account for the problem.

$$d_{ih} = \mathbf{1}(\alpha_1 + \alpha_2 Z_{ih} + \alpha_3 X_{ih} + \mu > 0) \quad (2)$$

where d_{ih} represents the indicator for living arrangement, $d_{ih} = 1$ represents that the child i in household h lives separately from his/her parents and $d_{ih} = 0$ otherwise. Research of the elderly's living arrangement has shown that housing area is positively related to the likelihood of living with children in China (Fan et al., 2018). Following this logic, we adopt the number of bedrooms in the parents' house, Z_{ih}, as the instrument for living arrangement. Our hypothesis is that a larger number of bedrooms increases the probability of living together, conditional on the household income. Finally, X_{ih} indicates the control variable, including children and parents' demographic information. The results for Heckman model are shown in Table 2.

5.2. Ordered probit model

To investigate how emotional and financial support improve parental health status, we consider the following regression

$$Y_{ihg} = \beta_1 \cdot Emotional_{ih} + \beta_2 \cdot Financial_{ih} + \mathbf{X_i}\gamma_1 + \mathbf{X_h}\gamma_2 + \mathbf{K_{hg}}\lambda_g + \mathbf{K_{h,-g}}\lambda_{-g} + \varepsilon_{ihg} \quad (3)$$

Table 2
First-stage: Heckman selection model.

	Prob: Separate	Contact Freq.	Money Transfer
Num. of Bedrooms	−0.0059***		
	(0.0011)		
The eldest son	−0.29***	14.5***	−0.95***
	(0.037)	(3.83)	(0.13)
The eldest daughter	−0.19***	10.8***	−0.58***
	(0.039)	(3.87)	(0.13)
Age	0.060***	−0.19	0.19**
	(0.023)	(2.22)	(0.079)
age2	−0.036	−0.87	−0.11
	(0.029)	(2.86)	(0.098)
Sex (1 = female)	0.22***	6.84	0.59***
	(0.057)	(4.36)	(0.20)
Married	0.32	−5.33	0.91
	(0.23)	(20.3)	(0.75)
Education level	−0.0077	8.83***	−0.035
	(0.012)	(1.41)	(0.039)
Children's income			
Income: <2000 yuan	0.18*	−22.9	0.63*
	(0.11)	(15.6)	(0.35)
Income: 2000–5000 yuan	0.30***	−25.2*	0.98***
	(0.098)	(14.6)	(0.33)
Income: 5000–10,000 yuan	0.51***	−30.5**	1.70***
	(0.088)	(13.3)	(0.30)
Income: 10,000–20,000 yuan	0.66***	−26.8**	2.21***
	(0.082)	(11.8)	(0.28)
Income: 20,000–50,000 yuan	0.81***	−23.9*	2.73***
	(0.078)	(12.3)	(0.27)
Income: 50,000–100,000 yuan	1.00***	−7.69	3.50***
	(0.10)	(13.5)	(0.35)
Income: 100,000–150,000 yuan	1.27***	−11.0	4.41***
	(0.20)	(15.7)	(0.66)
Income: 150,000–200,000 yuan	1.33***	−14.2	4.73***
	(0.27)	(33.2)	(0.92)
Income: 200,000–300,000 yuan	1.22**	−24.4	4.50**
	(0.55)	(21.2)	(1.83)
Income: >300,000 yuan	0.90**	55.5	3.18**
	(0.39)	(46.1)	(1.32)
Father's age	0.0024	−0.59	0.0081
	(0.0063)	(0.63)	(0.021)
Mother's age	−0.00027	0.51	0.0023
	(0.0058)	(0.60)	(0.019)
Constant	−2.04***	43.4	−6.96***
	(0.62)	(57.6)	(2.09)
F-statistics		9.57	36.94
Observations	5805	4808	4808

Note: This table presents the coefficient estimate of the Heckman's selection model. Column 1 takes the number of bedrooms into account in the probit estimate. Columns 2 and 3 are the results that take the selection bias into account. The F-statistics is the significance level of testing the instruments jointly. All variables are demographic characteristics of the children. The coefficient estimate of income level is relative to no income. We add the province fixed effects in this model. Cluster-robust standard errors are clustered at the city level and shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

where Y_{ihg} is the outcome of the physical and mental health status of the father ($g = 0$) or mother ($g = 1$) of child i in household h. In our data, the metrics of health are discretely ranked. Hence, our regression model follows an ordered probit model rather than a linear regression. $Emotional_{ih}$ and $Financial_{ih}$ are key explanatory variables, indicating the emotional and financial support that a child i in household h provides to his/her parents. β_1 and β_2 capture the corresponding causal effect of emotional and financial support.

We have four parts in the control variables. The first part is $\mathbf{X_i}$, the demographic vector of child i, which controls for the potential correlation between parents' health and a child's characteristics. The second part is the household characteristics that are invariant in household h. The third control vector is the demographic characteristics of g in household h that directly affect g's health status. The last part, designed to eliminate any spillover effect from the spouse $-g$ in household h, is the spouse's demographic characteristics, $\mathbf{K_{h,-g}}$.

5.3. Identification

Despite controlling for the effect of oneself, the spouse, and the household, an endogeneity challenge still exists due to reverse causality. Better parental health could decrease a child's effort to provide emotional and/or financial support. Hence, β_1 and β_2 fail to identify the causal effect of such supports on the parents' health.

To account for the endogeneity, we take advantage of instrumental variables, Son_i^{1st} and $Daughter_i^{1st}$. Son_i^{1st} indicates whether child i is the eldest son among all male children, while $Daughter_i^{1st}$ indicates whether child i is the eldest daughter among all female children. The valid instrument must fulfil the "relevant" & "exclusion" criterion. First, the instruments are highly relevant to the intergenerational support since firstborns are likely to take a leading role among their siblings in providing parental eldercare support (Hansson et al., 1978; Zuo et al., 2013), considering the Confucian beliefs of filial piety in China (Wenyi, 2019). We also test the relevance by the rigorous statistical method in the result section. Second, the exclusion criterion requires that there should be no mechanism through which the firstborn child would affect parental health status other than children's intergenerational support. The exclusion restriction is only testable when the model is over-identified (Kiviet, 2020). We could not test the exclusion restriction given that our model is just identified with the same number of instruments and endogenous variables. But this assumption is well documented in literature that employed family characteristics as instruments, such as the proportion of female children (Bonsang, 2009) and the sex of the children (Van Houtven & Norton, 2004; Wolf et al., 1997).

The role of the firstborn child should not be correlated with parental health status. Hence, the indicators, Son_i^{1st} and $Daughter_i^{1st}$, are valid instruments in this setting. We explore the One Child Policy to avoid any confounding effect from this family planning policy, and we find that the older cohorts of parents in our sample were not subject to the One Child Policy. For younger parents, the variation in policy implementation and time among different regions were likely to result in changes of the exogenous number of children. More details are discussed in Appendix B.

The first estimate captures the variation in emotional and financial support caused by the role of the firstborn child. In our data, emotional and financial support are reported only when the child lives separately from the parent. Therefore, the first estimate involves a Heckman selection model. Specifically,

$$S_{ih} = \pi_1 \cdot Son_i^{1st} + \pi_2 \cdot Daughter_i^{1st} + \mathbf{X_i}\gamma_1 + \mathbf{X_h}\gamma_2 + IMR_i + \eta_{ih} \quad (4)$$

where $S_i \in \{Emotional_{ih}, Financial_{ih}\}$, and IMR_i is the inverse Mill's ratio obtained by the probability of living separately. To estimate the normal density function, we implement the variable "# bedrooms in the parents' house" as the probability shifter of living separately. The underlying assumption is that, for a given household income, lacking bedrooms results in a higher probability of children living separately from parents.

In this step, we include children's characteristics X_i and household characteristics X_h but exclude the parents' characteristics. The reason is that our data only report the child's support for the household rather than for the father and mother individually, and hence parents' heterogeneity do not affect this determination process.

The second step is to identify the coefficient β_1 and β_2 in Eq. (3). Generally, in a linear model, a two-stage least-squares regression can be used to estimate these parameters. However, in our ordered probit model, we cannot directly plug the fitted value in the first stage into the second stage. Instead, the alternative control function approach is to predict the residuals in the first stage and add the residuals as control variables to Eq. (3). That is, we calculate fitted value, $\widehat{S}_{ih}$ from Eq. (4) and then obtain the residuals

$$\widehat{\eta}_{ih} = S_{ih} - \widehat{S}_{ih}$$

where $\widehat{\eta}^e_{ih}$ represents the residual of emotional supports and $\widehat{\eta}^f_{ih}$ represents the residual of financial supports. Then we add $\widehat{\eta}^e_{ih}$ and $\widehat{\eta}^f_{ih}$ as control variables to the main regression

$$Y_{ihg} = \beta_1 \cdot Emotional_{ih} + \beta_2 \cdot Financial_{ih} + \mathbf{X_i}\gamma_1 + \mathbf{X_h}\gamma_2 + \mathbf{K_{hg}}\lambda_g + \mathbf{K_{h,-g}}\lambda_{-g} + \kappa_e \cdot \widehat{\eta}^e_{ih} + \kappa_f \cdot \widehat{\eta}^f_{ih} + \varepsilon_{ihg} \tag{5}$$

This method eliminates the endogeneity by allowing the residuals, $\widehat{\eta}^e_{ih}$ and $\widehat{\eta}^f_{ih}$, to capture the effect that cannot be explained by $S_i \in \{Emotional_{ih}, Financial_{ih}\}$, and then the remaining variation in S_i is endogenously caused by the instrumental variables. To obtain the correct standard errors of coefficient estimate, we estimate these equations in an equation system by Roodman (2011)'s method.

6. Results

6.1. First-stage results

A valid instrument should generate exogenous variation that is strong enough to identify the causal effect of an endogenous explanatory variable. In this section, we show that our instrumental variables—-whether an individual is the firstborn son or daughter or neither—generate adequate variation in the fitted value of emotional and financial support. As mentioned in the previous section, our first-stage estimate uses a Heckman selection model in which the provision of emotional and/or financial support is dependent on whether the child lives separately from his/her parents. Emotional and financial support are reported only when the child lives separately from the parent. Hence, in the Heckman model, we consider the indicator "living separately" endogenous and use the inverse Mill's ratio to account for the problem.

Table 2 presents the results of the Heckman's model. Column 1 represents the probability of living separately, taking advantage of the variable "# bedrooms in the parents' house". As the sign of the coefficient estimate suggests, a larger number of bedrooms increases the probability of living together. This effect is conditional on the household income level, eliminating the bias caused by the non-monotonicity of the exogenous variable; that is, more bedrooms suggest a higher level of income and probably a higher level of filial mobility, causing them to live farther away and separately. Overall, this variable performs well in calculating the inverse Mill's ratio.

Columns 2 and 3 show the estimates of the effects of instrumental variables, Son^{1st} and $Daughter^{1st}$, on the emotional and financial support that the children provide to their parents. Column 2 reveals that the eldest son and daughter contact their parents more, respectively, than the non-eldest son/daughter. This contrasts with the results for financial support, shown in column 3. The eldest son and daughter provide less financial support, respectively, than the non-eldest child. Each coefficient estimate in Columns 2 and 3 is statistically significant, where the F-statistics of instruments are 9.57 and 36.94, eliminating the problem of weak instruments (Staiger & Stock, 1997).

6.2. Second-stage results

Table 3 and Table 4 report the ordered probit estimates of the physical and mental health status of the father and mother, respectively. Each column is a type of health status. In this table, we control for the parents' demographic characteristics.

The parameter estimates of interest are the coefficients of emotional support and financial support. Since we include the residuals obtained from the first stage in the ordered probit model (not reported), such residuals capture the unobserved factors that affect emotional support and financial support. Hence, the residuals capture the endogeneity, and the remaining coefficient estimates of emotional support and financial support are identified.

Based on the results, both emotional and financial support play vital roles in improving parental health. Note that all of the dependent variables are ranked in discrete integers. For health score and cognitive ability, a larger number indicates better health status, whereas, for the rest of the indicators, a larger number indicates worse physical or mental health. Parameters for emotional effects are positive for SRH and COGN and negative for CESD, ADL, and IADL. The pattern is mostly the same for fathers and mothers, except that emotional support significantly improves paternal cognitive status but has a null effect on maternal cognition. In the realm of financial support, the continuous metrics suggest that parental health is affected by the amount of money available. The coefficient estimates for financial support suggest that health status improves significantly as the amount of money transferred to parents increases, although the effect on cognitive status is null.

With such continuous metrics, the coefficient estimate allows us to calculate the trade-off between money transfer and contact frequency. For example, a 1% increase in money transfer and $1\% \times \frac{0.055}{0.0034} = 0.16$ day increase in contact frequency have an equivalent effect on fathers' health score rankings. Similarly, a 1% increase in money transfer and $1\% \times \frac{0.076}{0.0026} = 0.29$ day increase in contact frequency affect maternal health equally. Furthermore, note that the coefficient ratios of financial support and emotional support are all approximately 15–30 for each type of health status. This pattern also suggests a robust result for the trade-off between financial support and contact frequency. This finding is in line with results from Table 2. As shown in Table 2, contact frequency is associated with negative coefficients of children's income level, which are statistically significant for category 2 to 5 (income: 2,000–50,000 yuan), while money transfer is associated with statistically significantly positive coefficients of children's income. The results from Table 2 indicate that children with higher income tends to provide higher level of financial support, but less emotional support to their parents, because their opportunity cost for contacting parents would be high, which is consistent with our conclusion regarding the trade-off between financial and emotional support.

We then estimate the marginal effect of intergenerational transfer on parental health outcomes. Tables 5 and 6 present the marginal effect of emotional support and financial support for the father and mother, respectively. Each column represents a type of health metric. Column 1 of Table 5 shows the marginal effect of self-reported health. Emotional support from children, defined as 10 additional days spent with children, reduces the probability of reporting the health conditions "very poor" (Lv. 1) and "poor" (Lv. 2) by 0.9% and 0.4%, respectively. Similarly, the emotional support of ten additional days spent with children increases the probability of reporting "good" (Lv. 3) health status by

Table 3
Ordered probit result: Father.

	(1)	(2)	(3)	(4)	(5)
	SRH	CESD	ADL	IADL	COGN
Contact Freq.	0.0034***	−0.0034***	−0.0041***	−0.0039***	0.0036***
	(0.00025)	(0.00020)	(0.00031)	(0.00026)	(0.00027)
Money Transfer	0.055***	−0.091***	−0.050***	−0.045***	0.016**
	(0.0071)	(0.0079)	(0.0095)	(0.0091)	(0.0071)
Age	−0.0089	0.0096	0.029	0.032	−0.020
	(0.025)	(0.022)	(0.031)	(0.027)	(0.026)
$Age^2/1000$	0.0080	−0.0089	−0.036	−0.044	0.032
	(0.030)	(0.028)	(0.038)	(0.034)	(0.032)
Female	−0.084**	0.10***	0.078*	0.018	−0.023
	(0.034)	(0.032)	(0.042)	(0.039)	(0.033)
Married	0.41	−0.23	−0.24	0.047	1.06***
	(0.28)	(0.25)	(0.54)	(0.42)	(0.37)
Father’s age	−0.0055	0.010	0.020**	0.014*	−0.036***
	(0.0079)	(0.0074)	(0.0092)	(0.0083)	(0.0076)
Mother’s age	0.0079	−0.012	0.0035	0.0060	0.00052
	(0.0074)	(0.0078)	(0.0095)	(0.0084)	(0.0072)
Household Income	0.018**	−0.00096	−0.012	−0.023**	0.030***
	(0.0081)	(0.0088)	(0.011)	(0.011)	(0.0096)
Father’s Education	0.042**	−0.044**	−0.051***	−0.097***	0.14***
	(0.017)	(0.018)	(0.018)	(0.021)	(0.018)
Mother’s Education	−0.012	−0.019	−0.0055	−0.016	0.0043
	(0.018)	(0.017)	(0.024)	(0.027)	(0.021)
Insurance	−0.15*	−0.061	−0.077	0.011	0.11
	(0.084)	(0.097)	(0.13)	(0.14)	(0.10)
Urban	0.26***	−0.26***	−0.30***	−0.25**	0.32***
	(0.080)	(0.078)	(0.11)	(0.10)	(0.099)
Observations	4808	4808	4808	4808	4808

Note: This table presents the coefficient estimate of the ordered probit model for *father*’s health. Each column represents a type of health measure. We omit the report of the cut level for the ordered probit model. We add the province fixed effects in this model. Cluster-robust standard errors are clustered at the city level and shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table 4
Ordered probit result: Mother.

	(1)	(2)	(3)	(4)	(5)
	SRH	CESD	ADL	IADL	COGN
Contact Freq.	0.0026***	−0.0039***	−0.0043***	−0.0030***	0.0033***
	(0.00021)	(0.00021)	(0.00032)	(0.00026)	(0.00027)
Money Transfer	0.076***	−0.093***	−0.062***	−0.12***	−0.0023
	(0.0074)	(0.0069)	(0.0088)	(0.0089)	(0.0074)
Age	−0.033	−0.011	0.042*	0.054*	0.037
	(0.026)	(0.023)	(0.024)	(0.028)	(0.030)
$Age^2/1000$	0.032	0.016	−0.053*	−0.061*	−0.043
	(0.033)	(0.028)	(0.030)	(0.035)	(0.037)
Female	−0.095***	0.086***	0.069*	0.11***	0.028
	(0.033)	(0.028)	(0.040)	(0.034)	(0.036)
Married	−0.38	0.32	0.44	0.18	0.33
	(0.25)	(0.24)	(0.53)	(0.28)	(0.44)
Father’s age	−0.0059	0.0097	−0.0022	0.00042	−0.0068
	(0.0074)	(0.0065)	(0.0074)	(0.0076)	(0.0075)
Mother’s age	−0.0023	−0.0042	0.036***	0.029***	−0.017**
	(0.0064)	(0.0062)	(0.0092)	(0.0078)	(0.0075)
Household Income	−0.015*	0.0082	−0.015	−0.0017	0.016*
	(0.0086)	(0.0086)	(0.011)	(0.0098)	(0.0086)
Father’s Education	−0.033*	−0.0037	−0.053**	−0.0081	0.022
	(0.017)	(0.016)	(0.023)	(0.018)	(0.017)
Mother’s Education	0.020	−0.040**	−0.0053	−0.068**	0.16***
	(0.018)	(0.018)	(0.025)	(0.028)	(0.020)
Insurance	0.038	−0.11	0.024	−0.056	0.20*
	(0.11)	(0.089)	(0.16)	(0.11)	(0.12)
Urban	0.18**	−0.24***	−0.36***	−0.29***	0.28**
	(0.083)	(0.088)	(0.11)	(0.10)	(0.11)
Observations	4808	4808	4808	4808	4808

Note:This table presents the coefficient estimate of the ordered probit model for *mother*’s health. Each column represents a type of health measure. We omit the report of the cut level for the ordered probit model. We add the province fixed effects in this model. Cluster-robust standard errors are clustered at the city level and shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table 5
Marginal effect of ordered probit: Father.

	(1)	(2)	(3)	(4)	(5)
	SRH	CESD	ADL	IADL	COGN
Contact Freq.					
Prob: Lv. 1	−0.00091***	0.00043***	0.0012***	0.0013***	−0.00063***
	(0.000073)	(0.000043)	(0.0001)	(0.00009)	(0.000063)
Prob: Lv. 2	−0.00045***	0.0003***	−0.00043***	−0.0035***	−0.00066***
	(0.000046)	(0.000039)	(0.000051)	(0.000045)	(0.00074)
Prob: Lv. 3	0.00062***	0.00032***	−0.00022***	−0.00023***	−0.00014***
	(0.00005)	(0.000029)	(0.000032)	(0.000032)	(0.000025)
Prob: Lv. 4	0.00053***	0.00014***	−0.00017***	−0.00019***	0.00018***
	(0.000054)	(0.000018)	(0.00003)	(0.000029)	(0.000032)
Prob: Lv. 5	0.00021***	0.000097***	−0.00012***	−0.00022***	0.00045***
	(0.000034)	(0.000013)	(0.00003)	(0.000033)	(0.00043)
Prob: Lv. 6		0.000068***	−0.00012***	−0.00024***	0.00041***
		(0.000012)	(0.000028)	(0.000038)	(0.000043)
Prob: Lv. 7		0.0000147*	−0.00013***		0.00025***
		(0.0000087)	(0.000027)		(0.000032)
Prob: Lv. 8		−0.000025***			0.000078***
		(0.0000077)			(0.000017)
Prob: Lv. 9		−0.000076***			0.000038***
		(0.000011)			(0.000016)
Prob: Lv. 10		−0.000078***			0.000021*
		(0.00001)			(0.000012)
Money Transfer					
Prob: Lv. 1	−0.015***	0.011***	0.014***	0.014***	−0.0029***
	(0.0019)	(0.0014)	(0.0029)	(0.003)	(0.0013)
Prob: Lv. 2	−0.0072***	0.0079***	−0.0052***	−0.0041***	−0.03***
	(0.0011)	(0.001)	(0.0011)	(0.00094)	(0.0013)
Prob: Lv. 3	0.01***	0.0084***	−0.0026***	−0.0027***	−0.0062**
	(0.0014)	(0.00096)	(0.00068)	(0.00066)	(0.003)
Prob: Lv. 4	0.0085***	0.0036***	−0.0021***	−0.0022***	0.0083**
	(0.0011)	(0.00054)	(0.00051)	(0.000033)	(0.004)
Prob: Lv. 5	0.0034***	0.0026***	−0.0015***	−0.0025***	0.0021**
	(0.006)	(0.00038)	(0.00042)	(0.00064)	(0.0009)
Prob: Lv. 6		0.0018***	−0.0014***	−0.0028***	0.0018**
		(0.00034)	(0.00041)	(0.00065)	(0.00084)
Prob: Lv. 7		0.00039*	−0.0016***		0.0011**
		(0.000023)	(0.00045)		(0.00052)
Prob: Lv. 8		−0.00067***			0.00035**
		(0.00021)			(0.00017)
Prob: Lv. 9		−0.002***			0.00017*
		(0.00031)			(0.000099)
Prob: Lv. 10		−0.0021***			0.000093*
		(0.0003)			(0.000056)
Observations	4808	4808	4808	4808	4808

Note: This table presents the corresponding marginal effect of the ordered probit model for *father*'s health at the sample-mean level. Each column represents a type of health measure. Each row represents the probability of being at the corresponding level. The first panel shows the effect of contact frequency and the second of money transfer. For efficiency, we truncate the CESD scores at 10 so that any CESD score greater than 10 is treated as 10. Cluster-robust standard errors are clustered at the city level and shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

0.6%. Note that the sample standard deviation is 104 days; hence one standard deviation increase in days spent with children could increase "good" health by 6.24%. The magnitude of the effect follows the trade-off pattern, in which the receipt of 1% more money is equivalent to 0.16 days spent with children. Or, to describe it equivalently, a 10% increase in financial support increases the probability of reporting "good" health by 10%. Considered in conjunction with the summary statistics, this number suggests that one standard deviation in financial support increases the probability of "good" health by 3.26%.

Columns 2 to 5 suggest similar effects. For CESD, we aggregate all scores over 10 into one grid because individuals are diagnosed as suffering from depression if the score is above 10. The marginal effect suggests that both emotional and financial support strongly decrease the probability of depression. The support also decreases the probability of ADL condition. For IADL, the marginal effect of emotional support is significantly positive (negative in metrics) for both parents, while the marginal effect of financial support is not significant for fathers.

Table 6 displays results similar to those in Table 5. For instance, column 1 of Table 6 shows that a 10% increase in financial support decreases the probability of reporting the health conditions "very poor" (Lv. 1) and "poor"' (Lv. 2) by 0.24% and by 0.05%, respectively. Overall, the marginal effects suggest the same conclusions regarding emotional and financial support as Tables 3 and 4

We conduct some sensitivity analyses to make sure that our conclusions are robust in the face of different specifications (see Appendix C for more details).

7. Concluding remark

The aging of China's population—an inevitable result of increased life expectancy and declining fertility—presents a major challenge. Eldercare is becoming a social and not just a family concern. We examine the extent to which intergenerational support may affect elder parents' physical and psychological health. Our analysis suggests that both emotional and financial support improve parental physical and psychological health. Emotional and financial support also increase

Table 6
Marginal effect of ordered probit: Mother.

	(1)	(2)	(3)	(4)	(5)
	SRH	CESD	ADL	IADL	COGN
Contact Freq.					
Prob: Lv. 1	−0.0008***	0.00039***	0.00096***	0.0011***	−0.00075***
	(0.000071)	(0.000051)	(0.00008)	(0.000092)	(0.000069)
Prob: Lv. 2	−0.00028***	0.00024***	−0.00044***	−0.00023***	−0.00051***
	(0.000029)	(0.000028)	(0.000049)	(0.000029)	(0.000068)
Prob: Lv. 3	0.0005***	0.0003***	−0.00022***	−0.00022***	−0.000054***
	(0.000047)	(0.000036)	(0.000028)	(0.000028)	(0.000018)
Prob: Lv. 4	0.00033***	0.00018***	−0.00013***	−0.00023***	0.00023***
	(0.00004)	(0.000023)	(0.00002)	(0.000031)	(0.00003)
Prob: Lv. 5	0.00014***	0.00015***	−0.000064***	−0.0002***	0.00042***
	(0.000025)	(0.000022)	(0.000015)	(0.000031)	(0.000047)
Prob: Lv. 6		0.00012***	−0.000072***	−0.0002**	0.00033***
		(0.000017)	(0.000014)	(0.000033)	(0.000037)
Prob: Lv. 7		0.00086***	−0.000036***		0.0002***
		(0.000014)	(0.0000093)		(0.0000652)
Prob: Lv. 8		0.000045***			0.000077***
		(0.00001)			(0.000018)
Prob: Lv. 9		0.000019**			0.000045***
		(0.0000091)			(0.0000137)
Prob: Lv. 10		−0.0000075			0.000009
		(0.0000064)			(0.000006)
Prob: Lv. 11					0.000002
					(0.000002)
Money Transfer					
Prob: Lv. 1	−0.024***	0.0094***	0.014***	0.042***	−0.00053
	(0.0017)	(0.0013)	(0.0021)	(0.0033)	(0.00775)
Prob: Lv. 2	−0.0053***	0.0057***	−0.0063***	−0.009***	−0.00036
	(0.00088)	(0.0076)	(0.001)	(0.0011)	(0.0012)
Prob: Lv. 3	0.015***	0.0072***	−0.0032***	−0.0087***	−0.000038
	(0.0017)	(0.00085)	(0.0006)	(0.001)	(0.00012)
Prob: Lv. 4	0.01***	0.0044***	−0.0018***	−0.0089***	−0.00016
	(0.0013)	(0.00053)	(0.00037)	(0.0012)	(0.00051)
Prob: Lv. 5	0.0042***	0.0037***	−0.00092***	−0.0079***	−0.0003
	(0.00072)	(0.00055)	(0.00022)	(0.0012)	(0.00094)
Prob: Lv. 6		0.003***	−0.001***	−0.0079***	−0.00023
		(0.00042)	(0.00023)	(0.0013)	(0.00074)
Prob: Lv. 7		0.0021***	−0.005***		−0.00014
		(0.00035)	(0.00016)		(0.00045)
Prob: Lv. 8		0.0011***			−0.000054
		(0.00026)			(0.00018)
Prob: Lv. 9		0.00045**			−0.000031
		(0.00022)			(0.0001)
Prob: Lv. 10		−0.00***			−0.00006
		(0.0221)			(0.00002)
Prob: Lv. 11					−0.000001
					(0.000005)
Observations	4808	4808	4808	4808	4808

Note: This table presents the corresponding marginal effect of the ordered probit model for *mother*'s health at the sample-mean level. Each column represents a type of health measure. Each row represents the probability of being in the corresponding level. The first panel shows the effect of contact frequency and the second of money transfer. For efficiency, we truncate the CESD scores at 10 so that any CESD score greater than 10 is treated as 10. Cluster-robust standard errors are clustered at the city level and shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

elders' abilities to perform activities of daily living (ADL) and instrumental activities of daily living (IADL). The only exception is for the cognitive status. Emotional but not financial support plays a vital role in improving parental cognition. Despite our rigorous analysis, this study is not free of limitations. Filial piety exists predominantly in East Asian countries such as China, Korea, and Japan. However, the degree of filial piety is changing over time, consequently first-born children feel less obligated to support their parents than the past.

Our results have two important implications. First, our model quantifies the trade-off between emotional and financial support. We show that an additional 1% of funds transferred from children to parents (financial support) is equivalent to approximately 16 days spent by children with their parents (emotional support) if all other factors are unchanged. This trade-off implies that the policy maker should consider and quantify counterfactual financial subsidy to unhealthy parents whose children are not able to be with them at all.

The second implication points to inefficiencies in health consumption among China's elders. Our results suggest a positive effect of income on health. We argue that the income effect should be null in an efficient health consumption bundle because people do not pursue health infinitely, even if they have the money to do so. The presence of a significant income effect indicates that health consumption among the elderly is below an efficient level. Hence, our results imply that the average health consumption of elders in China is too low, and they rely heavily on children's informal care.

Author statement

Yang Li: Conceptualization, Methodology, Investigation, Resources, Data Curation, Writing - Original Draft, Project administration.

Miao Guo: Software, Validation, Writing - Review & Editing, Visualization, Supervision.

Ethical statement

The medical ethics committee approved the CHARLS study, and all interviewees were required to sign informed consent. Ethics approval for the data collection in CHARLS was obtained from the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015). Ethics approval for the use of CHARLS data was obtained from the University of Newcastle Human Research Ethics Committee (H-2015-0290).

Declaration of competing interest

None.

A. Health Variables from CHARLS

We select a rich set of variables on health status and functioning from those available in CHARLS. Self-reported health status is based on the elder's response to the question "Would you say your health is excellent, very good, good, fair, or poor?" (scored from 0 for poor to 4 for excellent). The CESD score is calculated from responses to ten questions about symptoms of depression experienced in the previous week (whether a respondent is bothered by things, has trouble concentrating, is depressed, finds everything an effort, is hopeful, fearful, happy and/or lonely, has poor sleep quality, and/or can't take action). The answers to the CESD are scored on a four-scale metric: rarely (less than 1 day in the week), some days (1–2 days), occasionally (3–4 days) and most of the time (5–7 days). We score these answers as suggested by the US National Institute of Mental Health researcher Lenore Radloff, using the values 0 (rarely) to 3 (most of the time) for negative questions (e.g, do you feel sad?) and reversing them (from 0—most of the time to 3—rarely) for positive questions (e.g., do you feel happy?). As described by Andresen (1994), the possible total score on the 10-item scale ranges from 0 to 30, and a score of 10 or higher indicates the presence of significant depressive symptoms.

Activities of daily living (ADL) are basic self-care tasks. Participants were asked whether they had any difficulty in completing the following six daily activities: dressing, bathing, eating, getting into or out of bed, using the toilet, and controlling urination and defecation. The ADL score is calculated as the total number of activities that the respondent has difficulty performing.

Instrumental activities of daily living (IADL) include doing housework, cooking, shopping for groceries, managing money, and taking medications. Participants were asked whether they needed help with 1) doing housework, including performing household chores, preparing hot meals, and making the bed, and/or 2) personal financial management, including paying the bills and managing their assets. If the respondent indicated that they had difficulty performing at least one of the ADLs or IADLs without assistance, we class them as a dependent elder.

Cognition is calculated as the total number of words the elder could recall from a list of 10 words. We use the total number of words that an elder could memorize as a positive indicator of cognitive ability.

B. One Child Policy

The One Child Policy, also known as Family Planning Program, has experienced several transitions. It has evolved from the 1970s period of moderate policy, represented by wan, xi, shao (late marriage and childbearing, birth spacing and limited fertility), through the strict one-child policy of 1979 to the early 1990s. From the mid-1990s to the present, a relatively lenient policy has been in force, characterized by client-centered informed choice (Wang, 2012). Moreover, the policy variation was also considerable across regions (Zhang, 2017). The implementation of the policy was formalized by local governments. Thus, local policies inevitably varied among provinces and between urban and rural regions (Liao, 2013).

Overall, the one child policy is a de facto two-tier policy: urban couples were only allowed to have one child, whereas rural couples were generally allowed to have a second child, particularly if the first child was female (Zhang, 2017). This is also documented in the community survey of CHARLS: statistics show that strict one-third policy only accounts for 30 per cent of our sample. In addition, there is some variation in the number of siblings across different households.

As shown in Table 1, the average ages of parents in our sample are 68 for male and 65 for female, respectively. The average parent in our sample would have been born in the 1940s, so they would have been in their late 20s and early 30s even during the family programs established during the early 1970s. These older cohorts were not subject to the One Child Policy during most of their childbearing years (Lei et al., 2015), although they were partially exposed to the increasingly strong family planning policies of the 1970s. It may be that cohorts younger than the ones studied here were exposed to the stronger family planning programs during their childbearing ages.

To sum up, the older cohorts of parents were not subject to the One Child Policy while for younger parents, the variation in policy implementation and time among different regions were likely to result in changes of the exogenous number of children.

B.1 Empirical Evidence

The dataset contains two corresponding questions about the One Child Policy (though the policy in some villages did not restrict the number of children to only one). The first is about the year when the respondent's village/city start One Child Policy and the second is about the specific content of policy. We use the first question to define the "young cohort", which is the individual whose was born after One Child Policy in the corresponding village/city.

We also combine the second question to define the young cohorts that are affected by the policy. In the second question, there are four possibilities: 1) "A couple can only have one child", 2) "A couple can have a second child if the first is girl", 3) "A couple can have two children", and 4) "A couple can have more than two children". Hence, type 3 and type 4 cohorts are not affected by the One Child Policy.

We then run regressions with the sub-sample. Table B1 presents the robustness check of One Child Policy's effect and whether our main results change accordingly. Column 1 consider only the Older Cohort of children (children born before the policy). Column 2 contains sub-sample that takes Older Cohort or unaffected Younger Cohorts into account. Column 3 is full sample from our original regression.

The results from the sample of Older Cohort (Column 1) and Older Cohort plus type 3 and 4 Younger Cohort (Column 2) are similar as the results from full sample (Column 3), in both magnitude and statistical significance, suggesting that the estimated magnitude and statistical significance are not driven by younger cohort. In addition, whether or not including younger cohort of children does not change our conclusion.

Table B1
One-child Policy: Affected Sub-sample

	(1)	(2)	(3)
	Older Cohort	All Unaffected Cohort	Full sample
Contact Freq.			
The eldest son	13.3***	14.7***	14.5***
	(4.15)	(4.04)	(3.83)
The eldest daughter	15.4***	12.6***	10.8***
	(4.87)	(4.21)	(3.87)
Money Transfer			
The eldest son	−0.92***	−0.97***	−0.95***
	(0.15)	(0.13)	(0.13)
The eldest daughter	−0.56***	−0.66***	−0.58***
	(0.14)	(0.13)	(0.13)
Mother's IADL score			
Contact Freq.	−0.0025***	−0.0038***	−0.0030***
	(0.00031)	(0.00029)	(0.00026)
Money Transfer	−0.091***	−0.075***	−0.12***
	(0.012)	(0.0096)	(0.0089)
Observations	3951	4974	5805

Note: This table presents the robustness check of One Child Policy's effect and whether our main results change accordingly. Column 1 consider only the Older Cohort of children (children born before the policy). Column 2 contains sub-sample that takes Older Cohort or unaffected Younger Cohorts into account. Column 3 is full sample from our original regression. All specifications include province fixed effects. Cluster-robust standard errors are clustered at the city level and are shown in parentheses.. *p<0.1, **p<0.05, ***p<0.01.

C. Robustness Check

We conduct some sensitivity analyses to make sure that our conclusions are robust in the face of different methods and assumptions, using binary health metrics as an alternative specification. We generate the CESD value as a binary based on the diagnostic threshold that an individual is depressed if the CESD score is above 10, and we use a diagnostic threshold of 0 for the ADL and IADL scores.

The results of these sensitivity analyses, illustrated in Table C1 and Table C2, suggest the same conclusions as tbl3Tables 3 and 4tbl4, respectively. Similarly, the marginal effects on these binary metrics imply that emotional and financial supports are positively significant except on cognitive status. Our conclusions remain the same as those of the main analysis, which uses continuous variables. Similarly, we calculate the marginal effect of binary probit, as shown in Tables C3 and C4.

Table C1
Binary Probit Result: Father

	(1)	(2)	(3)	(4)
	CESD	ADL	IADL	COGN
Contact Freq.	−0.0039***	−0.0041***	−0.0050***	0.0023***
	(0.00030)	(0.00034)	(0.00034)	(0.00045)
Money Transfer	−0.12***	−0.028***	−0.046***	0.00093
	(0.0095)	(0.0093)	(0.0094)	(0.013)
Age	0.038	0.039	0.035	−0.082
	(0.027)	(0.032)	(0.027)	(0.051)
$Age^2/1000$	−0.047	−0.051	−0.041	0.10*
	(0.035)	(0.039)	(0.034)	(0.059)
Female	0.11***	0.050	0.039	0.019
	(0.041)	(0.041)	(0.041)	(0.049)
Married	−0.25	0.15	0.22	1.49***
	(0.38)	(0.42)	(0.41)	(0.38)
Father's age	0.016*	0.023**	0.010	−0.060***
	(0.0091)	(0.0098)	(0.0087)	(0.014)
Mother's age	−0.016*	0.0047	0.0061	0.029**
	(0.0082)	(0.010)	(0.0089)	(0.012)
Household Income	0.012	0.0036	−0.010	0.040**
	(0.0097)	(0.010)	(0.011)	(0.016)
Father's Education	−0.045**	−0.031	−0.082***	0.084**
	(0.020)	(0.021)	(0.020)	(0.034)
Mother's Education	−0.0088	−0.021	−0.021	−0.077*
	(0.023)	(0.026)	(0.026)	(0.041)
Insurance	−0.20	−0.042	0.092	0.18
	(0.13)	(0.14)	(0.12)	(0.18)
Urban	−0.22**	−0.17	−0.044	0.43**
	(0.088)	(0.12)	(0.10)	(0.19)
Observations	5805	5805	5805	5805

Note: This table presents the coefficient estimate of the binary probit model of *father*'s health. Each column represents a type of health measure. The point estimate is the probability of the indicator taking a value of 1. Cluster-robust standard errors are clustered at the city level and are shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table C2
Binary Probit Result: Mother

	(1)	(2)	(3)	(4)
	CESD	ADL	IADL	COGN
Contact Freq.	−0.0045***	−0.0038***	−0.0041***	0.0022***
	(0.00031)	(0.00034)	(0.00030)	(0.00059)
Money Transfer	−0.11***	−0.049***	−0.10***	0.020
	(0.0087)	(0.0092)	(0.0088)	(0.015)
Age	0.013	0.076***	0.058*	0.023
	(0.032)	(0.029)	(0.035)	(0.043)
$Age^2/1000$	−0.016	−0.090***	−0.063	−0.022
	(0.040)	(0.035)	(0.043)	(0.052)
Female	0.090***	0.068*	0.10***	0.0065
	(0.035)	(0.041)	(0.035)	(0.049)
Married	0.069	0.39	0.072	0.65*
	(0.37)	(0.59)	(0.41)	(0.34)
Father's age	0.0080	0.00050	0.0014	−0.028**
	(0.0084)	(0.0083)	(0.0083)	(0.012)
Mother's age	−0.0012	0.035***	0.025***	0.00061
	(0.0078)	(0.0096)	(0.0093)	(0.011)
Household Income	0.025***	0.0056	0.013	0.033**
	(0.0090)	(0.012)	(0.011)	(0.015)
Father's Education	−0.011	−0.050**	0.011	−0.025
	(0.017)	(0.023)	(0.018)	(0.028)
Mother's Education	−0.033	0.014	−0.074**	0.11***
	(0.021)	(0.027)	(0.030)	(0.032)
Insurance	−0.19*	0.033	−0.084	0.37**
	(0.10)	(0.16)	(0.12)	(0.16)
Urban	−0.21**	−0.27**	−0.12	0.41**
	(0.090)	(0.12)	(0.11)	(0.18)
Observations	5805	5805	5805	5805

Note: This table presents the coefficient estimate of the binary probit model regarding *mother*'s health. Each column represents a type of health measure. The point estimate is the probability of the indicator taking a value of 1. Cluster-robust standard errors are clustered at the city level and are shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table C3
Marginal Effect of Binary Probit: Father

	(1)	(2)	(3)	(4)
	CESD	ADL	IADL	COGN
Contact Freq.	−0.0013***	−0.0013***	−0.0016***	0.00041***
	(0.00015)	(0.00012)	(0.00011)	(0.00008)
Money Transfer	−0.041***	−0.087***	−0.015***	0.00017
	(0.0035)	(0.0029)	(0.00032)	(0.0023)
Observations	4808	4808	4808	4808

Note: This table presents the corresponding marginal effect of the binary probit model of *father*'s health at the sample-mean level. Each column represents a type of health measure. Cluster-robust standard errors are clustered at the city level and are shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table C4
Marginal Effect of Binary Probit: Mother

	(1)	(2)	(3)	(4)
	CESD	ADL	IADL	COGN
Contact Freq.	−0.0018***	−0.0013***	−0.0015***	0.00049***
	(0.00012)	(0.00012)	(0.00011)	(0.00013)
Money Transfer	−0.044***	−0.016***	−0.037***	0.00045
	(0.0035)	(0.0032)	(0.0034)	(0.0035)
Observations	4808	4808	4808	4808

Note: This table presents the corresponding marginal effect of the binary probit model of *mother*'s health at sample-mean level. Each column represents a type of health measure. Cluster-robust standard errors are clustered at the city level and are shown in parentheses.. *p<0.1, **p<0.05, ***p<0.01.

D. Instrument and Parents' Income Effect

Children might have different incentive structures based on parental health and income levels. Parents' income level could potentially affect how children, especially the firstborns, behave. Based on this scenario, the parents' household income could challenge the validity of our instruments. Hence, in this part, we conduct the robustness check to show that the parents' income effect does not quite change our final results.

We first divide the parents' income level into three groups: low, median, and high. We divide them according to the distribution of their income. The household income has the following distributive characteristics that there exist a number of zero-income households and the rest follow a log-normal distribution.

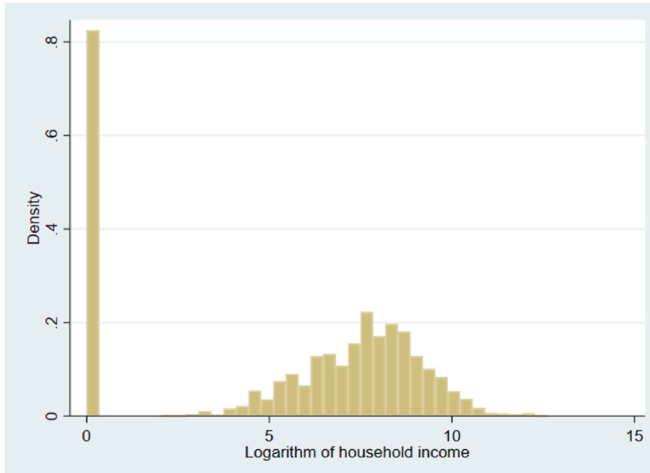

Fig. D1. Household Income Distribution
Note: This figure presents the distribution of households' income. The horizontal axis represents household income with logarithm. To deal with the zero income, we make the value of all sample plus one before we take the logarithm.

We define the zero-income household as group Low. Then for the household with non-zero income, we separate them evenly, i.e. by median. The left-side half is group Median and the right-side half is group High. Based on this separation, we add the group dummies in the model. Furthermore, we also add the interaction term "Group Dummies × Instruments" in our model. Hence, the result would show how the variation and significance of instruments change. And finally, we compare whether the final results, i.e., the treatment effect on health, change accordingly.

Table D1 presents the results of the robustness check. Column 1 is our original specification. For comparison, column 2 and 3 are the specification adding dummies of income group. Group Low is omitted due to co-linearity. We find that the coefficient of instrument might change in each specification, but the magnitude and the sign are close. Moreover, the interaction term are not quite significant, indicating that the heterogeneity of parents' income are not large. And for the last stage (where we take the mother's IADL score as an example), the result are almost identical, meaning that our instrument variables are robust to the extent of the household's income effect.

We also consider the continuous situation because three discrete groups may not necessarily be enough. Hence, we add the continuous household income variable into the model, and we add the interaction term as well. Table D2 displays the corresponding results, where the first column is the original specification, and column 2 and 3 are the specifications for comparison. The heterogeneity is not quite large nor very significant. The final results also do not deviate from the original model. Hence, we claim that our instruments are robust.

Table D1
Instruments and Parents' Income Effect: Income Group

	(1)	(2)	(3)
Contact Freq.			
The eldest son	14.4***	12.9***	21.0***
	(3.89)	(3.73)	(7.32)
The eldest daughter	10.1***	8.47**	20.2***
	(3.63)	(3.65)	(7.26)
Household Income Median		−33.1***	−24.2***
		(6.38)	(7.79)
Household Income High		−43.1***	−35.8***
		(5.67)	(6.64)
Household Income Median × The eldest son			−11.2
			(9.31)
Household Income High × The eldest son			−10.8
			(8.88)
Household Income Median × The eldest daughter			−18.7**
			(8.06)
Household Income High × The eldest daughter			−14.2**
			(6.96)
Money Transfer			
The eldest son	−0.93***	−0.91***	−0.66***
	(0.13)	(0.14)	(0.23)
The eldest daughter	−0.55***	−0.54***	−0.65***
	(0.14)	(0.14)	(0.22)
Household Income Median		0.72***	0.75***
		(0.19)	(0.24)
Household Income High		0.39*	0.50*
		(0.22)	(0.27)
Household Income Median × The eldest son			−0.22

(*continued on next page*)

Table D1 (*continued*)

	(1)	(2)	(3)
			(0.28)
Household Income High × The eldest son			−0.49*
			(0.28)
Household Income Median × The eldest daughter			0.15
			(0.24)
Household Income High × The eldest daughter			0.17
			(0.24)
Mother's IADL score			
Contact Freq.	−0.0037***	−0.0039***	−0.0035***
	(0.00029)	(0.00031)	(0.00030)
Money Transfer	−0.077***	−0.067***	−0.061***
	(0.0095)	(0.0096)	(0.0098)
Observations	4808	4808	4808

Note: This table presents the robustness check of how household income effect affects the instruments and final results. All specifications include province fixed effects. Cluster-robust standard errors are clustered at the city level and are shown in parentheses.. *p<0.1, **p<0.05, ***p<0.01.

Table D2
Instruments and Parents' Income Effect: Continuous Income

	(1)	(2)	(3)
Contact Freq.			
The eldest son	14.4***	13.5***	18.7***
	(3.89)	(3.76)	(6.82)
The eldest daughter	10.1***	8.72**	17.3***
	(3.63)	(3.67)	(6.52)
Household Income		−4.67***	−3.95***
		(0.67)	(0.78)
Household Income × The eldest son			−0.99
			(0.99)
Household Income × The eldest daughter			−1.55**
			(0.79)
Money Transfer			
The eldest son	−0.93***	−0.91***	−0.55**
	(0.13)	(0.13)	(0.22)
The eldest daughter	−0.55***	−0.53***	−0.67***
	(0.14)	(0.14)	(0.21)
Household Income		0.044*	0.058**
		(0.023)	(0.029)
Household Income × The eldest son			−0.067**
			(0.032)
Household Income × The eldest daughter			0.027
			(0.026)
Mother's IADL score			
Contact Freq.	−0.0037***	−0.0039***	−0.0042***
	(0.00029)	(0.00030)	(0.00030)
Money Transfer	−0.077***	−0.083***	−0.078***
	(0.0095)	(0.0094)	(0.0093)
Observations	4808	4808	4808

Note: This table presents the robustness check of how household income effect affects the instruments and final results. All specifications include province fixed effects. Cluster-robust standard errors are clustered at the city level and are shown in parentheses.. *p<0.1, **p<0.05, ***p<0.01.

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