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Fang Chang, Yaojiang Shi, Hongmei Yi, Natalie Johnson,

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Fang Chang and Yaojiang Shi
Center for Experimental Economics in Education, Shaanxi Normal University, Xi'an, China
Hongmei Yi
School of Advanced Agricultural Sciences, Peking University, Beijing, China, and
Natalie Johnson
Rural Education Action Program (REAP), Freeman Spogli Institute for International Studies, Stanford University, Stanford, California, USA

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Abstract

Purpose – The purpose of this paper is to evaluate the effect of adult children migration on the health status of elderly parents. Increased labor migration in developing countries that lack adequate social security systems and institutionalized care for the elderly is a phenomenon that is important to understand. When their adult children go away to work, it is not clear what effect there will be on "left-behind" elderly parents.

Design/methodology/approach – This study employs nearly nationally representative data from five provinces, 25 counties, 101 villages and 2,000 households, collected from two waves of data in 2007 and 2011. This sample comprises a subset of households which include both elderly individuals (above 60 years old) and their grown (working-aged) children in order to estimate the impact of adult child migration on the health of elderly parents in rural China.

Findings – This study finds that adult child migration has a significant positive impact on the health of elderly family members.

Practical implications – These findings are consistent with the explanation that migration raises family resources, which in turn may contribute to better health outcomes for elderly household members.

Originality/value – This is the first paper to attempt to identify the relationship between household migration and the health of elderly parents within the Chinese context.

Keywords Rural development, Health, Employment, labour use and migration

Paper type Research paper

As China entered the twenty-first century, economic development, the one child policy and the increased quality of medical services raised the average life expectancy and accelerated the rate of aging in the population. In 1990 the proportion of the population over the age of 60 was only 8.6 percent. This figure rose to 10.3 percent by 2000 and reached 13.3 percent in 2010 (National Bureau of Statistics of China, 1990, 2000, 2010). In China's rural areas the elderly comprise an even larger share of the population, due to the fact that a large segment of the young population has migrated to cities, leaving behind retirees in the countryside (National Bureau of Statistics of China, 2012).

JEL Classification — I13, J6, I3

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According to some forecasts, the elderly share of the population in rural China may be as high as 37.2 percent by 2035 (Ding and Wang, 2012).

In spite of rapid population aging, the issue of rural pensions has not been included in the scope of public investment in any major way (Zhou and Wang, 2010; Shen *et al.*, 2012). Although in recent years China has begun to implement the New Rural Pension System (NRPS) in rural areas, it is still in its pilot stage and the free basic pension amounts to less than 100 yuan per month, an amount which is inadequate to cover elderly living and health costs in China today (MHRSS, 2012; Chang *et al.*, 2014; Zhang and Fu, 2013). The NRPS also does not provide coverage for catastrophic illness (MHRSS, 2012). As a result, most of China's rural elderly population must continue to rely on the traditional form of elderly care: adult children caring for and supporting the living and health costs of their aging parents out of their own labor and income (Wang and Shuzhuo, 2011).

Today, new economic trends in rural China may be putting the traditional model of decentralized elderly care under increasing strain. Following the development of the economy and the rapid rate of urbanization in the 30 years since China's reform and opening up, a large proportion of the rural labor force now migrates into the cities in search of off-farm work. According to official statistics, out of 263 million rural workers in 2011, 163 million of them were migrant workers and 46.8 percent of whom were migrating across province borders (National Bureau of Statistics of China, 2013). Most of these migrant workers are young and middle-aged adults: 36.8 percent of them are 16-30 years old and 48.1 percent are 31-50 years old.

The correlation between this migration and rural families – and the elderly family members that younger migrants leave behind – is not clear. On the one hand, when rural residents migrate to cities for jobs, they are generally able to earn higher incomes and, as such, it is possible that migration could improve the living conditions of their family members (Asis, 2006; Taylor *et al.*, 2003; Ma *et al.*, 2004). In other words, elderly parents of migrating workers may be able to use the increased earnings of migrated children to afford a higher quality of life and better health care than elderly residents whose children remain at home and only have access to local employment with lower earnings potential (Kuhn *et al.*, 2011). On the other hand, when rural laborers move away from home to find work, they may be less capable of looking after the family members that they leave behind (Antman, 2012). In particular, elderly parents facing health concerns may lack for care or even have to take on increased responsibilities around the home (Bai *et al.*, 2007). When trying to understand the relationship between increased migration and elderly health, the direction of the effect is therefore ambiguous.

Empirical studies from the international literature that examine the relationship between adult child migration and elderly health show mixed results. For instance, a study in Mexico finds that migration of adult children increases the likelihood that elderly parent health will deteriorate (Antman, 2013). By contrast, studies in Bangladesh and Romania show that adult child migration raises income, increases financial support to elderly parents and ultimately has a positive effect on elderly health (Kuhn, 2005; Böhme *et al.*, 2015).

In China little empirical research has been conducted to answer this question and the studies that do exist present mixed results. Wang and Shuzhuo (2011) and Luo *et al.* (2011) find that increased rural labor mobility has a positive effect on the health of left-behind elderly parents. However, Song (2014) finds that the migration of the children was not significantly associated with the health of the elderly in each household. Similarly, Zhang and Li (2004) and Dai and Kong (2005) show that migrating adult

children provide less physical and emotional support for their elderly parents, but are unable to draw conclusions on the relationship with elderly health.

Given this small and mixed literature, the correlation between adult child migration and elderly parent health in the Chinese context is still an open question. In addition, the previous results are based on regional samples. There has not been an effort to identify the relationship between household migration and the health of the elderly.

The overall goal of this paper is to understand the impact of the migration of adult children on the health of their elderly parents in rural China. To meet this goal, we have two specific objectives. First, we document the current state and recent trends of elderly health in rural China. Second, we empirically identify the effects of adult child migration on elderly health.

The paper is divided into five sections. First, we present a description of the data sources and variables. Second, we describe our econometric model. Third, we share our results. Finally, we present a brief conclusion and discussion.

Data

The data used in this paper are from a nearly nationally representative survey in rural China conducted by our research team at the Center for Chinese Agricultural Policy of the Chinese Academy of Sciences and the Northwest Socioeconomic Development Research Center in 2008 and 2012. In this survey, 101 villages were randomly selected from 50 townships in 25 counties located in five provinces.

The sample villages were selected as follows. First, five provinces were each randomly selected to represent China's five major agro-ecological zones: Jiangsu represents the Eastern Coastal areas (Jiangsu, Shandong, Shanghai, Zhejiang, Fujian and Guangdong); Sichuan represents the Southwestern Provinces (Sichuan, Guizhou and Yunnan) plus Guangxi; Shaanxi represents the provinces on the Loess Plateau (Shaanxi and Shanxi), Inner Mongolia, and represents the provinces in the northwest (Gansu, Ningxia, Qinghai and Xinjiang); Hebei represents the north and central provinces (Hebei, Henan, Anhui, Hubei, Jiangxi and Hunan); and Jilin represents the Northeastern Provinces (Jilin, Liaoning and Heilongjiang).

After the provinces were selected, the second step of the sample selection involved choosing the counties, towns and villages. Five counties were selected from each province, one from each quintile from a list of counties arranged in descending order of per capita gross value of industrial output (GVIO). GVIO was used because Rozelle (1996) shows that it is one of the best predictors of standard of living and development potential and is often more reliable than net rural per capita income. Within each county, the survey team chose two townships, one from each half of a list of townships also arranged in descending order of per capita GVIO. Finally, within each township, two villages were chosen following the same procedure as the township selection.

The third step was to choose the sample households. Within each sample village, 20 households were chosen randomly. A household is defined as everyone in the family who "has a single fire" or cooks and eats together on a regular basis. We then selected only those households with at least one elderly member over the age of 60. Out of the 2,028 households in our full sample, 1,812 had at least one elderly member over the age of 60.

Next, we limited our sample to those households where the elderly individual or individuals live with exactly one married pair of adult children (or more accurately, one adult child and his or her spouse, both of 16 years of age or higher). This was done for two reasons. First, in examining the correlation between adult child migration and elderly health, it is important to recognize that one elderly parent may have many adult

children that contribute to their health in different ways (through physical care, emotional support, financial support, etc.). Household structure is also often very complicated in rural China – some families continue living with multiple generations all under one roof, while others live in smaller households. Because of this heterogeneity of household structure, it would be hard to disentangle the correlation between many different migration patterns of children and the health status of elderly parents if we did not limit our sample in this way. By limiting our model to a consideration of the simplest case – elderly individuals who live with only one child and his or her spouse – we can most directly examine the relationship between adult child migration and elderly health.

Second, it is likely that the relationship between migration and elderly health may depend upon which family member out-migrates. If there were more than two adult children in the household, it would be much more complicated to categorize the household's overall migration pattern in terms of each individual's migration status. Limiting our sample allows us to evaluate the correlation between multiple patterns of household-level migration and elderly health rather than the correlation of only a binary variable indicating whether or not the elderly individual has any migrated children, and therefore allows us to more accurately assess the relationship between adult child migration and elderly health. Out of the 1,812 households in our sample with elderly members, 148 households fit this simplified household structure (for a total of 244 elderly individuals).

As is seen from the above discussion, although procedurally useful, focusing on this subset of households does reduce our sample size and the generalizability of our findings. Household structure in rural China is often complicated. While the traditional household consisted of multiple generations living together under one roof, increasingly families live in smaller family units. Following the one child policy, the nuclear family household structure – explored in this study – is becoming more and more common simply because fewer families have multiple children (Hesketh *et al.*, 2005; Ding and Hesketh, 2006). To assess the importance of our assumptions for the findings of the study, after the conclusion of our primary analysis we rerun all regressions using the full sample of households with elderly members as a robustness check and find consistent results (see Table AIII).

The data set collected for this study includes basic information about the household as a whole and about all individuals in each sample household in the study areas for both 2007 (collected in 2008) and 2011 (collected in 2012). In order to understand elderly health, we asked each elderly individual to self-report the number of times he or she fell ill in the last year (*Illness instances*) as well as whether he or she was healthy or unhealthy overall in the past year (*Self-reported health*). Although physical health indicators or medical records are more credible, it is costly and difficult to collect, and therefore self-reported health is an appropriate second choice to measure the elderly health. In order to measure another key variable, migration status, we collected detailed information on the migration histories of each household member.

In addition to elderly health and migration status, we also collected information on other variables that may affect elderly health. We collected basic individual information for all elderly individuals in the sample. This set of variables included whether the individual was married (*married*) and whether the individual had off-farm income (*off-farm income*). We also collected basic household information, including the number of people in the household (*household size*), the number of kids younger than 16 in the household (*number of kids*), the household's per capita land holdings (*per capita land*), the household's asset value (*household asset value*), and the household's per capita off-farm income (*per capita off-farm income*)[1].

Multivariate approach

Based on the panel nature of our data we estimate a fixed effects (FE) model to analyze the correlation between adult children migration (controlling for individual and household-level FE) and elderly health (Wooldridge, 2010). In this way we are able to control for all non-time varying observable and unobservable characteristics. The basic specification for the analysis is:

$$\Delta Illness\ instances_{i,t} = \beta_0 + \beta_1 \times \Delta Migration_{i,t} + \beta_2 \times \Delta Individual_{i,t} + \beta_3 \times \Delta Household_{i,t} + \beta_5 \times Year_{i,t} + e_{i,t} \quad (1)$$

$$\Delta Self-reported\ health_{i,t} = \beta_0 + \beta_1 \times \Delta Migration_{i,t} + \beta_2 \times \Delta Individual_{i,t} + \beta_3 \times \Delta Household_{i,t} + \beta_5 \times Year_{i,t} + e_{i,t} \quad (2)$$

Where Δ*Illness instances*, Δ*Self-reported health*, Δ*Migration*, Δ*Individual* and Δ*Household* are changes between time periods 1 and 2 of the variables defined below (and used in the estimation of Equations 1 and 2). In order to better understand the correlation between adult migration and elderly health, we run each regression at both the household and individual level. *Illness instances* is a continuous variable representing the number of times the elderly individual fell ill in the past year. *Self-reported health* is a binary variable that is equal to 1 if the elderly individual reported that they were healthy overall in the past year, and is equal to 0 if they reported being unhealthy overall in the past year[2].

The variable *Migration* is specified in two ways (and used in separate models). First, we run all of our models with migration defined in terms of a binary variable. This variable indicates whether or not a given household has any adult child migrants. This variable is defined as equal to 1 if either or both adult children have migrated and equal to 0 if both the adult children are at home. Second, recognizing that the relationship between migration and elderly health may be affected by which family member out-migrated, we further subdivide the migrant households into four types of households. Since all families included in our final sample have two working-age adult children in their household, we categorize the migration status of these two individuals (son and daughter-in-law or daughter and son-in-law) into four categories based on each household member's migration status[3]: only son migrated; only daughter-in-law migrated; adult children both migrated; and adult children both at home. We then estimate the model in reference to three dummy variables with a, b, and c all equal to 1 and adult children both at home as the base group, which is equal to 0.

The model in Equations 1 and 2 also controls for other factors. Specifically, *Individual* is a vector of the characteristics of the elderly individuals in our sample, including whether the individual is *married* (a dummy variable equal to 1 if the elderly individual is married and living with his or her spouse and equal to 0 otherwise) and whether the individual *has off-farm income* (a dummy variable equal to 1 if the elderly individual has off-farm income and equal to 0 otherwise). The variable, *Household*, is a vector of household characteristics including economic factors such as household size, number of kids, per capita land, household asset value, and per capita off-farm income. In the notation, i denotes the elderly individual and t denotes the time period. A year dummy (*Year*) is added to control the impact of time. The symbol e is the error term.

Results

Trends in adult child migration

We first report on rural migration patterns in 2007 and 2011. In Table I we show that about half of the elderly individuals have at least one adult child who has migrated for work, and the proportion of elderly individuals with migrant children increased from 2007 to 2011. Specifically, we find that the share of elderly individuals for whom one or both of their adult children had migrated in 2007 is 48.8 percent (Table I, column 3, row 2-4). By 2011, this proportion had increased to 54.3 percent (Table I, column 6, row 2-4).

According to our data, 88 elderly individuals had adult children who both remained at home in 2007 and 2011 (Table II, row 1, column 1). Only 5 elderly individuals went from having no migrated adult children in 2007 to having both children migrated in 2011 (Table II, row 1, column 4). Overall, we can see that 34 households (58 elderly individuals) had some kind of change in their adult children's migration status from 2007 to 2011 (Table III). From Tables II and III we can conclude that a sizeable portion of our sample was affected by changes in adult child migration patterns across the study period.

Trends in elderly health

We next turn to a description of the trends in overall elderly health in 2007 and 2011. We use two metrics of elderly health: self-reported health and illness instances. Figure 1 shows that the proportion of elderly individuals in our sample reporting that they were healthy decreased from 54.8 percent in 2007 to 43.2 percent in 2011. Similarly, the

Table I.
Trends in adult child migration and elderly health

	Adult child migration in 2007			Adult child migration in 2011		
	Households (1)	Elderly individuals (total) (2)	% (3)	Households (4)	Elderly individuals (total) (5)	% (6)
Both at home	79	125	51.2	67	109	44.7
Only son migrated	42	78	32	48	87	35.7
Only daughter-in-law migrated	25	37	15.2	24	33	13.5
Both migrated	2	4	1.6	9	15	6.2
Total	148	244	100	148	244	100

Source: Authors' survey

Table II.
Number of elderly individuals living in households with each of four adult child migration patterns (number of elderly individuals)

2011	Both at home (1)	Only son migrated (2)	Only daughter-in-law migrated (3)	Both migrated (4)	Total (5)
2007					
Both at home	88	17	15	5	125
Only son migrated	12	59	5	4	78
Only daughter-in-law migrated	8	12	13	4	37
Both migrated	2	0	0	2	4
Total	109	87	33	15	244

Source: Authors' survey

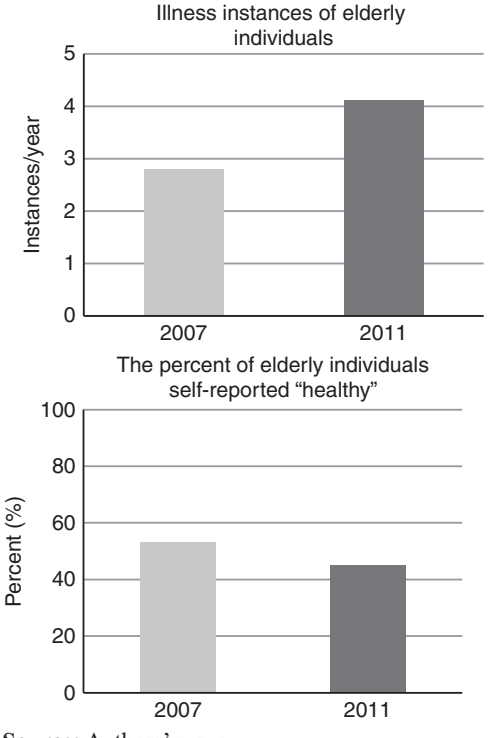
average number of annual illness instances per elderly individual increased from 3.3 in 2007 to 4.3 in 2011. This shows that on average for our sample, elderly health declined from 2007 to 2011. It should be noted that because our sample is made up of the same individuals from 2007 to 2011, a certain amount of health deterioration should be expected due to aging.

Next, we document the share of our elderly sample that had changes in health status between 2007 and 2011. Table IV shows the share of the sample that had a change in self-reported health and illness instances between 2007 and 2011. In Table IV, we see that the share of the elderly sample that had a change in health was 36.5 percent,

Table III. Number of elderly individuals and households with each of two adult children migration patterns (number of elderly individuals and number of households)

	Elderly Individuals		Households	
2011	Both at home (1)	Either or both migrated (2)	Both at home (3)	Either or both migrated (4)
2007				
Both at home	88	37	56	23
Either or both migrated	21	98	11	58

Source: Authors' survey



Source: Authors' survey

Figure 1. Two measures of elderly health in 2007 and 2011

Table IV.
Change in elderly self-reported health and illness instances from 2007 to 2011

	Change in elderly self-reported health from 2007 to 2011			Change in elderly illness instances from 2007 to 2011			
	Change in elderly self-reported health from 2007 to 2011	Number of elderly individuals (1)	% of the total sample of elderly individuals (2)	Change in elderly illness instances from 2007 to 2011	Households (3)	Number of elderly individuals (4)	% of the total sample of elderly individuals (5)
Pattern 1	From unhealthy to unhealthy	85	34.8	Annual illness instances increased by 3 or more	38	74	30.3
Pattern 2	From unhealthy to healthy	32	13.1	Annual illness instances decreased by 3 or more	16	30	12.3
Pattern 3	From healthy to unhealthy	57	23.4	No change[a]	94	140	57.4
Pattern 4	From healthy to healthy	70	28.7				
Total		244	100	Total	148	244	100

Note: [a]"No change" in illness instances includes elderly individuals whose annual illness instances increased or decreased by 0, 1 or 2 instances
Source: Authors' survey

including 13.1 percent of the elderly sample whose health improved over this period (row 2, column 2) and 23.4 percent whose health declined (row 3, column 2).

We next examine change in average annual illness instances for our elderly sample [4]. As shown in Table IV, the proportion of the elderly sample with a significant increase or decrease in their annual illness instances from 2007 to 2011 was more than 40 percent (row 4-5, column 5). Specifically, 30.3 percent of our elderly sample showed a decrease in overall health status as measured by annual illness instances and 12.3 percent of our elderly sample showed an improvement in overall health status as measured by annual illness instances.

The correlation between adult child migration and elderly health

The unadjusted results show moderate support for the hypothesis that families with increased adult child migration from 2007 to 2011 are more likely to show an improvement in elderly health (Table V). Of the elderly individuals who had children migrate out from 2007 to 2011, 27 percent showed an improvement in self-reported health during this period (Table V, row 1, column 2). By contrast, only 18.9 percent of these elderly individuals had a deterioration in self-reported health (row 1, column 1). Elderly individuals whose adult children migrated out between 2007 and 2011 were more likely to show a decrease (21.6 percent; row 1, column 5) than an increase in annual illness instances (18.9 percent; row 1, column 6). Overall, it appears that out migration of adult children is associated with improvement in elderly health, on average.

From Table V we can also see that those elderly individuals whose adult children returned home between 2007 and 2011 or showed no change in migration status across this period had the opposite trend: the elderly in their households were more likely to experience a decrease in health status. We can see that among this subset of elderly individuals, a larger proportion experienced a decrease in self-reported health than an improvement (row 2-3, column 1-2). Likewise, among families with decreased migration or no change in migration status, elderly individuals were more likely to show an increase than a decrease in annual illness instances, suggesting that their health was more likely to deteriorate (row 2-3, column 4-5).

To better understand the relationship between adult child migration and elderly health we run a series of regressions. The results of the econometric estimation of Equations 1 and 2 are shown in Tables VI and VII. In all four models presented in Table VI, we find that adult child migration has a positive and significant correlation with elderly health. For the individual sample in model 1, the elderly illness instance decreased 1.71 times when only the son migrated (row 2, column 1). When the son and daughter-in-law both migrated, the elderly illness instance decreased 3.27 times (row 3, column 1). The same results were found using the household sample regression with illness instance in model 3 (row 2, column 3). In model 2, we found the probability of an elderly individual self-reporting to be healthy will increase significantly when only the son or only the daughter-in-law migrates (row 2-3, column 2). In model 4, the results indicate the number of the elderly individuals self-reporting to be unhealthy significant decreases if one or both of the adult children migrate (row 1-2, column 4).

Overall, all of the relationships shown in Table VI are of the expected signs and several are statistically significant for a decrease in elderly illness instances and an increase in elderly self-reported health following increased adult child migration. Specifically, in all 12 models the coefficient is of the expected sign, and 7 out of the 12 results are significant at least at the 10 percent level. We therefore conclude from

Table V.
The relationship between change in adult child migration pattern and change in elderly self-reported health and illness instances (percent of elderly individuals)

Adult child migration pattern (2007-2011)	Change in elderly self-reported health (2007-2011)			Change in elderly illness instances (2007-2011)		
	Healthy to unhealthy (1)	Unhealthy to healthy (2)	No change (3)	Annual illness instances increased by 3 or more (4)	Annual illness instances decreased by 3 or more (5)	No change (6)
Out migration: from both at home to at least one migrated	18.9	27.0	54.1	18.9	21.6	59.5
Return home: from at least one migrated to both at home	33.3	14.3	52.4	28.6	0	71.4
No change: both at home or at least one migrated	23.1	10.2	66.7	32.8	11.8	55.4

Note: "No change" in illness instances includes elderly individuals whose annual illness instances increased or decreased by 0, 1 or 2 instances
Source: Authors' survey

	Fixed effect OLS models (elderly individuals sample)			
	Dependent variable			
	Individual sample			Household sample
Independent variable	Illness instances (instances/year) (1)	Self-reported health (1 = healthy; 0 = unhealthy) (2)	Illness instances (instances/year) (3)	Self-reported health (0 = two elderly individuals both unhealthy, 1 = one elderly individual unhealthy , 2 = no elderly individuals unhealthy) (4)
1. Only son migrated	−1.48 (−1.64)	0.16 (1.72)*	−1.59 (−1.44)	0.32 (1.71)*
2. Only daughter-in-law migrated	−1.71 (−1.79)*	0.18 (1.79)*	−2.28 (−2.01)**	0.33 (1.71)*
3. Both migrated	−3.27 (−2.08)**	0.09 (0.54)	−3.01 (−1.64)	0.14 (0.45)
4. Married (1 = yes)	3.65 (1.99)**	0.03 (0.14)	4.14 (2.37)**	−0.37 (−1.24)
5. Off-farm income (1 = yes)	1.59 (1.39)	−0.11 (−0.96)	1.62 (1.37)	−0.14 (−0.70)
6. Household size (people)	−0.98 (−1.10)	−0.10 (−1.08)	−1.31 (−1.22)	−0.21 (−1.16)
7. Number of kids (aged 0-16; people)	2.01 (2.15)**	0.03 (0.26)	1.82 (1.67)*	0.04 (0.24)
8. Per capita land (mu)	0.07 (0.71)	−0.02 (−1.60)	0.08 (0.69)	−0.03 (−1.62)
9. Household asset value (ten thousand yuan)	0.00 (0.05)	0.00 (1.37)	0.01 (0.26)	0.01 (1.16)
10. Per capita off-farm income (ten thousand yuan)	−0.75 (−1.12)	0.03 (0.37)	−0.77 (−0.97)	0.09 (0.66)
11. Enrolled in NCMS (1 = yes)	−2.57 (−1.51)	−0.32 (−1.76)*	−2.01 (−1.18)	−0.58 (−1.98)**
12. 2011 year dummy	2.34 (4.51)***	−0.13 (−2.41)**	2.59 (4.17)***	−0.22 (−2.09)**
13. Constant	4.88 (1.11)	1.22 (2.63)***	6.04 (1.20)	0.87 (1.01)
14. Observations	488	488	296	296
15. R^2	0.121	0.087	0.177	0.139
16. Number of pid	244	244	148	148

Notes: *t*-Statistics are in parentheses. *,**,***Statistically significant at the 10, 5 and 1 percent levels, respectively
Source: Authors' survey

Table VI.
The effect of adult child migration on elderly health (four types of migration)

Table VII.
The effect of adult child migration on elderly health (two types of migration)

	Fixed effect OLS models (elderly individuals sample)			
	Dependent variable			
	Individual sample		Household sample	
Independent variable	Illness instances (instances/year) (1)	Self-reported health (1 = healthy; 0 = unhealthy) (2)	Illness instances (instances/year) (3)	Self-reported health (0 = two elderly individuals both unhealthy, 1 = one elderly individuals unhealthy, 2 = no elderly individuals unhealthy) (4)
1. Either or both migrated (1 = yes)	−1.77 (−2.36)**	0.16 (2.05)**	−2.08 (−2.31)**	0.30 (1.96)*
2. Married (1 = yes)	3.55 (1.95)*	0.03 (0.14)	4.01 (2.32)**	−0.38 (−1.28)
3. Off-farm income (1 = yes)	1.69 (1.49)	−0.11 (−0.92)	1.70 (1.47)	−0.12 (−0.62)
4. Household size (people)	−0.90 (−1.03)	−0.10 (−1.11)	−1.17 (−1.12)	−0.21 (−1.18)
5. Number of kids (aged 0-16; people)	1.85 (2.01)**	0.02 (0.18)	1.75 (1.63)	0.03 (0.15)
6. Per capita land (mu)	0.07 (0.70)	−0.02 (−1.62)	0.09 (0.71)	−0.03 (−1.63)
7. Household asset value (ten thousand yuan)	−0.00 (−0.02)	0.00 (1.40)	0.00 (0.17)	0.01 (1.17)
8. Per capita off-farm income (ten thousand yuan)	−0.70 (−1.05)	0.03 (0.41)	−0.73 (−0.92)	0.10 (0.72)
9. Enrolled in NCMS (1 = yes)	−2.59 (−1.52)	−0.32 (−1.78)*	−2.01 (−1.19)	−0.58 (−2.00)**
10. 2011 year dummy	2.24 (4.42)***	−0.14 (−2.58)**	2.54 (4.21)***	−0.23 (−2.27)**
11. Constant	4.83 (1.11)	1.24 (2.72)***	5.59 (1.13)	2.90 (3.43)***
12. Observations	488	488	296	296
13. R^2	0.116	0.085	0.173	0.136
14. Number of pid	244	244	148	148

Notes: *t*-Statistics are in parentheses. *,**,***Statistically significant at the 10, 5 and 1 percent levels, respectively
Source: Authors' survey

Table VI that increased adult child migration is significantly correlated with improvement in elderly health status overall.

Furthermore, keeping other variables unchanged, the "Married" and the "Number of kids" and "Enrolled in New Rural Cooperative Medical System (NCMS)" variables have negative effects on elderly health. Although the finding that living with an spouse is negatively related to elderly health status stands in contrast to previous research (Goldman *et al.*, 1995; Schone and Weinick, 1998), we believe our result is related to increased care that an elderly individual must provide to their spouse. When an elderly individual is married and living with his or her spouse, he or she may need to take care the spouse. Similarly, the greater the number of children under 16 years old that live in the household, the more elderly individuals will need to look after the children. Both of these situations have the effect that elderly individuals will spend more time and expend energy caring for others in their family, which may subsequently affect their health (Dai and Kong, 2005; Luo *et al.*, 2011).

Also, when an elderly individual is enrolled in the NCMS, we find that their self-reported health tends to be lower. This may be due to the fact that as physical examinations become increasingly routine among the elderly with access to medical insurance through NCMS, more elderly individuals were made aware of their poor health status (Wang, 2014).The findings in Table VII are consistent with those in Table VI. The results show that the elderly individuals who have had one or two adult children migrate have significantly lower average illness instances and significantly better average self-reported health as compared to families with no migrated adult children. These findings remain robust and significant for all four measures of elderly health. In other words, the estimation results show that adult child migration seems to have a significant positive effect on elderly health status across all 16 of our models.

Robustness checks

The primary analyses provide consistent and compelling results. We conduct several further analyses to verify their robustness. First, it is possible that individuals above the age of 60 are still too young to require much care from their adult children. Thus, the relationship between adult child migration and elderly health may be different if we choose a different age-cutoff for our definition of "elderly."

To check the robustness of the relationship between adult child migration and elderly health, we rerun the same analyses with a sample that defines elderly residents as 65 years of age or older (instead of 60). We find that our result is in fact robust with this more stringent definition of old age. For all 16 models, the estimated coefficient on adult child migration is positive for all measures of elderly health (Tables AI and AII). Also, 7 out of 16 models have at least one result that is statistically significant. We therefore conclude that the positive relationship between adult child migration and elderly health is robust for both definitions of old age.

As a second robustness check, we also examine the relationship between adult child migration and elderly health for a larger, less-limited sample. As we explained in the data section, to improve the precision of our models we initially limited our sample to only those households that included exactly two individuals of working age (generally a son and a daughter-in-law). While this limitation has its procedural advantages, it reduces the external validity of our findings for the many households in rural China that have more complicated household structures.

To understand how applicable our results are to these families, we therefore also run the same models with the larger sample (limited only by the condition that all families

have at least one elderly member over the age of 60). We define our independent variable as a binary dummy variable for whether at least one working-age household member has migrated (yes = 1, no = 0). Using this approach, we find that the results are consistent with our primary findings (presented in Tables VI and VII) and robust. The coefficients are of the expected signs in both models, though only significant for self-reported health at the 10 percent level (Table AIII). Overall, we see that adult child migration in this sample remains associated with decreased elderly illness instances and higher (or relatively higher) self-reported elderly health. We can therefore conclude that our findings from our more limited sample likely carry over to a larger portion of the population with more varied household structures.

Finally, it should be noted that there is the possibility of an endogeneity bias in this research. While adult child migration could affect elderly health (e.g. through higher income or reduced care), elderly health could also potentially affect adult child migration (e.g. if an elderly parent becomes sick and therefore their adult child returns home to take care of them). Although we used the panel and FE OLS models to overcome the potential endogeneity bias, it cannot be avoided entirely (Antman, 2013). To understand the scope of this problem, we run all of our original regression models "in reverse," with the dependent and independent variables switched. After doing so we find that two of these regressions are statistically significant. These two regressions are presented in Tables AIV and AV. One regression shows that a decrease in elderly health is associated with a decrease in the likelihood that adult children migrate (Table AIV). This result is consistent with the research of Giles and Mu (2007), which found that poor parent health lowers the probability of child migration in rural China. All other models show no significant relationship and no consistency in the direction of the effect (e.g. Table AV). While this robustness check does not allow us to completely reject the hypothesis of an endogenous relationship, we are able to state that the correlation between elderly health and adult child migration is relatively weak.

Based on all of our data, we can conclude with some confidence that adult child migration in rural China is not negatively related to elderly health and it may even be positively correlated.

Conclusion

With increasing rates of labor migration and a rapidly aging rural population receiving little public assistance, ensuring elderly health has become and will continue to be an important public problem in rural China. Previous studies show that the migration of adult children may be either positively or negatively correlated with elderly health in different contexts. The findings of our empirical analysis suggest that increased adult child migration is significantly and positively associated with two different measures of elderly health in rural China. We recognize that there may be an endogenous relationship between adult child migration and elderly health, because elderly health could potentially influence the migration decisions of adult child. Still, we believe our robustness check results at the very least make it clear that increasing levels of labor migration are not negatively associated with elderly health in rural China. While it is beyond the scope of this paper to definitively identify the source of our empirical results, it is possible to speculate as to how we reach these findings. Elderly health may improve as a result of adult child migration due to the increased income that migration brings into rural households. It is well documented in rural China that off-farm labor earns much higher wages than farm work (De Janvry *et al.*, 2005), particularly off-farm labor in the form of migrant work (Fan, 2001; Zhao, 1999). The more earnings from

migration, the better a household can provide for its elderly members. Increased household income might improve elderly health through a variety of channels. For example, increased income could improve an elderly individual's daily life (such as the ability to buy more nutritious foods, have more leisure time, less stress, etc.). Increased income may also increase the ability of elderly individuals to seek quality medical care.

In China today, urbanization, migration and population aging are trends that seem unlikely to slow. Therefore, understanding the relationship between adult child migration and elderly parent health is of critical importance for China today and into the future. Our research suggests that, at least for now, increasing migration is unlikely to negatively associated with the health of elderly parents who are left-behind by their migrating children. However, as elderly parents become too old to take care themselves, adult children migration certainly poses challenges for their livelihoods. For this reason, we expect that social security for the elderly will be important in the future.

Notes

1. The survey included a number of questions about specific household assets. A monetary value was attached to each asset to produce an overall household asset value. Asset values were based on the National Household Income and Expenditure Survey, published by the China National Bureau of Statistics – CNBS, 2007.
2. When we run the regression on the household level, we redefine this variable as equal to 0 if two elderly individuals are both unhealthy, 1 if one elderly individual is unhealthy and 2 if no elderly individuals are unhealthy.
3. Because in most Chinese families elderly parents live with their son and daughter-in-law (rather than daughter and son-in-law) we refer from here on to all male and female members of the younger generation as "son" and "daughter-in-law," respectively, for the sake of simplicity.
4. Based on the assumption that a change of one or two illness instances per year might not be indicative of a true change in health, we define a decrease or increase of three illness instances per year as the cutoff to describe whether or not elderly health changed from 2007 to 2011.

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Further reading

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Corresponding author
Yaojiang Shi can be contacted at: shiyaojiang7@gmail.com

(The Appendix follows overleaf.)

Table AI.
The effect of adult child migration on elderly health (elderly individuals defined as 65 years or older, four types of migration)

	Fixed effect OLS models			
	Dependent variable			
	Elderly individual sample			Household sample
Independent variable	Illness instances (instances/year) (1)	Self-reported health (1 = healthy; 0 = unhealthy) (2)	Illness instance (instances/year) (3)	Self-reported health (0 = two elderly individuals both unhealthy, 1 = one elderly individual unhealthy , 2 = no elderly individual unhealthy) (4)
1. Only son migrated	−3.64 (−2.39)**	0.33 (2.21)**	−3.40 (−1.85)*	0.51 (1.97)*
2. Only daughter-in-law migrated	−0.50 (−0.33)	0.04 (0.24)	−0.88 (−0.56)	0.10 (0.45)
3. Both migrated	−3.76 (−2.01)**	0.07 (0.41)	−3.07 (−1.48)	0.19 (0.64)
4. Married (1 = yes)	3.60 (1.64)	0.28 (1.34)	3.84 (1.84)*	0.30 (1.02)
5. Off-farm income (1 = yes)	1.89 (1.03)	−0.43 (−2.43)**	2.28 (1.31)	−0.49 (−2.01)**
6. Household size (people)	−0.13 (−0.11)	−0.01 (−0.12)	−0.34 (−0.29)	0.01 (0.08)
7. Number of kids (aged 0-16; people)	2.15 (1.75)*	−0.03 (−0.25)	1.69 (1.17)	−0.04 (−0.20)
8. Per capita land (mu)	0.05 (0.38)	−0.00 (−0.18)	0.05 (0.38)	−0.00 (−0.10)
9. Household asset value (ten thousand yuan)	−0.01 (−0.34)	0.01 (3.09)***	−0.02 (−0.36)	0.02 (2.66)***
10. Per capita off-farm income (ten thousand yuan)	−0.49 (−0.55)	−0.02 (−0.21)	−0.70 (−0.75)	0.02 (0.13)
11. Enrolled in NCMS (1 = yes)	−3.37 (−1.72)*	−0.16 (−0.88)	−3.36 (−1.71)*	−0.22 (−0.82)
12. 2011 year dummy	2.37 (3.53)***	−0.17 (−2.67)***	2.72 (3.62)***	−0.27 (−2.61)**
13. Constant	1.04 (0.18)	0.42 (0.77)	2.60 (0.44)	1.11 (1.35)
14. Observations	280	280	200	200
15. R^2	0.189	0.148	0.239	0.160
16. Number of pid	140	140	100	100

Notes: *t*-Statistics are in parentheses. *,**,***Statistically significant at the 10, 5 and 1 percent levels, respectively
Source: authors' survey

	Fixed effect OLS models			
	Dependent variable			
	Elderly individual sample			Household sample
Independent variable	Illness instances (1)	Self-reported health (1 = healthy; 0 = unhealthy) (2)	Illness instances (3)	Self-reported health (0 = two elderly individuals both unhealthy, 1 = one elderly individual unhealthy, 2 = no elderly individual unhealthy) (4)
1. Either or both migrated (1 = yes)	−2.43 (−2.37)**	0.15 (1.49)	−2.16 (−1.89)*	0.24 (1.48)
2. Married (1 = yes)	4.02 (1.86)*	0.22 (1.04)	4.22 (2.08)**	0.21 (0.75)
3. Off-farm income (1 = yes)	1.84 (1.02)	−0.39 (−2.24)**	2.07 (1.20)	−0.44 (−1.84)*
4. Household size (people)	−0.51 (−0.46)	0.03 (0.28)	−0.58 (−0.50)	0.06 (0.35)
5. Number of kids (aged 0-16; people)	1.90 (1.56)	−0.03 (−0.24)	1.55 (1.08)	−0.03 (−0.17)
6. Per capita land (mu)	0.04 (0.30)	−0.00 (−0.11)	0.05 (0.35)	−0.00 (−0.06)
7. Household asset value (ten thousand yuan)	−0.01 (−0.16)	0.01 (2.75)***	−0.01 (−0.26)	0.02 (2.45)**
8. Per capita off-farm income (ten thousand yuan)	−0.66 (−0.75)	0.01 (0.06)	−0.81 (−0.87)	0.04 (0.30)
9. Enrolled in NCMS (1 = yes)	−3.00 (−1.54)	−0.19 (−1.00)	−3.04 (−1.57)	−0.26 (−0.96)
10. 2011 year dummy	2.37 (3.51)***	−0.18 (−2.72)***	2.74 (3.65)***	−0.28 (−2.65)***
11. Constant	2.81 (0.49)	0.28 (0.52)	3.53 (0.60)	0.98 (1.20)
12. Observations	280	280	200	200
13. R^2	0.170	0.130	0.226	0.142
14. Number of pid	140	140	100	100

Notes: *t*-Statistics are in parentheses. *,**,***Statistically significant at the 10, 5 and 1 percent levels, respectively
Source: authors' survey

Table AII.
The effect of adult child migration on elderly health (elderly individuals defined as 65 years and older; two types of migration)

Table AIII.
The effect of migration of household members of working age on elderly health (elderly individuals defined as 60 years and older, enlarged sample)

	Fixed effect OLS models	
	Dependent variable	
Independent variable	Illness instances (1)	Self-reported health (1 = healthy; 0 = unhealthy) (2)
1. At least one household member between 16 and 60 years old has migrated (1 = yes)	−0.32 (−0.78)	0.07 (1.74)*
2. Married (1 = yes)	1.53 (1.85)*	−0.03 (−0.41)
3. Off-farm income (1 = yes)	0.42 (0.82)	0.06 (1.29)
4. Household size (people)	0.14 (0.92)	−0.02 (−1.26)
5. Number of kids (aged 0-16; people)	0.24 (0.63)	−0.03 (−0.69)
6. Per capita land (mu)	−0.02 (−0.33)	−0.01 (−1.28)
7. Household asset value (ten thousand yuan)	−0.01 (−0.88)	0.00 (1.34)
8. Per capita off-farm income (ten thousand yuan)	−0.39 (−1.11)	0.01 (0.23)
9. Enrolled in NCMS (1 = yes)	0.24 (0.31)	−0.14 (−1.84)*
10. 2011 year dummy	1.37 (5.67)***	−0.13 (−5.41)***
11. Constant	0.98 (0.79)	0.78 (6.46)***
12. Observations	2,145	2,145
13. R^2	0.040	0.046
14. Number of pid	1,162	1,162

Notes: *t*-Statistics are in parentheses. *,***Statistically significant at the 10 and 1 percent levels, respectively
Source: Authors' survey

Table AIV.
The effect of elderly health on adult child migration (two types, elderly individuals sample)

	Fixed effect OLS models (elderly individuals sample)	
	Either son or daughter-in-law or both migrated	
	(1)	(2)
1. Illness instances	−0.01 (−2.36)**	
2. Self-reported health (1 = healthy; 0 = unhealthy)		0.11 (2.05)**
3. Married (1 = yes)	0.09 (0.59)	0.04 (0.28)
4. Off-farm income (1 = yes)	0.04 (0.40)	0.03 (0.30)
5. Household size (people)	−0.06 (−0.76)	−0.03 (−0.46)
6. Number of kids (aged 0-16; people)	0.09 (1.13)	0.06 (0.81)
7. Per capita land	0.00 (0.15)	0.00 (0.26)
8. Household asset value (ten thousand yuan)	−0.00 (−0.04)	−0.00 (−0.22)
9. Per capita off-farm income (ten thousand yuan)	0.04 (0.75)	0.05 (0.86)
10. Enrolled in NCMS (1 = yes)	0.12 (0.81)	0.19 (1.28)
11. 2011 year dummy	0.10 (2.27)**	0.09 (2.00)**
12. Constant	0.47 (1.27)	0.28 (0.73)
13. Observations	488	488
14. R^2	0.054	0.049
15. Number of individuals	244	244

Notes: *t*-Statistics are in parentheses. **Statistically significant at the 5 percent
Source: Authors' survey

	Fixed effect OLS models (household sample)					
	Only son migrated (1)	Only daughter-in-law migrated (2)	Both migrated (3)	Only son migrated (4)	Only daughter-in-law migrated (5)	Both migrated (6)
1. Illness instances	−0.00 (−0.47)	−0.01 (−1.41)	−0.00 (−1.20)			
2. Self-reported health (1 = healthy; 0 = unhealthy)				−0.05 (−1.09)	−0.04 (−1.10)	0.00 (0.02)
3. Married (1 = yes)	−0.10 (−0.67)	0.15 (1.01)	0.07 (0.85)	−0.10 (−0.66)	0.13 (0.87)	0.05 (0.63)
4. Off-farm income (1 = yes)	0.07 (0.67)	0.16 (1.66)*	−0.08 (−1.36)	0.07 (0.66)	0.15 (1.56)	−0.08 (−1.49)
5. Household size (people)	0.15 (1.71)*	−0.20 (−2.28)**	−0.03 (−0.69)	0.17 (1.87)*	−0.18 (−2.03)**	−0.03 (−0.59)
6. Number of kids (aged 0-16; people)	0.04 (0.41)	−0.03 (−0.38)	0.11 (2.06)**	0.03 (0.33)	−0.05 (−0.58)	0.10 (1.92)*
7. Per capita land (mu)	0.00 (0.37)	−0.00 (−0.35)	0.00 (0.07)	0.01 (0.49)	−0.00 (−0.28)	−0.00 (−0.00)
8. Household asset value (ten thousand yuan)	−0.00 (−1.35)	0.00 (1.59)	0.00 (0.34)	−0.00 (−1.47)	0.00 (1.46)	0.00 (0.33)
9. Per capita off-farm income (ten thousand yuan)	0.03 (0.42)	0.02 (0.29)	−0.04 (−0.97)	0.03 (0.39)	0.02 (0.33)	−0.03 (−0.86)
10. Enrolled in NCMS (1 = yes)	0.07 (0.46)	0.02 (0.11)	0.02 (0.28)	0.10 (0.68)	0.06 (0.44)	0.03 (0.41)
11. 2011 year dummy	0.05 (1.00)	−0.01 (−0.12)	0.09 (2.94)***	0.06 (1.07)	−0.02 (−0.39)	0.08 (2.64)***
12. Constant	−0.54 (−1.28)	1.07 (2.63)***	−0.01 (−0.04)	−0.60 (−1.43)	0.98 (2.39)**	−0.03 (−0.13)
13. Observations	296	296	296	296	296	296
14. R^2	0.056	0.086	0.097	0.062	0.081	0.087
15. Number of pid	148	148	148	148	148	148

Notes: *t*-Statistics are in parentheses. *, **, ***Statistically significant at the 10, 5 and 1 percent levels, respectively
Source: Authors' survey

Table AV.
The effect of elderly health on adult child migration (four types, household sample)