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The health implications of social pensions: Evidence from China's new rural pension scheme☆

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ABSTRACT

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This paper estimates the causal effect of income on health outcomes of the elderly and investigates underlying mechanisms by exploiting an income change induced by the launch of China's New Rural Pension scheme (NRPS). Using this policy experiment, we address the endogeneity of pension income by applying a fixed-effect model with instrumental variable correction. The results reveal that pension enrollment and income from the NRPS both have had a significant beneficial impact on objective measures of physical health and cognitive function of the rural elderly. Pension recipients respond to the newly acquired pension income in multiple ways: improved nutrition intake, better accessibility to health care, increased informal care, increased leisure activities, and better self-perceived relative economic situation. These in turn act as channels from pension income to health outcomes of the Chinese rural elderly. *Journal of Comparative Economics* **000** (2016) 1–25. Institute for Advanced Research, Shanghai University of Finance and Economics, China; China Economics and Management Academy, Central University of Finance and Economics, China; School of Business, Nanjing University, China; School of Labor and Human Resources, Renmin University of China, China.

1. Introduction

Population aging presents one of the greatest challenges for developing countries to ensure the well-being of their growing old population. Social pension programs have been widely regarded and implemented as an important policy device to provide income security for old people. Recently many developing countries such as Brazil, South Africa, Mexico, and

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China have initiated government transfer or social pension programs for the uncovered elderly, which may have important implications for the health and well-being of these new pension recipients (Jung and Tran, 2012).

The positive association between income and health is well established in the literature (van Doorslaer et al., 1997; Gerdtham and Johannesson, 2004; Smith and Goldman, 2007; Smith, 2007). However, there remain crucial open questions that deserve further investigation, such as whether the association reflects causality from income to health and what mechanisms underlie the effects of income on health (Deaton and Paxson, 1998; Smith, 1999). The main empirical challenge in establishing causality from income to health is to correct the potential bias from reverse causality. The reverse causality can be due to contemporary factors or life-cycle factors. The possibility that the correlation between current health and current income at old ages is partly driven by health shocks at earlier ages complicates the estimation, and may bias welfare analysis based on association between income and health (Smith, 1998; Richter, 2006). The life-cycle factors also imply that the causality between income and health may vary considerably with age (Cutler et al., 2008; Smith, 2007).

A number of empirical studies have attempted to identify the causal effects of income and wealth on health, using exogenous income shocks or sophisticated panel data models, but they have produced mixed results. For example, Ettner (1996) finds a large positive effect of income on physical and mental health for United States adults, by applying an instrumental variable approach.[1] Frijters et al., (2005) find that the positive effect of income changes on health is statistically significant but economically small in magnitude, based on a panel data of East and West Germans in the years following the German reunification. Using lottery prizes as an exogenous source of income variation, Lindahl (2005) show that higher incomes lead to better health for the full sample of the lottery players aged 34–76, but the income effect is not significant for those aged 60 and above. Several recent studies on the United States find little evidence that changes in wealth have a significant effect on health for adults (Meer et al., 2003), for couples aged over 50 (Michaud and van Soest, 2008), or for the elderly aged 70 and above (Adams et al., 2003). As the above empirical studies all focus on wealthy and industrialized nations, the finding of no income gradient of elderly health is not particularly surprising, given universal biological frailty, good public health insurance, and well-functioning social security systems in those countries (Kim and Durden, 2007; Wilkinson and Pickett, 2006). However, contradicting the main findings in the literature, Snyder and Evan (2006) show that the American elderly who received less income in social security benefits had significantly lower mortality than those with higher earnings.[2]

As transition and developing countries usually provide limited social safety nets, income should be more important for health production, particularly for the elderly population, who are vulnerable to economic and health risks. The income-health gradient and its underlying mechanisms in these counties deserve special attention. Among the few recent studies, Case (2004) shows that exogenous increases in pension income have improved the health status of pensioners and other household members in households that pool income in South Africa. Two studies on Russia by Jensen and Richter (2004) and Richter (2006) have found adverse effects of exogenous negative income shocks. The first one finds that the pension loss, associated with the Russian pension crisis, has led to worsened health and higher mortality rate among the pensioners. Similarly, the second one shows that during the wage arrears crisis in Russia, the loss in household wage income had detrimental effects on health outcomes of the elderly.[3] Galiani et al. (2016) find that a social pension program targeting rural elderly has significantly improved the mental health of beneficiaries in Mexico.

The first contribution of this paper is to identify and estimate the causal effect of income on health outcomes of the elderly in China, a middle-income developing country, by using an income change induced by China's New Rural Pension Scheme (NRPS). As one of the pillars of China's social security system, the NRPS is a public pension program for the rural population that was established in 2009 and expanded gradually to nearly all counties by the end of 2012. At the time of introduction, individuals aged 60 years and above were eligible for a basic monthly pension that varied across regions, but the amount of the pension was uncorrelated with observed or unobserved individual characteristics, such as current or past labor supply behavior. Taking advantage of this unique policy experiment, we identify the causal effect of income on health by exploiting exogenous time variation in the NRPS implementation at the county level through an instrumental variable approach.

The second contribution of this paper is to study multiple health outcomes. Our analysis draws on panel data from the Chinese Longitudinal Healthy Longevity Survey. That is a longitudinal survey since 1998, mainly focusing on the elderly population, and covers a rich set of well-being and health outcomes. Johnston et al. (2009) suggest that using commonly available self-reported measures of health may lead to underestimation of the income-health gradient, because reporting error is related to income. Our data set allows us to examine not only self-reported health measures, but also objective measures of health, cognitive function, psychological well-being, and mortality.

Thirdly, the rich information in the data allows us to explore more thoroughly how income affects different health outcomes through a variety of important channels, such as consumption, health behaviors, perceived access to medical care,

[1] Ettner (1996) uses the state unemployment rate, work experience, parental background, and spouse characteristics as instruments for family income. However, the exogeneity of these instruments has often been questioned (Meer et al., 2003; Frijters et al., 2005).

[2] Snyder and Evan (2006) suggest that those elderly with lower income have engaged in more post-retirement part-time work, which may have prevented social isolation, and thus reduced mortality.

[3] Those studies have considered several pathways such as nutrition, health care accessibility, and health behaviors. However, there are additional channels that deserve further investigation. Moreover, the underlying causal mechanisms may vary across countries, due to different economic development stages, social welfare systems, and cultural contexts.

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informal care service, labor supply, leisure activities, and perceived relative economic status. We also quantify the relative importance of those channels.

The last contribution of our study is to add to the limited literature on the evaluation of social pension programs in developing and transition countries (Kakwani and Kalanidhi, 2005; Palacios and Sluchynsky, 2006; Barrientos, 2009). As one of the few studies to evaluate the impact of the NRPS, this paper not only shows evidence that the NRPS has improved the well-being of the elderly, but also provides a useful set of health-related results for evaluating the effects of other government interventions on health outcomes. Our results have important implications for future comparison studies on health benefits of the social pension program and public health programs. Given the rapid aging of the population around the world and the limited social safety net in developing countries, our findings are of great significance for other countries as well.

The rest of the paper is structured as follows. Section 2 provides background on China's rural pension system. Section 3 describes the data and main variables. Section 4 outlines our empirical framework, and Section 5 gives our main results, with discussions on identification issues and potential threats to our findings. Section 6 investigates how pension income affects health, and Section 7 provides heterogeneous analysis for different subsamples. Section 8 concludes the paper.

2. China's rural pension system

The old age pension in China has comprised two separate systems for urban and rural residents. With the establishment of the People's Republic of China in 1949, China's first formal pension system – an enterprise-based, pay-as-you-go benefit scheme – was introduced in 1951 for state employees, civilian and military. At this time, rural people had to depend on the low-level rural economic collective system for employment and income, and old age support was jointly provided by the collective (at the village level) and the family.

Starting in 1978, the urban old-age pension system was reformed and extended to cover the private sector in the 1990s. In the meantime, the transition from the collective commune system to the "household responsibility system" dismantled the institutional basis for collective-based old age security system in rural China. Rural people were left to rely mainly on their own families for old-age support (Shi, 2006). In 1986, the government initiated some pilot projects for re-establishing a rural pension scheme, starting from well-off counties. These projects placed most financial responsibility on individuals, supplemented by the local collectives, and this financial arrangement led to a very low take-up rate. Despite significant expansion of the geographical coverage of these pilots in the 1990s, there were wide concerns about their financial sustainability and effectiveness. The government ceased the expansion of the pilot schemes in 1998, and their coverage shrank rapidly. According to the 2000 census, less than 5% of the rural elderly aged 60 and above had pension benefits, about 43% still had to work, and 48% depended on family support (Wang, 2006).

To promote the economic well-being of rural residents, the government launched a brand new nationwide pension project known as the New Rural Pension Scheme in rural China in 2009. It was first implemented in 320 pilot rural counties, and was expanded to 838 counties in 2010, to 1914 counties in 2011, and to nearly all 2853 counties by 2012. According to China Statistical Yearbook 2012, there were 326.4 million rural residents participating in this scheme, accounting for nearly one-quarter of the total population, and there were 89.2 million pension beneficiaries in 2011.

The NRPS is composed of two components – the social pension part and the contributory pension part – to provide minimum income protection in old age as well as some saving incentives. As the individuals in our study sample are mainly subject to the non-contributory component, we focus on the key features of the social pension part, and briefly introduce the contributory pension part of the scheme.[4]

Following the guideline issued by the central government, the program operates at the county level. Local rural residents aged 16 and above are eligible to participate if they are not in school or not covered by the basic urban pension scheme. Participation is voluntary. Participants who have contributed for 15 years will be eligible for a pension at age 60, which consists of a non-contributory basic pension and a monthly payment from the individual account. In this initial stage, people aged 60 and over are eligible to directly receive the non-contributory basic pension, as long as their eligible adult children enroll in the scheme.

Different from the old pilot schemes, the NRPS is heavily subsidized by the government. The central government funds the whole non-contributory basic pension for the relatively poor central and western regions, and half their cost for eastern regions. Local governments are encouraged to supplement the basic pension benefit at their discretion from their own revenues. Enrollees are required to contribute 100–500 Chinese yuan annually to individual pension accounts, which is partially matched by local government in the amount of at least 30 Chinese yuan per year.[5]

The minimum basic pension benefit was 55 Chinese yuan per month initially, and increased to 70 Chinese yuan in 2014, in accordance with the GDP growth and inflation. The amount of the basic pension varies considerably across counties; it was as high as about 370–380 Chinese yuan per month in Beijing and Shanghai in 2012, but was only 55 Chinese yuan per month in some less developed areas. In some regions, such as Chongqing and Shanxi province, the elderly aged 70 and over also receive an additional monthly subsidy of 10–20 Chinese yuan on top of their basic benefit.

[4] The detailed description of the design of the contributory pension part can be found in Cai et al. (2012).

[5] 1 US dollar is about 6.28 Chinese yuan on March 1, 2013.

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The average level of the basic pension was 78.6 Chinese yuan (12.5 US$) per person per month in March 2013.[6] This amount is approximately 12% of the average per capita net income (7916 Chinese yuan)[7] and 17% of the average per capita living expenses among Chinese rural households (5415 Chinese yuan) in 2012, and equals 41% of China's latest official rural poverty line.[8] Though the basic pension benefit of the NRPS is not enough to ensure a minimum living standard for the elderly, it is not economically negligible and can help them to pay for basic subsistence.

3. Data and variables

The data in this study are from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which has been conducted by the Center for Healthy Aging and Development Studies at Peking University in China and co-sponsored by the National Institute on Aging in the United States. It provides extensive information on the health status and quality of life of the population aged 60 and above in China. The survey covers 22 out of 34 provinces, including 10 eastern, 8 central, and 4 western provinces, which host approximately 85% of the total population in China. Half of the counties and cities in each sample province were randomly selected. The CLHLS primarily focused on the oldest-old population aged 80 and above in the first two waves, i.e., wave 1998 and wave 2000, and was expanded to cover the elderly aged 60 and above in follow-up waves conducted in 2000, 2002, 2005, 2008/09, 2011/12, and 2014.[9] For the purpose of this analysis, we mainly use the 2008/09 and 2011/12 waves, i.e., one wave before and one wave after the introduction of the NRPS in 2009.

3.1. Health outcomes

As the CLHLS consists of an in-home interview and a basic physical examination, the data set has multiple high-quality health outcome measures.

First, we have four types of physical health measures: self-assessed general health, limitations on the physical ability to perform instrumental activities of daily living (IADL), and measured hypertension and height. We measure self-assessed general health according to a five-category survey question, "How do you rate your health at present?" and code a dummy health indicator as 1 if the respondent reports "excellent" or "good" and 0 otherwise.

The CLHLS contains an assessment of an individual's physical ability to perform IADL. The survey instrument was based on international standard questionnaires and modified to fit into the Chinese culture and social context with extensive pilot testing (Zeng et al., 2002). The IADL measure is a binary indicator taking on a value of 1 if a respondent reports that he or she can finish eight daily activities without assistance, including visiting the neighbors, doing shopping, cooking a meal, washing clothes, walking continuously for 1 km, lifting a weight of 5 kgs, continuously crouching and standing up three times, and taking public transportation.

Johnston et al. (2009) show that the income-health gradient may be underestimated using self-reported health measures because of reporting error. The strength of our data set is that, in addition to the above two self-reported measures, we have two objective health measures: hypertension and height, measured by the medical personnel during the face-to-face interviews in each wave.

Following the medical standard, we use the average of the two blood pressure readings taken in the interview, and define respondents as having hypertension if their systolic blood pressure is higher than 140 mmHg or diastolic pressure is higher than 90 mmHg

Although adult height is widely considered as a health indicator, most elderly persons experience shrinkage in height as a consequence of aging. Huang et al., (2013) show that height shrinkage is an important marker of later-life health and it is positively correlated with the deterioration of a variety of health outcomes. The CLHLS has height measurements in the 2008/09 and 2011/12 waves; the estimated height shrinkage of a respondent can be interpreted as the impact of the NRPS on one dimension of objective health measurements of the elderly.

Second, following the wide practice in the literature (Crum et al., 1993; Folstein et al., 1975), we use the Mini-Mental State Examination (MMSE) to measure five areas of cognitive function of the elderly: orientation, reaction, calculation, recall, and language. It is a 24-question measure with a total score ranging from 0 to 30. As an alternative we construct an indicator of whether the respondent has a MMSE score no less than 24, suggested in the literature as indicating no cognitive impairment (Folstein et al., 1975). There are few studies on the effect of income on cognitive function of the elderly in the literature (Case, 2004; Jensen and Richter, 2004; Richter, 2006). Given the importance of cognitive function as a dimension of quality of life, our study provides new insight into this important yet under-researched area.

[6] The data come from the government report available online: http://www.mohrss.gov.cn/ncshbxs/NCSHBXSgongzuodongtai/201305/t20130531_104217.htm.

[7] The replacement rate from the non-contributory social pension of the NRPS was at the low end of the range for the OECD countries, with a cross-country average of around 30% of average earnings (Cai et al., 2012).

[8] In 2011, the Chinese government raised the poverty line from 1274 Chinese yuan per year in 2010 to 2300 Chinese yuan (370 US$) per year, which is higher than the international poverty line of $1.90 a day in 2011 purchasing-power parity.

[9] The most recent wave of the CLHLS data was collected in 2014 and is not available at present, so we are not able to include the 2014 wave in the main analysis.

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Table 1.
Descriptive statistics of health and economic status.

	Wave 2008/09		Wave 2011/12		
	Eligible, NRPS pensioners	Eligible, non-pensioners	Eligible NRPS pensioners	Eligible, non-pensioners	Diff-in-Diff
Sample size	907	3246	907	3246	
Health outcomes					
Self-reported health is good	0.533***	0.458	0.411	0.389	−0.053
	(0.499)	(0.498)	(0.492)	(0.488)	[0.040]
No IADL limitation	0.428	0.417	0.358***	0.307	0.041*
	(0.495)	(0.493)	(0.480)	(0.461)	[0.023]
Measured hypertension	0.473***	0.417	0.421***	0.467	−0.101**
	(0.500)	(0.493)	(0.494)	(0.499)	[0.047]
Measured height	156.20	155.81	154.81***	153.04	1.371**
	(9.21)	(9.81)	(11.50)	(12.13)	[0.610]
MMSE score	23.200	22.976	22.202**	21.322	0.657
	(8.481)	(8.574)	(9.015)	(9.350)	[0.480]
Cognitive function is good	0.671	0.654	0.608*	0.575	0.016
	(0.470)	(0.476)	(0.489)	(0.494)	[0.030]
Self-reported depression index	5.187***	5.914	5.147*	5.370	0.505*
	(3.022)	(3.293)	(2.998)	(3.191)	[0.269]
Economic characteristics					
Monthly pension income	0.000	0.000	92.120***	0.000	92.120***
	(0.000)	(0.000)	(92.378)	(0.000)	[5.922]
Total annual household income	10,891.9	11,806.2	18,984.0	18,303.5	1594.9
	(12,554.6)	(14,974.6)	(21,800.1)	(22,329.6)	[1339.9]
Poverty rate	0.217**	0.250	0.165***	0.216	−0.018
	(0.412)	(0.433)	(0.372)	(0.412)	[0.027]

Notes:
(a) Standard deviation in parenthesis; standard errors clustered at the county level in brackets.
(b) *t*-test was applied for pairwise comparisons of the treated and control groups in each wave. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(c) We use the 2009 official rural poverty line of 1196 Chinese yuan.

Third, psychological well-being of the respondent is measured using an index of depression consisting of six items.[10] Following the literature, we use the sum of all the responses as a measure of mental well-being, where the response to each question ranges from 0 to 3, and higher scores indicate lower well-being. According to Gardner and Oswald (2007), the typical score for healthy individuals is around 5–6.5 for our 18-point Likert scale.

3.2. Sample definition and description

We restrict the study sample to the rural elderly, and exclude about 15% of the observations with missing information or having other pensions than the NRPS.[11] Out of the 8683 rural elderly interviewed in wave 2008/09, 4153 remained in the 2011/12 survey, 3362 (38.7%) died before wave 2011/12, and 1168 (13.5%) were lost to follow-up. The issue of panel attrition will be addressed in a later subsection. Our main study sample is a panel composing of 4153 elderly individuals who were targeted by the NRPS and surveyed in both waves.[12]

In each wave, the respondents were asked whether they were covered by a retirement pension, social pension, or private pension. As the NRPS was the only social pension initiated in rural China since 2009 and has been expanded gradually to all rural areas, those respondents who reported no social pension in wave 2008/09 but having a social pension in wave 2011/12 are considered as the NRPS pensioners. Those who have had no social pension during the study period are taken as the control group. In wave 2011/12, 907 respondents (about 22%) enrolled in the NRPS, and received an average monthly pension income of 92 Chinese yuan.

Table 1 presents descriptive statistics of health and economic status separately for the NRPS pensioners (i.e. the treated) and non-pensioners (i.e. the control) with the *t*-test indicating the significance level of pairwise comparisons of the two groups before and after implementation of the NRPS, respectively. The last column presents the simple difference-in-differences results, which compare the difference between pensioners and non-pensioners in wave 2011/12 with the corresponding difference in wave 2008/09. Prior to the NRPS, the pensioners were statistically similar to the non-pensioners with

[10] The six items include (1) "Do you always look on the bright side of things?" (2) "Do you often feel fearful or anxious?" (3) "Do you often feel lonely and isolated?" (4) "Do you feel that the older you get, the more useless you are?" (5) "Are you as happy as when you were younger?" (6) "How do you rate your life at present?" Although we have less depression-related items here, the individual questionnaire items are virtually identical to those used in standard psychological health measures in the literature (Gardner and Oswald, 2004; 2007; Proper et al., 2005).

[11] The other types of pension include retirement pension, private or commercial old age insurance, the old rural pension that started before 2009, etc.

[12] Since all the observations in our study sample are aged 60 and above, the NRPS enrollees are the same as the NRPS recipients in this paper.

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regard to baseline IADL, measured height, and cognitive function, but healthier in terms of self-reported general health and depression, and had a higher rate of hypertension than the non-pensioners. After controlling for baseline health conditions, the simple difference-in-differences analysis shows that the NRPS pensioners are 4% more likely to have no IADL limitation, are 10% less likely to have hypertension, are about 1.37 cm taller, but have slightly higher self-reported depression index.

The last three rows of Table 1 show that total annual household income has increased by 8092 yuan for the pensioners and by 6497 yuan for the non-pensioners, leading to a net increase of 1595 yuan (a net increase by 15%) for the pensioners between these two waves.[13] Thus, overall the descriptive statistics suggest that this net increase is modest but not negligible; in the following analysis we will show that this 15% net increase in income from the NRPS can result in significant improvements in health outcomes of the elderly.

We consider several channels through which the NRPS may affect health. First, we create several indicators measuring consumption of the respondent, including whether the respondent has sufficient financial support for daily expenses, and whether the respondent frequently consumes high-protein foods (such as meat, fish, and eggs, etc.) or high-vitamin foods (fruits and vegetables). We also have two indicator variables measuring smoking and drinking behavior of the respondent.

Second, we construct a set of variables to capture informal care services and perceived access to medical care for the respondent.

Third, we consider the change of labor supply and leisure activities. Labor supply of the elderly is measured by two binary variables, one indicating formal labor force participation – i.e., whether the respondent is still working in the formal workforce (including both on-farm and off-farm work) at the survey time – and another indicating informal work, including doing household chores or taking care of grandchildren every day. The respondents were asked about their participation in a number of leisure activities.[14] The sum of the responses is used as a leisure index, which ranges from 0 to 5.

Last, we construct a binary variable measuring the self-perceived relative economic status of the elderly person, which equals one if the respondent rated his/her economic status as very rich or rich when compared to others in the local area, and zero otherwise. To measure the pension recipient's power within the household, we create another binary variable indicating whether the respondent can make decisions on some of the main spending in the household. We have two variables measuring the total amount of private transfer[15] and the value of net transfers (transfers in minus transfers out) received by the elderly from their children.

Summary statistics for the above channel variables and covariates of interest are reported in Table 2. In comparison with non-pensioners, the pensioners were more likely to have someone to talk with, be able to get help when having problems, and have sufficient medical care when sick; they had more leisure and reported better relative economic status and more involvement in household decision-making on spending after the reform, although the two groups did not differ in these characteristics in the baseline data. At baseline the pensioners had more living children and were more likely to have health insurance, but the simple difference-in-differences values are both statistically insignificant.

4. Main empirical method

To estimate the effects of pension enrollment and income on health, one simple reduced-form strategy would be to compare the health changes of the NRPS pensioners and non-pensioners before and after the implementation of the scheme. Given the data we have, we first specify the following fixed effect (FE) model:

$$Y_{ijt} = \beta_0 + \beta_1 NRPS_{ijt} + \beta_2 X_{ijt} + \beta_3 \mathrm{W}_{\mathrm{jt}} + \beta_4 v_t + c_i + \varepsilon_{ijt} \quad (1)$$

where the subscripts i, j and t represent individuals, counties and wave. Y_{ijt} is a set of health outcome variables. $NRPS_{ijt}$ represents our key independent variable, the NRPS enrollment status or pension income. The vector X_{ijt} includes observed individual and household characteristics, such as age, age squared, marital status, number of living children, household size, home ownership, and health insurance status. The vector W_{jt} includes observed county specific characteristics, such as total agricultural population, urbanization level (measured by the percentage of nonagricultural population to total population in the county), GDP per capita, government spending per capita, and hospital beds per 10,000 persons. v_t is the wave effect and c_i is the individual fixed effect.

Under the NRPS, the elderly aged 60 and above are allowed to directly receive basic pension benefits without contributing, conditional on the enrollment of their eligible adult children.[16,17] Due to the voluntary nature of the NRPS, taking up the pension may be an endogenous household decision. For example, a richer child may have a healthier elderly parent because of more unobserved transfers from the child to the parent; such households may choose to enroll in the NRPS

[13] All incomes are adjusted to 2011 Chinese yuan.

[14] The leisure activities include planting flowers or raising pets, reading newspaper or books, watching TV or listening to radio, playing cards or mah-jong, and participating in organized social activities

[15] Here private transfers include both monetary transfers and in-kind transfers.

[16] This requirement, however, has not been strictly enforced and increasingly been ignored in some places. Unfortunately, we have no detailed information about where and when the condition was dropped.

[17] In some counties those aged 60 and over are also allowed to make up the shortfall on vesting contributions in a lump sum, which may or may not be subsidized, depending on local policies, so that they can receive higher pension payments.

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Table 2.
Descriptive statistics of individual, household and county characteristics.

		Wave 2008/09		Wave 2011/12	
	Full sample	Eligible, NRPS pensioners	Eligible non-pensioners	Eligible, NRPS pensioners	Eligible non-pensioners
Sample size	8306	907	3246	907	3246
Potential channels from income to health					
Have sufficient financial support for daily expenses	0.736	0.762***	0.718	0.781***	0.735
	(0.441)	(0.426)	(0.450)	(0.414)	(0.442)
Frequent intake of protein-rich food	0.531	0.535	0.515	0.540	0.543
	(0.499)	(0.499)	(0.500)	(0.499)	(0.498)
Frequent intake of vitamin-rich food	0.591	0.701***	0.622	0.590***	0.530
	(0.492)	(0.458)	(0.485)	(0.492)	(0.499)
Smoking	0.190	0.212	0.198	0.195	0.175
	(0.393)	(0.409)	(0.399)	(0.396)	(0.380)
Drinking	0.183	0.245***	0.184	0.197**	0.161
	(0.387)	(0.430)	(0.388)	(0.398)	(0.368)
Hours of care received from children last week	7.293	2.810	4.015	10.101	11.134
	(26.948)	(14.929)	(20.641)	(29.810)	(33.129)
Have someone to talk with in daily life	0.946	0.953	0.945	0.964***	0.941
	(0.225)	(0.213)	(0.228)	(0.186)	(0.235)
Get help when having problems/difficulties	0.976	0.972	0.978	0.984*	0.973
	(0.153)	(0.164)	(0.148)	(0.125)	(0.163)
Get sufficient medical care when sick	0.913	0.921	0.904	0.939**	0.914
	(0.281)	(0.271)	(0.294)	(0.239)	(0.281)
Fail to get necessary care due to costs	0.044	0.042*	0.058	0.026	0.035
	(0.205)	(0.201)	(0.234)	(0.158)	(0.185)
Still work	0.162	0.197**	0.166	0.176**	0.144
	(0.368)	(0.398)	(0.372)	(0.381)	(0.351)
Do household chores or grandchild care	0.497	0.547	0.546	0.467	0.442
	(0.500)	(0.498)	(0.498)	(0.499)	(0.497)
Leisure index	0.661	0.677	0.659	0.740***	0.636
	(0.771)	(0.736)	(0.749)	(0.807)	(0.790)
Perceived relative economic status is high	0.122	0.108	0.103	0.162**	0.133
	(0.340)	(0.311)	(0.305)	(0.465)	(0.340)
Can make decisions on household spending	0.332	0.353	0.333	0.371***	0.314
	(0.471)	(0.478)	(0.471)	(0.483)	(0.464)
Total transfers received	2096.5	1983.1	2076.4	2185.1	2124.4
	(3342.6)	(2451.1)	(3182.2)	(4295.1)	(3416.9)
Net transfers received	1944.3	1893.8	1926.0	2024.5	1954.9
	(3468.4)	(2536.1)	(3264.8)	(4737.5)	(3482.7)
Household/Individual characteristics					
Age	84.54	82.46	83.15	85.56	86.23
	(11.26)	(10.93)	(11.23)	(10.90)	(11.21)
Male	0.411	0.430	0.406	0.430	0.406
	(0.492)	(0.495)	(0.491)	(0.495)	(0.491)
Had a white-collar career before age 60	0.012	0.015	0.011	0.015	0.011
	(0.107)	(0.123)	(0.102)	(0.123)	(0.102)
Han	0.920	0.957***	0.909	0.957***	0.909
	(0.272)	(0.203)	(0.288)	(0.203)	(0.288)
Married	0.356	0.399	0.374	0.371***	0.322
	(0.479)	(0.490)	(0.484)	(0.483)	(0.467)
Years of schooling	1.507	1.615	1.477	1.615	1.477
	(2.584)	(2.596)	(2.581)	(2.596)	(2.581)
Household size	3.304	3.159	3.209	3.370	3.424
	(2.045)	(1.849)	(1.977)	(2.131)	(2.132)
Owns the home	0.429	0.482	0.471	0.403	0.380
	(0.495)	(0.500)	(0.499)	(0.491)	(0.485)
Number of living children	4.003	4.138**	3.980	4.096**	3.961
	(1.796)	(1.806)	(1.791)	(1.820)	(1.791)
Have health insurance	0.824	0.808***	0.756	0.933***	0.865
	(0.381)	(0.394)	(0.430)	(0.250)	(0.342)
County characteristics					
Program duration in the county (years)	0.356	0.000	0.000	1.318***	0.542
	(0.640)	(0.000)	(0.000)	(0.792)	(0.646)
Total agricultural population (ten thousand)	68.844	68.287*	70.602	65.762*	68.104
	(35.590	(31.076	(36.941)	(30.427)	(36.641)

(*continued on next page*)

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Table 2. (*continued*)

	Full sample	Wave 2008/09		Wave 2011/12	
		Eligible, NRPS pensioners	Eligible non-pensioners	Eligible, NRPS pensioners	Eligible non-pensioners
Urbanization (percentage)	22.593	20.718	20.192	24.980	24.850
	(15.632)	(14.490)	(14.647)	(15.371)	(16.516)
GDP per capita (1000 yuan)	29.038	26.878***	20.352	42.759***	34.494
	(24.163)	(21.026)	(18.376)	(27.781)	(25.660)
Government spending per capita (1000 yuan)	3.073	2.164	2.084	4.101	4.029
	(2.264)	(1.310)	(1.476)	(2.194)	(2.588)
Hospital beds per 10,000 persons	25.151	24.817***	22.311	29.013***	27.005
	(12.040)	(10.010)	(10.146)	(11.455)	(13.702)

Notes: Standard deviation in parenthesis. *t*-test was applied for pairwise comparisons of the two groups in each wave. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

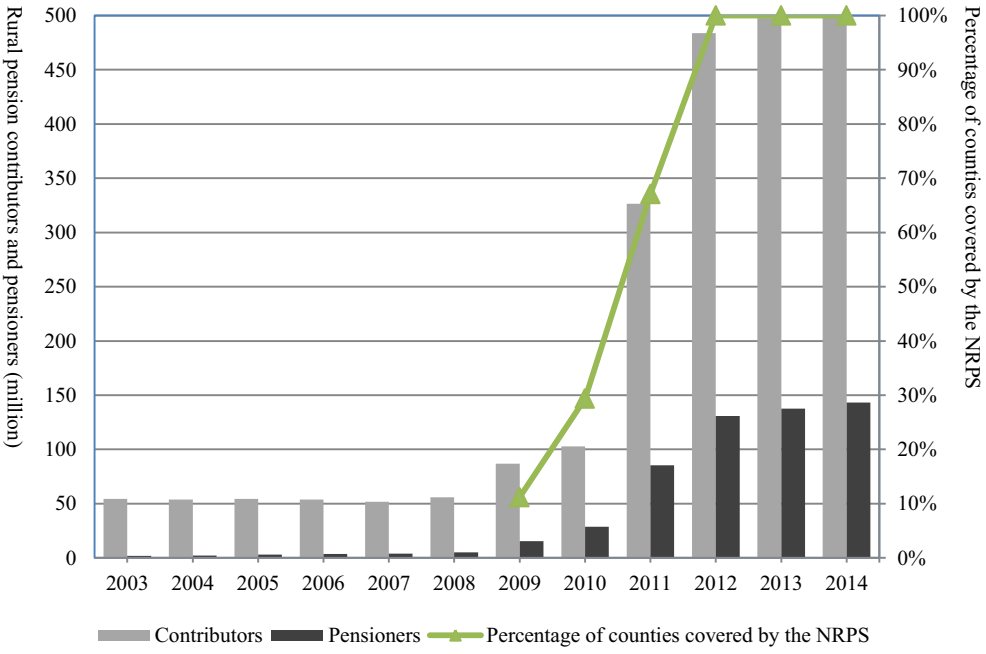

Fig. 1. the Coverage of the Rural Pension System (2003–2014).
Notes: (a) Data source: China's Ministry of Human Resources and Social Security (MHRSS), Statistic Bulletin on Human Resources and Social Security Development 2003–2015.
(b) Rural pension system refers to the local pilots of rural pension prior to 2009 and the NRPS from 2009 and after.

since the adult children can afford the contributions to the scheme (implying an upward bias), but may probably choose not to participate because the low-level basic pension is not attractive to high-income people (implying an downward bias).[18] Thus, the overall direction of the selection bias is ambiguous.

To address the above concern, besides controlling for a rich set of the observed variables, our FE model includes individual fixed effects c_i, which not only help address endogenous selection into the NRPS, but also correct for time-invariant sources of attrition bias. We also control for the wave effect v_t, which represents the common time-series changes in health outcomes for pensioners and non-pensioners. However, if the unobserved time-variant factors are correlated with both the NRPS status and income and the health outcomes of the elderly, the FE estimate of the coefficient β_1 will still be biased. We rely on an instrumental variable (IV) approach to attenuate this bias, so our main empirical approach is a fixed effect model with instrumental variable correction (FE-IV).

For identification of the FE-IV model, we exploit the timeline of the implementation and expansion of the NRPS at county level to generate an exogenous instrument for individual pension status. As shown in Fig. 1, China started the NRPS in about

[18] Lei et al. (2013) shows that eligible rural residents under age 60 have lower incentive to enroll or choose a higher premium level, not only because the design of the NRPS is a disincentive for individual participation and contribution, but also because rural residents have low levels of trust in government projects.

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11% of rural counties in 2009, and gradually expanded its coverage to nationwide by the end of 2012.[19] As the NRPS operates at the county level, rural elderly with a local household registration permit (*hukou*) but no retirement pension[20] are eligible for the local NRPS. For the study sample of individuals aged 60 and above from wave 2008/09 to wave 2011/12, the major eligibility requirement for NRPS participation is the implementation of the program in that county. Simply speaking, the elderly with a local *hukou* in the project counties were eligible for the NRPS, whereas the elderly without a local *hukou* in the project counties were not. However, when a county implemented the NRPS was mainly decided by central and provincial governments. Even though a county might be able to influence the decision of the upper-level governments to some degree, the timing of implementation of the NRPS is still exogenous to households and individuals.

According to the lists of the NRPS pilot counties authorized by China's central and provincial governments, we are able to determine when each sample county started the NRPS. We generate a variable measuring the program implementation duration at time of survey, by subtracting each county's date of program initiation from the interview date of each respondent. It is coded as 0 if the respondent was interviewed before the introduction of the NPRS in the county. The identification strategy crucially hinges on the assumption that the instrumental variable only affects health outcomes through individual enrollment into the NRPS. We defer examining and discussing the validity of our IV to Section 5.2.

The FE-IV estimate of the coefficient β_1 is a local average treatment effect (LATE) as in Imbens and Angrist (1994), which identifies the causal impact of pension for the group of complier, i.e. who receive pension income with the introduction of the local NRPS and who would not receive pension income without the introduction of the local NRPS.

5. The health implications of the NRPS

5.1. Main results

This subsection presents the main empirical results of the paper. As discuss before, we examine a host of health outcomes: self-assessed general health, IADL limitation, measured hypertension, measured height, MMSE score, cognitive status, and depression index. We report three sets of results for each health outcome,[21] and clustered standard errors at the county-year level in the parentheses, and at the county level in the brackets.[22]

Column 1 of Table 3 presents the estimated coefficients of program duration of the NRPS in the county, which can be interpreted as the intention-to-treat (ITT) estimates of treatment effects, i.e., the impact of being able to obtain social pension through the NRPS. Generally speaking, the ITT estimates are smaller than the LATE estimates, i.e., the FE-IV coefficients of individual pension status and pension income in columns 3 and 5, which is consistent with a positive self-selection story, i.e. an elderly who benefits more from the NRPS is more likely to self-select into the program. We focus our discussion primarily on the results from the FE-IV estimations, which use program duration of the NRPS at county level as the IV.

For physical health outcomes, the FE-IV results show that the take-up of the NRPS has no significant effect on self-rated general health of the elderly, but improves their IADL performance by 15 percentage points. The pension enrollment has also significantly reduced the incidences of hypertension by 23 percentage points. Its impact on measured height is positive and significant; as we control for height before the NRPS, the FE-IV estimate suggests that the pensioners have experienced 3.2 cm less height shrinkage than the non-pensioners.[23] Overall, the NRPS has a positive effect on objective measures of physical health.

The NRPS take-up also positively affects cognitive functions of the elderly. Specifically, the pension enrollment has significantly improved the MMSE score by 2 points (a nontrivial effect given that the average MMSE score is 22 with a standard deviation of about 9), and increased the probability of good cognitive function by 16 percentage points. Finally, in the FE-IV specification, we find that the coefficient on the NRPS take-up is negative for depression index, suggesting that the NRPS has modestly improved the psychological well-being of the pensioners.

We now turn to examine the effects of pension income on health outcomes, and the key independent variable is the log income from the NRPS (see columns 4 and 5).[24] Again, the income from the NRPS has significant positive effects on a host

[19] In our CLHLS sample, out of 535 surveyed counties, the NRPS covered 77 (14%) in 2009, 204 (38%) in 2010, and almost all counties in late 2011 or early 2012. This suggests that our sample has a similar timing pattern of county-level NRPS implementation to that of the official statistics.

[20] In China, retirement pension can cover those rural residents who are employed in government, public institutions, and urban enterprises. The CLHLS data show that about 7% of the rural elderly sampled had retirement pensions, and they are ineligible for the NRPS. We exclude them because they account for a small fraction of the rural population, and may differ considerably from the target population of the NRPS.

[21] For simplicity, we exclude the coefficients of non-key variables from the main tables except in Appendix Table A2, where we report the coefficients for all explanatory variables from the FE-IV estimations. We defer discussing the coefficients of other explanatory variables until Section 7, where we carry out a heterogeneous analysis along multiple important dimensions such as gender, age, living arrangement, and income, and highlight the role of some key variables.

[22] For analysis of binary health outcomes, we apply linear probability models for each step of the FE-IV estimation (Angrist, 2001; Angrist and Pischke, 2009), which is computationally undemanding with directly interpretable parameters. When calculating standard errors in the second stage, we take into account that the second stage regression includes a generated regressor from the first stage.

[23] Our 3.2 cm height shrinkage estimate is comparable to the ones in Huang et al. (2013), who show that the average estimated height shrinkage is 3.3 cm for males and 3.8 cm for females with a standard deviation of 5 cm among the elderly aged 60 and above in China. Moreover, in Section 7 we find that the NRPS has reduced height shrinkage more for the pensioners aged 85 and above than for those under age 85.

[24] It takes on the value 0 for zero pension income.

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Table 3.
Effects of pension income on health outcomes.

	Coefficient on NRPS duration	*Coefficient on NRPS take-up*		*Coefficient on* ln*(NRPS income)*	
	FE	FE	FE-IV	FE	FE-IV
	(1)	(2)	(3)	(4)	(5)
Self-reported health is good	−0.007	−0.054	−0.025	−0.010	−0.007
	(0.014)	(0.027)**	(0.051)	(0.007)	(0.012)
	[0.020]	[0.038]	[0.073]	[0.009]	[0.017]
Observations	7926	7926	7926	7630	7630
No IADL limitation	0.041	0.046	0.152	0.012	0.033
	(0.013)***	(0.017)***	(0.050)***	(0.004)***	(0.012)***
	[0.019]**	[0.023]*	[0.071]**	[0.006]**	[0.016]**
Observations	7940	7940	7940	7644	7644
Measured hypertension	−0.063	−0.088	−0.233	−0.020	−0.058
	(0.019)***	(0.032)***	(0.071)***	(0.008)**	(0.017)***
	[0.026]**	[0.045]*	[0.101]**	[0.012]*	[0.023]**
Observations	7530	7530	7530	7252	7252
Measured height	0.871	1.631	3.241	0.326	0.757
	(0.251)***	(0.368)***	(0.936)***	(0.095)***	(0.214)***
	[0.355]**	[0.520]***	[1.323]**	[0.135]**	[0.303]**
Observations	7346	7346	7346	7082	7082
MMSE score	0.582	0.582	2.140	0.167	0.526
	(0.194)***	(0.311)*	(0.730)***	(0.079)**	(0.169)***
	[0.274]**	[0.439]	[1.033]**	[0.111]	[0.240]**
Observations	7930	7930	7930	7634	7634
Cognitive function is good	0.044	0.015	0.160	0.006	0.037
	(0.011)***	(0.020)	(0.043)***	(0.005)	(0.010)***
	[0.016]***	[0.028]	[0.060]***	[0.007]	[0.014]***
Observations	7930	7930	7930	7634	7634
Self-reported depression index	−0.281	0.451	−1.050	0.106	−0.217
	(0.131)**	(0.180)**	(0.516)**	(0.045)**	(0.122)*
	[0.185]	[0.255]*	[0.730]	[0.064]*	[0.173]
Observations	6992	6992	6992	6740	6740
First-stage coefficients on IV					
Program duration in the county (years)	–	–	0.272***	–	1.167***
	–	–	(0.015)	–	(0.063)
			[0.022]		[0.089]
Observations			7940		7644

Notes:
(a) Standard errors clustered at the county-year level in parenthesis; standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(b) For binary health outcomes, we apply the linear probability model with individual fixed effects.
(c) All regressions include age, age squared/100, marital status, number of living children, household size, health insurance coverage, home-ownership, wave dummies, and time-varying county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

of health outcomes of the pensioners, except self-reported general health. A 100-percent increase in pension income has significantly improved the likelihood of performing IADL by 3.3 percentage points, lowered the probability of experiencing hypertension by 5.8 percentage points, and reduced height loss by 0.76 cm. Moreover, a 100-percent rise in the NRPS benefits leads to a 0.53-point increase in MMSE score, 3.7 percentage points more pensioners having good cognitive function, and a 0.22-point decrease in depression index.

As a whole, our main results show that both pension enrollment and income from the NRPS have improved the physical health, psychological well-being, and cognitive function of the elderly.

5.2. Validity of the instrumental variable

In this subsection, we address several concerns about the validity of the instrumental variable. One concern is that the IV is not strongly correlated with individual pension status or pension income.[25] We test this directly from the data. The

[25] Pension income is endogenous mainly due to selection into the NRPS in our context. The justification is that the elderly who were covered by the scheme for longer periods should be more likely to enroll in the scheme and receive pension income.

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Table 4.
Relationship between county-level rollout and pre-program health outcomes.

	Fraction of good self-reported health in 2008			Fraction of no IADL limitation in 2008			Prevalence of hypertension in 2008		
NRPS introduced in 2009	0.044	0.007	0.005	0.033	0.011	0.016	0.086**	0.056	0.052
	(0.043)	(0.047)	(0.047)	(0.039)	(0.041)	(0.041)	(0.044)	(0.042)	(0.042)
NRPS introduced in 2010	0.087**	0.031	0.032	0.090**	0.010	0.004	−0.045	−0.007	−0.007
	(0.038)	(0.052)	(0.050)	(0.037)	(0.049)	(0.049)	(0.038)	(0.048)	(0.048)
County characteristics	No	No	Yes	No	No	Yes	No	No	Yes
Province fixed effect	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
P-value of joint test	0.0682	0.8290	0.8018	0.0553	0.9583	0.9246	0.0302	0.3352	0.3853
Observations	534	534	534	534	534	534	532	532	532
	Average height in 2008			Average MMSE score in 2008			Average depression score in 2008		
NRPS introduced in 2009	−0.199	−0.903	−1.152	0.475	0.374	0.268	−0.433	−0.040	0.017
	(0.872)	(0.816)	(0.823)	(0.760)	(0.797)	(0.793)	(0.324)	(0.349)	(0.348)
NRPS introduced in 2010	1.548**	−0.428	−0.520	−0.034	−0.549	−0.562	−1.193***	−0.535	−0.501
	(0.658)	(0.787)	(0.774)	(0.648)	(0.837)	(0.835)	(0.275)	(0.400)	(0.393)
County characteristics	No	No	Yes	No	No	Yes	No	No	Yes
Province fixed effect	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
P-value of joint test	0.0399	0.5415	0.3763	0.7989	0.5902	0.6428	0.0001	0.3766	0.3818
Observations	532	532	532	534	534	534	523	523	523

Notes: Robust Standard errors are reported in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions are for the pre-treatment year 2008. The dependent variables are the average level of each health outcome at county j in wave 2008. County characteristics include total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

bottom part of Table 3 shows that the NRPS duration at the county level is strongly positively correlated with individual pension status and pension income. The first-stage *F*-statistics are 154.7 and 172.3; both are well above the usual threshold value for weak–strong IV in the literature. Being selected as pilot counties one year earlier is associated with a 27 percentage point increase in the probability that the elderly receive pension income during our study period.

Another concern is whether the elderly can migrate to other counties to enroll in the NRPS. If so, then this will invalidate the instrument based on the duration variation of the NRPS implementation at the county level. One eligibility requirement is that the enrollee must have a local *hukou*. According to current *hukou* policy, it is generally difficult to change the *hukou* location across counties, and even harder for the elderly, since they are unlikely to change their *hukou* through marriage migration or going to college, the two main channels for *hukou* mobility in China. Thus, an elderly person can hardly migrate and change her *hukou* location from a non-NRPS county to a NRPS county to obtain pension benefits.

One key assumption of our empirical approach is that the timing of county-level NRPS implementation is exogenous and is uncorrelated with pre-program health status at county level. In the FE specification, we control for all time-invariant unobserved determinants of health outcomes that may be correlated with program timing, as well as a rich set of time-varying county specific characteristics. In addition, we apply several tests to gauge the validity of this assumption.

First, one threat to our identification is that the county-level rollout may be correlated with pre-program county-level health outcomes. To check for this, we use a regression of the average level of health outcomes in county j in wave 2008/09 on indicators for the year in which the NRPS was introduced in the county. Table 4 reports the estimates on dummies variables for counties exposed in 2009 and 2010 with those counties exposed in 2011 as the base group. The results show that pre-program county-level health outcomes were uncorrelated with the year of program implementation in all regressions after controlling for province fixed effects.

Another possible threat is that our results are driven by different patterns of health dynamics between the rural elderly in the NRPS and non-NRPS regions, which can be caused by different rural health insurance policies for different counties. The public health insurance for rural residents, called the New Cooperative Medical Scheme (NCMS), was first introduced in 2003, and covered all rural counties by 2008.[26] If the duration of the NCMS was correlated with the starting time of the NRPS due to unobserved county-specific factors, it would be possible that the NRPS and non-NRPS regions had different health dynamics.

Though we control for individual health insurance status and time-invariant characteristics of the NCMS in our main analysis, we conduct pre-trend tests to check how important this threat is. We limit the analysis to those who have also been observed in wave 2005, and estimate a "false experiment" specification in which the NRPS has not started yet. If, in the absence of the program, the rural elderly in the NRPS regions were on different health tracks from those in non-NRPS regions due to unobserved regional characteristics, such difference would very likely have existed before the launch of the

[26] The NCMS is a voluntary public health insurance program operated at the county level. In 2008 the NCMS enrollment rate is normally above 90% for most counties.

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Table 5.
Tests of the validity of the identification assumption.

Sample	*Coefficient on program duration of the NRPS in the county (years)*		
	Study sample before the introduction of the NRPS	Sample of rural elderly with urban retirement pensions	Sample of urban elderly
	FE using panel 2005–2008/09 (1)	FE using panel 2008/09–2011/12 (2)	FE using panel 2008/09–2011/12 (3)
Self-reported health is good	0.020	−0.029	−0.027
	(0.024)	(0.027)	(0.022)
	[0.034]	[0.038]	[0.031]
Observations	2958	442	3034
No IADL limitation	0.015	−0.021	−0.012
	(0.018)	(0.025)	(0.018)
	[0.026]	[0.035]	[0.026]
Observations	3018	442	3036
Measured hypertension	−0.022	−0.001	−0.026
	(0.026)	(0.029)	(0.024)
	[0.037]	[0.041]	[0.035]
Observations	2966	434	2912
Measured height	−0.144	−0.765	−0.140
	(0.286)	(0.794)	(0.282)
	[0.404]	[1.123]	[0.398]
Observations	2988	406	2742
MMSE score	0.397	−0.709	−0.183
	(0.273)	(0.323)**	(0.287)
	[0.384]	[0.456]	[0.406]
Observations	3018	442	3030
Cognitive function is good	0.018	0.020	0.001
	(0.019)	(0.019)	(0.017)
	[0.026]	[0.027]	[0.025]
Observations	3018	442	3030
Self-reported depression index	−0.155	0.024	−0.440
	(0.146)	(0.151)	(0.159)***
	[0.206]	[0.214]	[0.224]*
Observations	2822	412	2718

Notes:
(a) Standard errors clustered at the county-year level in parenthesis; standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(b) All regressions include age, age squared/100, marital status, number of living children, household size, health insurance coverage, homeownership, wave dummies, and time-varying county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

NRPS. In column 1 of Table 5, the FE estimates based on the panel 2005–2008/09 are all insignificant, suggesting that this threat is not important.

Another possibility is that our results may be driven by county-level unobserved factors (e.g., pilots of home-based elder care services) other than the NRPS during the study period. We test for this by using the sample of rural retired pensioners who are ineligible for the NRPS as well as the sample of urban elderly, and apply FE to the new data in a specification similar to that in column 1 of Table 3. Columns 2 and 3 of Table 5 present the results for this placebo test, and the estimates on program duration in the county either are insignificant or have the opposite sign in most cases, except for depression of the urban elderly.

The above checks provide supportive evidence in favor of our identification strategy. However, we admit that the exogeneity of an IV is inherently untestable, and we cannot definitively rule out the possibility that county-level NRPS duration could have some other health effects beyond the one working through pension status, though we believe that these other effects are likely to be minor.

5.3. Mortality and sample selection

One more threat to our main results may come from potential bias related to mortality and sample attrition. In our data, mortality and attrition rates during the survey interval (i.e., waves 2008/09 and 2011/12) are substantial: 38.7% and 13.5%, respectively. The specific question is whether our main results on health benefits of the NRPS might be due to specific features (e.g., attrition) of our sample.

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Mortality itself is an important health outcome.[27] If the NRPS pensioners have higher (lower) mortality rates than non-pensioners during the study period, our main results on the health outcomes of the survivors may be overestimated (underestimated). We employ the stratified Cox proportional hazard model, which is a partial maximum likelihood estimation method, and conduct the analysis of mortality in two ways.

First, we explore the impact of the NRPS on mortality risk, using the sample interviewed in the CLHLS 2011/12.[28] Time was defined as the number of months from survey 2011/12 until death or survey 2014.[29] We model the hazard rate of death as

$$h_{ijt} = h_{0jt}\exp\left(\gamma_1 NRPS_{ij} + \gamma_2 X_{ij} + \gamma_3 W_j + \gamma_4 \hat{v}_{ij}\right) \tag{2}$$

where h_{0jt} is an arbitrary baseline hazard function, which is assumed to be the same for respondents in county j, but may differ by counties.[30] As defined before, $NRPS_{ij}$ indicates the NRPS enrollment status or pension income of respondent i at county j in wave 2011; X_{ij} and W_j are other covariates in wave 2011/12. To address the endogeneity in the hazard model, we employ the two-stage residual inclusion (2SRI) method to obtain the consistent estimator for γ_1 (Blundell and Smith, 1993; Wooldridge, 2002; Terza et al., 2008). Specifically, we include $\hat{v}_{ij}$, the OLS residuals from the first-stage regression of $NRPS_{ij}$ on program duration and other covariates, as an additional regressor in Eq. (2). The standard errors of the second-stage estimates are obtained by bootstrapping over both steps with 500 replications.

Part A of Table 6 reports the hazard ratio estimates for Eq. (2). The 2SRI columns show that the NRPS pensioners had a 43.8% lower risk of dying than that of the non-pensioners (hazard ratio = 0.562), though this effect is only marginally significant at the 15% level. The hazard ratio associated with the NRPS income is 0.962, but is not statistically different from one at conventional levels (p-value = 0.22).

Second, we examine the ITT effect of the NRPS on mortality risk in a difference-in-differences (DID) framework, using the sample of respondents who entered the CLHLS in wave 2005. The observation period begins with this entry point and ends in whichever comes first – the time of death or survey in 2014. We estimate the following hazard model:

$$\begin{aligned} h_{ijt} = h_{0jt}\exp(&\theta_1 Elig_{ij} + \theta_2 Elig_{ij} \times W08_{it} + \theta_3 Elig_{ij} \times W11_{it} \\ &+ \theta_4 W08_{it} + \theta_5 W11_{it} + \theta_6 X_{ijt} + \theta_7 W_{jt}) \end{aligned} \tag{3}$$

where $Elig_{ij}$ takes the value 1 if individual i belongs to the NRPS target population (i.e., the rural elderly without any non-NRPS pension), and zero if individual i is either a rural retired pensioner or urban elderly person (i.e., ineligible for the NRPS). $W08_{it}$ and $W11_{it}$ are two dummies for waves 2008/09 and 2011/12. X_{ijt} and W_{jt} include both time-invariant and time-varying covariates at the individual level or at the county level.

In part B of Table 6, the interaction between wave 2011/12 and eligibility status suggests that the hazard ratio for death in the eligible group as compared with the ineligible group falls by (an insignificant) 12.1% after 2011 (hazard ratio = 0.879, p-value = 0.237). Moreover, the interaction between wave 2008/09 and eligibility status indicates a 7.4% increase in the hazard for the eligible group, which is far from being significant (hazard ratio = 1.074, p-value = 0.439). It suggests that attrition due to mortality is of little concern for our main results.

Overall, the results in Table 6 provide only very modest evidence for the long-run effects of the NPRS on mortality risk of the rural elderly.[31] Although modest, our results are nevertheless consistent with the negative long-run association between income and mortality documented in the literature (see, e.g., Smith, 1999; Deaton, 2003; Gerdtham and Johannesson, 2004).

Loss to follow-up is another important question concerning sample selection.[32] Our empirical method controls for individual fixed effects that are able to correct for time-invariant sources of attrition bias. As a further check for nonrandom nonresponse, we test for attrition on time-variant observables following the approach in Becketti et al. (1988) and Ding and Lehrer (2010). Specifically, we regress the baseline health outcomes on baseline individual characteristics and their interactions with an indicator for attrition (i.e., loss to follow-up), using the full sample of wave 2008/09. In Appendix Table A4, the coefficients on the attrition indicator suggest no significant difference in most baseline health outcomes between subsequent attritors and non-attritors, after controlling for demographic and socioeconomic covariates. In the bottom part of Table A4, the F-tests of the joint significance of the attrition indicator and its interaction terms with time-varying observables are rejected at conventional significant levels in most specifications. This implies that those lost to follow-up do not

[27] In the CLHLS, mortality information for the respondents who died between survey intervals was gathered in interviews with a close family member of the deceased.

[28] Similar to our main analysis, we restrict the sample to the rural elderly without any non-NRPS pension.

[29] Although the 2014 wave of CLHLS data has not been released yet when the present study is carried out, we have access to the information whether and when the respondents surveyed in wave 2011/12 died prior to wave 2014.

[30] In Cox proportional hazard model, the baseline hazard is assumed to be constant across people. We relax this assumption by allowing the baseline hazards to differ by counties.

[31] In an earlier version of this paper, we have estimated probit and linear probability models for the mortality analysis and reached similar conclusions.

[32] Appendix Table A3 shows that respondents who were particularly likely to be lost to follow-up had worse self-reported health, higher depression index, less health insurance coverage, and smaller household size, but were taller, and had a higher proportion of owning the home and having a white-collar career before age 60.

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Table 6.
Effects of pension income on mortality from Cox proportional models.

Part A. The eligible sample in survey 2011/12, during the follow–up period 2011/12–2014

	Baseline model	2SRI	Baseline model	2SRI
NRPS take-up	0.880	0.562		
	[0.093]	[0.237]		
ln(NRPS income)			0.967	0.962
			[0.025]	[0.030]
First-stage residual		1.636		1.072
		[0.807]		[0.089]
Observations	4248	4248	4109	4109
Fraction of spells ending with death		31.97%		31.81%
Mean duration until death or censoring (months)		26.61		26.62

Part B. The eligible and ineligible sample who entered the survey in wave 2005, during the follow–up period 2005–2014

	Model 1	Model 2
Wave 2008/09×Eligible status	1.064	1.074
	[0.099]	[0.099]
Wave 2011/12×Eligible status	0.950	0.879
	[0.111]	[0.096]
Wave 2008/09	0.548	0.484
	[0.114]***	[0.191]*
Wave 2011/12	0.212	0.162
	[0.092]***	[0.157]*
Eligible status	1.139	1.065
	[0.076]*	[0.062]
Observations	21,057	21,057
Fraction of spells ending with death		
in the eligible group		38.45%
in the ineligible group		34.97%
Mean duration until death or censoring (months)		55.58

Notes:
(a) Table entries are hazard ratios, with standard errors clustered at the county level in brackets. Bootstrapped standard errors are reported in the two-stage residual inclusion estimation (2SRI). They are based on 500 replications of the data. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Unit of observation is the individual/wave.
(b) All regressions except Model 1 include age, age squared/100, married, number of living children, household size, health insurance coverage, homeownership, a dummy variable for no IADL impairment at baseline, MMSE score at baseline, gender, ethnicity, years of schooling, a dummy variable for having a white-collar career before age 60, county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

differ systematically from those in the follow-up sample or known to be deceased,[33] and the attrition bias due to loss to follow-up is not serious.

6. How the NRPS affects health of the elderly

Given our main findings that the NRPS status and income both have important health benefits for the elderly, we further examine multiple transmission channels from the NRPS to health outcomes of the elderly.

6.1. Nutrition intake and health behavior

One obvious mechanism is that pension income from the NRPS would relax the budget constraint and lead to changes in food consumption. Studies on the nutritional status of the Chinese elderly population show that the rural elderly suffered from insufficient intakes of protein and many micronutrients, as their intake levels were far below the recommended dietary allowances (Side et al., 1991; Shi et al., 2015). Poor nutrition is strongly associated with adverse health outcomes, such as frailty, morbidity, cognitive impairment, depression, and mortality (Cederholm et al., 1995; Ortega et al., 1997; Bartali et al., 2006; Woo et al., 2006).

Part A of Table 7 shows that pension status and income have significantly improved individuals' perceived financial sufficiency related to daily expenses. This improved sufficiency is further supported by the findings that the NRPS status and

[33] Using panel data from waves 2005–2008, we find that, after controlling for time-invariant heterogeneities, those lost to follow-up in wave 2011 (i.e., attritors) did not differ significantly in objective measures of physical health and cognitive function from non-attritors, although the attritors were more likely to feel unhealthy during 2005–2008.

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Table 7
Pension income and health inputs and health behaviors.

	Coefficient on NRPS duration FE	*Coefficient on NRPS take-up* FE-IV	*Coefficient on* ln*(NRPS income)* FE-IV
Part A. Nutrition intake and health behaviors			
Have sufficient financial support for daily expenses	0.056	0.205	0.048
	(0.018)***	(0.072)***	(0.017)***
	[0.026]**	[0.101]**	[0.024]**
Frequent intake of protein-rich food	0.041	0.152	0.032
	(0.016)**	(0.064)**	(0.015)**
	[0.023]*	[0.090]*	[0.021]
Frequent intake of vitamin-rich food	−0.009	−0.032	−0.008
	(0.016)	(0.061)	(0.014)
	[0.023]	[0.086]	[0.020]
Smoking	0.003	0.013	0.002
	(0.007)	(0.024)	(0.006)
	[0.009]	[0.034]	[0.008]
Drinking	−0.015	−0.055	−0.017
	(0.008)*	(0.032)*	(0.007)**
	[0.012]	[0.045]	[0.010]*
Part B. Informal care and health care access			
Hours of care received from children last week	0.997	3.685	0.881
	(0.596)*	(2.175)*	(0.524)*
	[0.843]	[3.076]	[0.742]
Have someone to talk with in daily life	0.016	0.059	0.016
	(0.006)***	(0.021)***	(0.005)***
	[0.008]**	[0.030]*	[0.007]**
Get help when having problems or difficulties	0.007	0.027	0.006
	(0.004)*	(0.014)*	(0.003)*
	[0.006]	[0.020]	[0.005]
Get sufficient medical care when sick	0.029	0.105	0.024
	(0.009)***	(0.034)***	(0.008)***
	[0.012]**	[0.049]**	[0.011]**
Fail to get necessary care due to costs	−0.010	−0.038	−0.009
	(0.005)**	(0.020)*	(0.005)*
	[0.007]	[0.028]	[0.007]

Notes:
(a) Standard errors clustered at the county-year level in parenthesis; standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(b) All regressions include age, age squared/100, marital status, number of living children, household size, health insurance coverage, homeownership, wave dummies, and time-varying county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

income have significantly increased the likelihood that the pensioners frequently consume protein-rich foods (meat, fish, and eggs). The income effect is small and insignificant for vitamin-rich foods (fruits and vegetables). This finding reflects the fact that protein-rich food is generally more expensive in rural areas, because most rural people eat vegetables they have grown themselves, but seldom purchase protein-rich food from the market.

Furthermore, we take a look at changes in smoking and drinking behaviors, as some evidence shows that tobacco is a normal good, especially among low-income people (Peck, 2011; Kenkel et al., 2014), and so is alcohol (Ruhm and Black, 2002). The results show that the pensioners have not spent the additional money on smoking, but reduced the incidence of drinking, suggesting no negative consequences of the increased pension income. Therefore, better nutrition intake with no increase in risky behaviors, resulting from the NRPS, could certainly contribute to improved health of the pensioners.

6.2. Informal care and health care access

Another obvious channel from income to health goes through informal care and health care access. As long-term care services are currently underdeveloped in China, informal care provided by spouses or children (especially sons) is still the most important source of care for the rural elderly (Giles et al., 2010; Li et al., 2013). An income increase may predict more health investments, via more family care or purchasing formal health care services (Sloan et al., 1997; Lei et al., 2015). Moreover, the literature shows that despite the development of a public health insurance system in rural China since 2003, financial difficulty is still the leading barrier faced by the rural elderly in access to health care (Cheng et al., 2015).

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Part B of Table 7 examines the income effects of the NRPS on informal care received and health care accessibility of the pensioners.[34] We can see that pension recipients have enjoyed more hours of informal care from their children in the previous week. The pensioners are about 6 percentage points more likely to have someone to talk with, and 2.7 percentage points more likely to get help when having difficulties in daily life. Moreover, looking at the results for perceived access to health care, we find that the pensioners are also more likely to get adequate medical care when they are sick, and less likely to be unable to afford medical costs. When we look into the estimates of the income from the NRPS, we see similar findings.

6.3. Labor supply and leisure

Pension enrollment may have an impact on labor supply of the NRPS enrollees, and lead to a change in demand for leisure. Recent studies show that most elderly people in rural China work long hours, either in the formal sector (mainly farm work) or in the informal sector (household work), until they are no longer physically capable (Pang et al., 2004; Giles et al., 2012). Increases in income or wealth can lead to a lower likelihood of doing physically demanding work (Benjamin et al., 2003; Giles et al., 2012), which would reduce the adverse effect of strenuous jobs on health outcomes (Fletcher et al., 2011; Giuntella and Mazzonna, 2015).

Part A of Table 8 shows that the pensioners have significantly decreased their labor force participation rate by about 6.2 percentage points. Moreover, we examine whether the pensioners spend more time doing household work or increase their leisure. The results indicate a marginally significant increase in the likelihood of participating in household chores or grandchild care among the pensioners.

Moreover, the pensioners are 11 percentage points more likely to watch TV or listen to radio, and are 5.8 percentage points more likely to participate in social activities. Overall, their leisure index has increased by 0.25 units as a result of the NRPS enrollment. Similar patterns can be found when we turn to the roles of the income from the NRPS. Evidence in the literature shows that participation in social and leisure activities is beneficial to perceived physical health, cognitive function, and life satisfaction in old age (e.g., Payne et al., 2006; Verghese et al., 2003; Menec and Chipperfield, 1997).

6.4. Relative economic status and private transfer

An indirect mechanism through which the NRPS appears to influence health is relative income. There is some evidence in the literature that perceived relative economic situation is significantly associated with disability, depression symptoms, and mortality risk among the elderly in Spain and Taiwan (e.g., Rodriguez-Laso et al., 2014; Collins and Goldman, 2008; Lee and Huang, 2015). Results in Part B of Table 8 show that pension recipients have significantly improved their perceived economic status relative to the others in the local area.

Both the ITT and FE-IV estimates show that the NRPS has no significant effect on the probability of pensioners involving themselves in household decision-making on financial spending. This finding is inconsistent with the corresponding studies on South Africa (Case and Menendez, 2007; Ambler, 2016). However, it is plausible given the family-binding eligibility criteria and low NRPS benefits at present.

One potential response to the pension is that an increase in the income of the elderly caused by the NRPS may crowd out intra-family transfers (e.g., Juarez, 2009; Jensen, 2003). To explore this possibility, we estimate the effects on gross transfers in and net transfers received in the bottom of Table 8. All relevant coefficients are positive, small and insignificant. It suggests no evidence for the crowding out effect of the NRPS, so the addition of the NRPS should be welfare-improving and thus health-improving for the elderly.

6.5. Importance of each channel

Table 9 assesses the relative importance of each channel in explaining the linkage between the NRPS and health outcomes. Column 1 shows the main results from Table 3. Columns 2–6 add the five channel variables one at a time, and column 7 controls for all channel variables in the regression. The results show that increased access to health care, more leisure activities and improved protein intake are important transmission channels for all health outcomes. Self-perceived relative economic status is another channel involving the positive effects of the NRPS on IADL. These channels explain 16% of the NRPS's impact on physical health.

The main channels through which the NRPS improves cognitive function are improvements in informal care, leisure activities, nutritional intake, and health care access; they account for about 34% of the total effect of the NRPS enrollment on MMSE score. For the NRPS's impact on depression index, the two most important channels are perceived access to health care and nutrition intake, followed by leisure activities and self-perceived relative economic status. The above channels can account for about half of the overall effect of the NRPS on psychological well-being.

[34] We also find an insignificant income effect of the NRPS on the probability of receiving assistance from paid caregivers. However, less than 1% (24 observations) of the sample is receiving paid assistance, so the results are not reported here.

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Table 8
Pension income and labor supply, relative economics status and private transfers.

	Coefficient on NRPS duration FE	*Coefficient on NRPS take-up* FE-IV	*Coefficient on* ln*(NRPS income)* FE-IV
Part A. Labor supply and leisure			
Still work	−0.017	−0.062	−0.014
	(0.004)***	(0.017)***	(0.004)***
	[0.006]***	[0.024]***	[0.006]***
Do household chores or grandchild care	0.022	0.080	0.018
	(0.010)**	(0.038)**	(0.009)**
	[0.014]	[0.053]	[0.012]
Plant flowers or raise pets	0.008	0.028	0.005
	(0.011)	(0.041)	(0.010)
	[0.016]	[0.059]	[0.014]
Read newspapers or books	0.007	0.026	0.005
	(0.006)	(0.021)	(0.005)
	[0.008]	[0.030]	[0.007]
Watch TV or listen to radio	0.030	0.110	0.025
	(0.016)*	(0.061)*	(0.014)*
	[0.023]	[0.086]	[0.020]
Play cards or mah-jong	0.006	0.023	0.004
	(0.009)	(0.035)	(0.007)
	[0.013]	[0.049]	[0.010]
Participate in social activities	0.016	0.058	0.012
	(0.004)***	(0.017)***	(0.004)***
	[0.006]**	[0.024]**	[0.005]**
Leisure index	0.067	0.247	0.052
	(0.031)**	(0.119)**	(0.026)**
	[0.044]	[0.169]	[0.037]
Part B. Relative economic status and private transfers			
Perceived relative economic status is high	0.024	0.088	0.016
	(0.010)**	(0.035)**	(0.008)**
	[0.013]*	[0.049]*	[0.011]
Can make decisions on household spending	0.014	0.053	0.011
	(0.011)	(0.041)	(0.010)
	[0.016]	[0.059]	[0.014]
Total transfers received	52.424	191.890	46.844
	(100.655)	(366.026)	(83.711)
	[142.348]	[517.640]	[118.386]
Net transfers received	22.415	82.210	30.897
	(102.599)	(375.259)	(84.971)
	[145.097]	[530.696]	[120.167]

Notes:
(a) Standard errors clustered at the county-year level in parenthesis; standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(b) All regressions include age, age squared/100, marital status, number of living children, household size, health insurance coverage, homeownership, wave dummies, and time-varying county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

7. Effects by population groups

One more interesting issue deserving examination is whether the relationship between pension and health outcomes differs across some important dimensions, such as gender, age, living arrangement, and income.

Columns 1 and 2 of Table 10 present results for males and females separately. Pension enrollment has yielded similar health benefits for males and for females, except in IADL; only females have seen a significant improvement in IADL. The subgroup results suggest that income has no differential effects by gender of the elderly on health. This is somewhat different from the previous literature; e.g., Jensen and Richter (2004) and Richter (2006) find that old men suffer more adverse health impact from pension loss or wage arrears than old women in Russia. One possible interpretation is that the males and females may respond to negative income shocks differently, but not to positive income shocks.

In columns 3 and 4, we divide the sample into two age groups, the eldest old (aged 85 and above) and younger old (aged 60–84). We can see that the NRPS is generally more effective on the younger-old group. Among this age group, pension recipients have significant better health outcomes, except self-reported general health, than non-recipients. Compared with the younger-old group, the eldest-old group benefits more from the NRPS with respect to height shrinkage. One possible explanation is that height shrinkage, associated with poor nutritional status, is more pronounced in the eldest old than in the younger old (Huang et al., 2013), so better nutrition intake resulting from the NRPS may benefit them more in this regard.

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Table 9
Transmission channels (FE-IV estimation).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Dependent variable: No IADL limitation				
NRPS take-up	0.152	0.148	0.154	0.142	0.143	0.147	0.128
	(0.050)***	(0.050)***	(0.050)***	(0.049)***	(0.048)***	(0.052)***	(0.049)***
	[0.071]**	[0.071]**	[0.071]**	[0.070]**	[0.068]**	[0.074]**	[0.069]*
Frequent intake of protein-rich food		0.029					0.015
		(0.014)**					(0.014)
		[0.020]					[0.020]
Have someone to talk with in daily life			0.022				0.020
			(0.014)				(0.014)
			[0.019]				[0.019]
Get sufficient medical care when sick				0.052			0.056
				(0.014)***			(0.015)***
				[0.020]***			[0.021]***
Leisure index					0.038		0.038
					(0.008)***		(0.008)***
					[0.011]***		[0.011]***
Perceived relative economic status is high						0.035	0.032
						(0.011)***	(0.011)***
						[0.016]**	[0.016]**
Observations	7940	7928	7748	7898	7936	7868	7628
			Dependent variable: MMSE score				
NRPS take-up	2.140	2.015	1.753	2.078	1.896	2.096	1.423
	(0.730)***	(0.724)***	(0.694)**	(0.721)***	(0.708)***	(0.749)***	(0.680)**
	[1.033]**	[1.024]**	[0.981]*	[1.020]**	[1.001]*	[1.059]**	[0.962]
Frequent intake of protein-rich food		0.916					0.615
		(0.355)***					(0.340)*
		[0.502]*					[0.481]
Have someone to talk with in daily life			4.901				4.625
			(0.471)***				(0.465)***
			[0.666]***				[0.658]***
Get sufficient medical care when sick				1.077			0.903
				(0.307)***			(0.295)***
				[0.435]**			[0.417]**
Leisure index					1.077		0.862
					(0.127)***		(0.125)***
					[0.179]***		[0.176]***
Perceived relative economic status is high						0.146	−0.091
						(0.249)	(0.244)
						[0.353]	[0.345]
Observations	7930	7918	7744	7888	7926	7858	7624
			Dependent variable: Self-reported depression index				
NRPS take-up	−1.050	−0.889	−1.016	−0.883	−0.938	−0.941	−0.535
	(0.516)**	(0.489)*	(0.517)**	(0.483)*	(0.509)*	(0.509)*	(0.456)
	[0.730]	[0.691]	[0.732]	[0.683]	[0.720]	[0.721]	[0.645]
Frequent intake of protein-rich food		−1.288					−1.144***
		(0.140)***					(0.132)
		[0.198]***					[0.187]***
Have someone to talk with in daily life			−0.469				−0.326
			(0.206)**				(0.199)
			[0.292]				[0.281]
Get sufficient medical care when sick				−1.697			−1.541***
				(0.172)***			(0.174)
				[0.243]***			[0.245]***
Leisure index					−0.355		−0.289***
					(0.057)***		(0.055)
					[0.081]***		[0.078]***
Perceived relative economic status is high						−0.612***	−0.524***
						(0.184)	(0.174)
						[0.260]**	[0.246]**
Observations	6992	6984	6960	6956	6990	6950	6876

Notes:
(a) Standard errors clustered at the county-year level in parenthesis; standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(b) All regressions include age, age squared/100, marital status, number of living children, household size, health insurance coverage, homeownership, wave dummies, and time-varying county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

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Table 10
Heterogeneous effects of pension income (FE-IV estimation).

	Coefficient on NRPS take-up							
Sample	Male (1)	Female (2)	85 and above (3)	60–85 (4)	Coresidence (5)	Living alone (6)	Above mean HH income (7)	Below mean HH income (8)
Self-reported health is good	0.043	−0.093	−0.140	0.070	−0.098	0.169	−0.026	−0.001
	(0.053)	(0.068)	(0.064)**	(0.067)	(0.057)*	(0.087)*	(0.082)	(0.061)
	[0.075]	[0.096]	[0.091]	[0.094]	[0.080]	[0.124]	[0.116]	[0.086]
No IADL limitation	0.056	0.209	0.007	0.256	0.117	0.203	0.113	0.146
	(0.052)	(0.062)***	(0.055)	(0.058)***	(0.060)*	(0.065)***	(0.075)	(0.052)***
	[0.074]	[0.087]**	[0.078]	[0.082]***	[0.085]	[0.091]**	[0.106]	[0.073]**
Measured hypertension	−0.250	−0.209	−0.069	−0.351	−0.297	−0.352	−0.200	−0.247
	(0.077)***	(0.085)**	(0.084)	(0.077)***	(0.084)***	(0.085)***	(0.093)**	(0.086)***
	[0.109]**	[0.120]*	[0.118]	[0.109]***	[0.119]**	[0.120]***	[0.132]	[0.121]**
Measured height	2.560	3.617	4.699	2.326	4.027	1.484	2.960	3.079
	(1.051)**	(1.131)***	(1.583)***	(0.766)***	(1.175)***	(1.019)	(1.424)**	(1.048)***
	[1.486]*	[1.600]**	[2.239]**	[1.083]**	[1.662]**	[1.441]	[2.014]	[1.483]**
MMSE score	1.836	2.282	2.048	2.158	1.512	2.962	1.198	2.696
	(0.732)**	(0.970)**	(1.265)	(0.636)***	(1.031)	(0.809)***	(1.349)	(0.736)***
	[1.036]*	[1.371]*	[1.788]	[0.900]**	[1.458]	[1.144]***	[1.908]	[1.041]***
Cognitive function is good	0.145	0.174	0.225	0.112	0.153	0.194	0.128	0.167
	(0.044)***	(0.058)***	(0.062)***	(0.044)***	(0.057)***	(0.059)***	(0.082)	(0.042)***
	[0.063]**	[0.083]**	[0.088]**	[0.062]*	[0.080]*	[0.083]**	[0.115]	[0.060]***
Self-reported depression index	−1.023	−1.163	−0.008	−1.748	−0.854	−1.843	−0.994	−1.001
	(0.536)*	(0.567)**	(0.577)	(0.587)***	(0.444)*	(0.888)**	(0.658)	(0.549)*
	[0.758]	[0.802]	[0.816]	[0.831]**	[0.628]	[1.256]	[0.930]	[0.776]
Observations	2986	4006	2748	4244	3630	2124	2024	4432

Notes:
(a) Standard errors clustered at the county-year level in parenthesis; standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(b) All regressions include age, age squared/100, marital status, number of living children, household size, health insurance coverage, homeownership, wave dummies, and time-varying county characteristics such as total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

Pension income may have differential effects for different household types. As the benefits of the NRPS may be shared with other household members, we first examine the living arrangement dimension according to the baseline information. Columns 5 and 6 report results separately for respondents living in an extended household (i.e., with adult children or other adult members) and living independently (i.e., alone or with a spouse). The results show that the NRPS has beneficial health effects for the pensioners co-residing with others as well as for those living alone, but those living alone benefit more. This is consistent with Jensen and Richter (2004) and Case (2004), and suggests that the pensioners living alone are likely to retain more income from the NRPS for their own personal use and health inputs.

To capture the differential generosity and relative importance of the NRPS benefits for different households, columns 7 and 8 divide the sample into two groups based on total household income in wave 2008/09. The higher income group (above mean income) has only seen decreases in the incidences of hypertension and height loss (which are marginally significant), whereas for the lower income group (below mean income) the NRPS has produced significant improvements in all health outcomes except, again, the self-reported health. This finding is not surprising, considering that the NRPS income matters more for the relatively poor elderly.

8. Conclusion and discussion

This paper contributes to research on the causal effects of income on health outcomes. To deal with the two-way causal link between income and health, we estimate the effect of an income increase caused by the NRPS on multiple health measures of the elderly. Since its launch in 2009, the NRPS has been rolled out gradually to the whole country. This feature allows us to exploit the time variation of county-level program implementation as the instrumental variable, and employ a fixed effects approach with instrumental variable correction to address the endogeneity of enrollment into, or pension income from, the NRPS.

Our results show that the elderly in the counties with the program establishment one year earlier were about 27 percentage points more likely to enroll in the NRPS during our study period. The NRPS status and income have had a significant beneficial effect on objective measures of physical health and cognitive function, and a modest positive effect on psychological well-being of the rural elderly. Consistent with the study of Johnston et al., (2009), we find no significant effect of pension status or income on self-reported general health. Our heterogeneous analyses by subpopulation groups have further suggested that the NRPS has generated more health benefits for the pensioners who are under age 85, have lower household

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income, and live independently. Moreover, we find very modest evidence that the NRPS has reduced the death hazard of the pensioners.

We investigate the mechanisms leading from the NRPS to health outcomes, and our results suggest that pension recipients respond to pension income in multiple ways. In particular, the pensioners not only get better access to health care, but also are more able to obtain informal care and have improved nutrition intake. The NRPS also allows the elderly to work less and have more leisure, which is beneficial for most health outcomes. Moreover, the improvement in self-perceived relative economic situation of elderly pensioners helps promote their physical function and mental well-being.

It is important to keep some issues in mind when interpreting our results. First, due to the voluntary nature and family-binding eligibility requirement of the NRPS at current time period, the impact of pension on health may well be larger for those who selected into it than for those enrolling when the scheme is mandatory. However, despite a low enrollment rate at 22% during our study period, we also find significant ITT effects of the NRPS in improving health outcomes of the elderly. For all health outcomes, the LATE estimates from FE-IV are larger in magnitude than the ITT estimates, which is consistent with the story that those who may benefit more from the NRPS are more likely to self-select into the program. Second, as health is a stock that can accumulated over time, the health benefits of pension over longer time horizons may exceed our estimated effects.

Our findings have important policy implications for social protection in China and many other developing countries. In rural China, the basic social insurance system consists of the NRPS and a new rural cooperative medical system (NCMS). The NCMS is a heavily subsidized public health insurance program aiming to protect households from impoverishment due to catastrophic health expenditure. Cheng et al., (2015) show that the NCMS enrollment has led to an improvement in physical and cognitive function of the elderly; however, most studies find little or only modest evidence that the NCMS or the basic public health insurance program in urban China have reduced out-of-pocket health expenditure (Wagstaff et al., 2009; Lei and Lin, 2009; Sun et al., 2009; Liu and Zhao, 2014; Cheng et al., 2015). The rising health care costs become an urgent challenge to the government. Our analysis provides another important rationale for developing social pensions in China, given the evidence that the NRPS has been able to improve health outcomes through both medical and non-medical mechanisms such as nutrition and leisure activities, while standard public health insurance programs have improved health mainly through provision of medical care. We believe that a fruitful area for future research would be to compare costs and benefits of these two types of social programs in the context of health economics. Moreover, our findings can also serve as a basis for formulating health-related interventions. For example, in some poor rural areas where it is difficult to deliver and maintain health interventions, direct cash transfers may be a cost-benefit intervention to improve health.

Appendix

Table A.1, Table A.2, Table A.3, Table A.4.

Table A.1
Number of respondents.

Main analysis	Number excluded	Number remaining
CLHLS 2008/09		16,950
Rural elderly aged 60 and above	6755	10,195
Exclude respondents with missing values for social pension	225	9970
Exclude respondents with any other types of pension	1287	**8683**
Respondents lost to follow-up in 2011/12 survey		1168
Respondents deceased before 2011/12 survey		3362
Participated in NRPS		270 (8.03%)
Did not participate in NRPS		3092 (91.97%)
Respondents re-interviewed in 2011/12 survey		**4153**
Participated in NRPS		907 (21.84%)
Did not participate in NRPS		3246 (77.45%)

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Table A.2.
FE-IV estimations for health outcomes of the elderly.

	First stage estimates															
	NRPS take-up	ln(NRPS income)	Self-reported health is good		No IADL limitation		Measured hypertension		Measured height		MMSE score		Cognitive function is good		Self-reported depression index	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
NRPS take-up			−0.025		0.152**		−0.233**		3.241**		2.140**		0.160***		−1.050	
			[0.073]		[0.071]		[0.101]		[1.323]		[1.033]		[0.060]		[0.730]	
ln(NRPS income+1)				−0.007		0.033**		−0.058**		0.757**		0.526**		0.037***		−0.217
				[0.017]		[0.016]		[0.023]		[0.303]		[0.240]		[0.014]		[0.173]
NRPS duration in the county	0.272***	1.167***														
	[0.022]	[0.089]														
Age	−0.052	−0.242	0.043	0.049	−0.130***	−0.131***	0.013	0.025	0.994	1.006	1.006	0.948	0.058*	0.049	0.461	0.391
	[0.040]	[0.187]	[0.052]	[0.051]	[0.035]	[0.034]	[0.054]	[0.057]	[0.928]	[0.972]	[0.624]	[0.635]	[0.034]	[0.034]	[0.281]	[0.284]
Age squared/100	−0.005	−0.035	0.003	−0.003	0.068***	0.069***	−0.036*	−0.039**	−0.893**	−0.884**	−0.629*	−0.636**	−0.027*	−0.026*	−0.426***	−0.422***
	[0.011]	[0.046]	[0.018]	[0.018]	[0.012]	[0.012]	[0.019]	[0.020]	[0.443]	[0.422]	[0.323]	[0.322]	[0.015]	[0.015]	[0.131]	[0.133]
Married	0.016	0.053	0.052	0.057*	0.026	0.021	0.006	0.010	−0.346	−0.171	0.294	0.195	0.006	−0.000	−0.399*	−0.447**
	[0.014]	[0.058]	[0.033]	[0.034]	[0.027]	[0.026]	[0.036]	[0.037]	[0.472]	[0.450]	[0.389]	[0.398]	[0.029]	[0.029]	[0.217]	[0.208]
Number of living children	−0.000	0.010	0.064***	0.069***	0.012	0.013	−0.051*	−0.049*	0.386*	0.399**	0.046	0.051	0.022	0.021	−0.105	−0.099
	[0.007]	[0.027]	[0.024]	[0.026]	[0.033]	[0.034]	[0.027]	[0.029]	[0.197]	[0.199]	[0.271]	[0.280]	[0.014]	[0.014]	[0.111]	[0.120]
Household size	0.002	0.016	0.003	0.003	−0.004	−0.004	−0.003	−0.005	−0.040	−0.021	−0.071	−0.072	−0.009*	−0.009**	−0.116***	−0.113***
	[0.003]	[0.014]	[0.005]	[0.005]	[0.004]	[0.004]	[0.005]	[0.006]	[0.076]	[0.077]	[0.075]	[0.077]	[0.005]	[0.005]	[0.036]	[0.037]
Owns the home	0.009	0.051	−0.005	−0.000	−0.020	−0.020	−0.032	−0.028	0.342	0.288	1.739***	1.762***	0.080***	0.082***	−0.026	−0.018
	[0.016]	[0.061]	[0.023]	[0.024]	[0.019]	[0.019]	[0.027]	[0.028]	[0.389]	[0.394]	[0.390]	[0.396]	[0.022]	[0.022]	[0.238]	[0.242]
Have health insurance	−0.041**	−0.160**	−0.016	−0.019	0.027*	0.030*	0.018	0.018	0.503	0.461	0.771***	0.779***	0.046***	0.048***	0.137	0.203
	[0.018]	[0.076]	[0.019]	[0.019]	[0.016]	[0.017]	[0.023]	[0.024]	[0.331]	[0.325]	[0.260]	[0.268]	[0.016]	[0.016]	[0.160]	[0.167]
County characteristics	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Wave 2011/12	0.264**	1.121**	−0.200*	−0.177	−0.058	−0.052	0.324*	0.309*	−1.977	−2.014	−1.972	−1.837	−0.167**	−0.146*	0.464	0.591
	[0.113]	[0.493]	[0.116]	[0.116]	[0.082]	[0.082]	[0.171]	[0.178]	[2.047]	[2.112]	[1.698]	[1.668]	[0.084]	[0.083]	[0.767]	[0.744]
Weak instrument test	154.73***	172.26***														
Observations	7940	7644	7926	7630	7940	7644	7530	7252	7346	7082	7930	7634	7930	7634	6992	6740

Notes: Standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. County characteristics include total agricultural population, urbanization, GDP per capita, government spending per capita, and hospital beds per 10,000 persons.

Table A.3.
2008/09 Characteristics by attrition status in 2011/12.

The elderly sample in wave 2008/09			Non-Attritors			Diff. (3)–(2)
	Full sample $N=8683$ (1)	Attritors $N=1168$ (2)	All $N=7515$ (3)	Alive $N=4153$ (4)	Deceased $N=3362$ (5)	
Self-reported health is good	0.406	0.364	0.413	0.474	0.337	0.049***
	(0.491)	(0.481)	(0.492)	(0.499)	(0.473)	
No IADL limitation	0.282	0.283	0.282	0.420	0.112	0.000
	(0.450)	(0.450)	(0.450)	(0.494)	(0.316)	
Measured hypertension at interview	0.410	0.388	0.414	0.429	0.395	0.026
	(0.492)	(0.488)	(0.493)	(0.495)	(0.489)	
Measured height	155.132	156.469	154.923	155.892	153.675	−1.546***
	(10.148)	(10.046)	(10.148)	(9.684)	(10.588)	
MMSE score	19.581	19.960	19.522	23.025	15.194	−0.438
	(10.474)	(10.291)	(10.502)	(8.553)	(11.059)	
Cognitive function is good	0.508	0.524	0.506	0.658	0.317	−0.018
	(0.500)	(0.500)	(0.500)	(0.474)	(0.466)	
Self-reported depression index	6.076	6.550	6.001	5.755	6.371	−0.549***
	(3.356)	(3.485)	(3.329)	(3.249)	(3.414)	
Age	87.742	87.303	87.810	82.997	93.756	0.507
	(11.733)	(13.279)	(11.474)	(11.163)	(8.740)	
Male	0.384	0.386	0.384	0.411	0.351	−0.002
	(0.487)	(0.487)	(0.486)	(0.492)	(0.477)	
Had a white-collar career before age 60	0.013	0.021	0.012	0.012	0.012	−0.009**
	(0.112)	(0.142)	(0.107)	(0.107)	(0.107)	
Han	0.922	0.953	0.917	0.920	0.914	−0.036
	(0.268)	(0.212)	(0.276)	(0.272)	(0.280)	
Married	0.273	0.251	0.276	0.380	0.148	0.025*
	(0.445)	(0.434)	(0.447)	(0.485)	(0.356)	
Years of schooling	1.252	1.327	1.241	1.507	0.912	−0.086
	(2.453)	(2.544)	(2.439)	(2.584)	(2.202)	
Household size	3.335	3.185	3.358	3.198	3.556	0.173***
	(1.962)	(1.818)	(1.983)	(1.950)	(2.005)	
Owns the home						
	0.388	0.442	0.380	0.473	0.264	−0.062***
	(0.487)	(0.497)	(0.485)	(0.499)	(0.441)	
Number of living children	3.806	3.585	3.840	4.015	3.626	0.255***
	(1.826)	(1.741)	(1.837)	(1.795)	(1.866)	
Have health insurance	0.730	0.624	0.746	0.767	0.720	0.122***
	(0.444)	(0.485)	(0.435)	(0.423)	(0.449)	

Notes: Standard deviation in parenthesis. *t*-test was applied to test the significance of the difference between columns (3) and (2) . *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.4.
Difference between the attrited and non-attrited samples.

Dependent variable:	Self-reported health is good		No IADL limitation		Measured Hypertension at interview		Measured height		MMSE score		Self-reported depression index	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Age	−0.025	[0.022]	−0.233***	[0.034]	0.050**	[0.024]	−0.319***	[0.144]	0.774***	[0.159]	0.453***	[0.064]
Age squared/100	0.009	[0.013]	0.089***	[0.020]	−0.031**	[0.014]	0.117*	[0.087]	−0.696***	[0.093]	−0.260***	[0.037]
Married	−0.052	[0.047]	0.059	[0.049]	−0.071	[0.044]	0.464**	[0.244]	0.241	[0.251]	−0.461***	[0.123]
Number of living children	0.020**	[0.010]	0.015	[0.012]	0.014	[0.009]	0.043	[0.050]	0.111*	[0.068]	−0.076***	[0.025]
Family size	0.023***	[0.009]	−0.015	[0.012]	−0.010	[0.011]	0.017	[0.062]	−0.101*	[0.059]	−0.197***	[0.022]
Owns an apartment	0.017	[0.043]	0.224***	[0.052]	−0.041	[0.047]	0.426*	[0.263]	1.210***	[0.264]	0.205**	[0.110]
Having some health insurance	0.133***	[0.049]	0.112**	[0.060]	0.066*	[0.061]	−0.445*	[0.300]	1.718***	[0.332]	−0.415***	[0.155]
Male	0.074**	[0.038]	0.418***	[0.049]	−0.107***	[0.043]	11.315***	[0.268]	1.517***	[0.220]	−0.292***	[0.105]
Han	−0.147**	[0.111]	−0.072	[0.179]	−0.037	[0.154]	−0.240	[0.705]	−1.097***	[0.597]	−0.183	[0.281]
Had a white-collar job before age 60	−0.170	[0.142]	−0.092	[0.147]	0.048	[0.157]	1.853**	[0.799]	0.054	[0.759]	0.606*	[0.338]
Years of schooling	0.016**	[0.008]	0.013	[0.008]	0.006	[0.009]	0.117***	[0.039]	0.264***	[0.044]	−0.052***	[0.019]
Constant	1.587*	[1.019]	11.885***	[1.472]	−1.559	[1.042]	174.007***	[6.019]	5.216	[6.866]	−13.730***	[2.941]
Attrition (loss to follow-up)	2.493	[1.978]	−6.221**	[2.965]	−0.466	[2.271]	−17.013	[12.291]	0.556	[12.045]	1.838	[5.005]
Attrition × Age	−0.045	[0.045]	0.161**	[0.071]	0.002	[0.053]	0.275	[0.280]	−0.127	[0.286]	−0.121	[0.117]
Attrition × Age squared/100	0.023	[0.026]	−0.098**	[0.043]	−0.003	[0.031]	−0.172	[0.165]	0.063	[0.172]	0.080	[0.069]
Attrition × Married	−0.067	[0.137]	0.060	[0.154]	−0.060	[0.137]	0.049	[0.655]	0.517	[0.802]	−0.424	[0.279]
Attrition × Number of living children	0.047*	[0.027]	−0.040	[0.035]	−0.007	[0.027]	−0.096	[0.148]	0.046	[0.171]	−0.018	[0.067]
Attrition × Family size	−0.031	[0.027]	−0.056	[0.037]	−0.075***	[0.028]	0.234*	[0.144]	−0.187	[0.153]	0.040	[0.068]
Attrition × Owns an apartment	−0.141	[0.115]	−0.079	[0.141]	−0.235**	[0.101]	0.962	[0.597]	−1.477**	[0.590]	0.595**	[0.347]
Attrition × Having health insurance	0.062	[0.118]	−0.081	[0.125]	0.047	[0.103]	0.212	[0.707]	−0.148	[0.685]	−0.102	[0.320]
Attrition × Male	−0.043	[0.109]	−0.219*	[0.128]	0.166	[0.097]	−0.825	[0.542]	−0.329	[0.606]	0.023	[0.230]
Attrition × Han	0.080	[0.186]	0.175	[0.259]	−0.131	[0.239]	1.398	[0.966]	3.017**	[0.980]	1.055**	[0.466]
Attrition × Had a white-collar job before age 60	−0.352	[0.364]	−0.017	[0.355]	−0.316	[0.364]	−1.186	[1.916]	−1.866	[2.085]	0.573	[0.650]
Attrition × Years of schooling	0.018	[0.022]	0.054**	[0.032]	0.014	[0.025]	0.028	[0.123]	−0.029	[0.119]	−0.026	[0.052]
Attrition × province dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Province dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Observations	8447		8427		7948		8191		8453		7259	
F-statistic for test on the joint effect of attrition on:												
constant and coefficient estimates	$F=10.11$	$P=0.2574$	$F=9.28$	$P=0.3190$	$F=15.72$	$P=0.0465$	$F=0.97$	$P=0.4608$	$F=1.52$	$P=0.1462$	$F=1.21$	$P=0.2923$
all coefficient estimates but no constant	$F=9.64$	$P=0.2098$	$F=9.28$	$P=0.2332$	$F=12.51$	$P=0.0850$	$F=0.83$	$P=0.5631$	$F=1.02$	$P=0.4191$	$F=1.09$	$P=.3658$
constant only	$F=1.59$	$P=0.2076$	$F=4.40$	$P=0.0359$	$F=0.04$	$P=0.8373$	$F=1.92$	$P=0.1667$	$F=0.00$	$P=0.9632$	$F=0.13$	$P=0.7136$

Notes: Standard errors clustered at the county level in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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