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RESEARCH PAPER

Older Adults' Mental Health in China: Examining the Relationship Between Income Inequality and Subjective Wellbeing Using Panel Data Analysis

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Abstract
Although people in China are experiencing rapid economic growth, higher income, and better living standards, the level of subjective wellbeing has not risen correspondingly. According to the 'Easterlin Paradox', economic growth does not necessarily bring about improvement in wellbeing, because an important part of happiness comes from making comparisons. This study investigates the relationship between income inequality and subjective wellbeing in China, focusing on older adults between 60 and 90 years. Empirical evidence is drawn from the Chinese Health and Nutrition Survey 2006, 2009, and 2011 waves. Using county-level fixed-effects estimation, the analyses show that generally, income inequality is negatively associated with subjective wellbeing, net of individual income. The association between inequality and wellbeing varies between people with rural or urban household registration status, and between people ranked within different income deciles. The association between inequality and wellbeing is stronger for people with urban household registration status, and for people ranked within higher income deciles.

Keywords Income inequality · Subjective wellbeing · Older adults · China

1 Introduction

Over the last few decades, China has witnessed a large degree of economic growth and greatly improved living standards. The annual gross domestic product growth rate averaged 9% between 1989 and 2015, and the disposable personal income in urban and rural areas has increased, respectively, from 343 to 134 CNY in 1978, to 28,844 and 10,489 CNY in 2014 (NBSC 2015).

Despite rising incomes, the levels of wellbeing in China have fallen. In the 1990 World Values Survey, 28% of the surveyed Chinese viewed themselves as being 'very happy'. In 2000, this proportion fell to 12% (Brockmann et al. 2008). In Gallup-Healthways' 2014

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country wellbeing ranking, China ranked as low as 127 out of 145 countries (Gallup-Healthways 2015). Bartolini and Sarracino (2015) have called China 'the world's largest example of the Easterlin paradox', calling attention to these seemingly contradictory development trends of economic growth and decline in subjective wellbeing.

A major challenge in China today is increasing socioeconomic inequality. Inequality may have an impact on people's wellbeing, since an important part of happiness comes from individuals comparing themselves with others and feeling relative advantage (Easterlin 1974). It is particularly interesting to study older Chinese adults because they have experienced not only rising incomes and better living conditions, but also increased social and economic inequality. Older people contribute to society both economically at workplaces, and informally within individual networks and as caregivers at home. The United Nations (2007) estimates that the aging population in China will account for one third of the national population in 2050. As the proportion of elderly people grows, challenges arise considering the wellbeing of more than 100 million people aged 65 and over (Feng and Xiao 2007). Focus on the elderly is therefore highly relevant.

Using 2006, 2009, and 2011 data from the China Health and Nutrition Survey (CHNS), this study examines the relationship between income inequality and subjective wellbeing among older adults in China. Furthermore, we look at how the relationship between inequality and wellbeing varies between older adults in different income groups and between those with urban versus rural household registration. The study contributes to the literature of subjective wellbeing and inequality studies with empirical evidence about older adults in China.

2 Subjective Wellbeing and Income Inequality

2.1 Subjective Wellbeing for Older Adults

Subjective wellbeing is defined as 'a person's cognitive and affective evaluation of his or her life' (Diener et al. 2002), and it is often used as an indicator of psychological health (Headey et al. 1993; Keyes 2005, 2006). It is highly associated with both psychosocial and health behavioural factors, and some scholars have shown that wellbeing affects health causally (Diener and Chan 2011). Psychologists have a long tradition of being interested in wellbeing, with a focus on individual factors and social relationships (e.g., Diener et al. 1999). In sociology, there has been increasing interest in subjective wellbeing, with an emphasis on socioeconomic status and institutional structures (Veenhoven 2008; Wang and Xie 2014).

The relationship between inequality and wellbeing among older adults can be explained from different perspectives. The social comparison theory states that individuals often evaluate themselves via comparison with others. An upward comparison often causes deprivation, whereas a downward comparison brings about higher self-esteem (Festinger 1954). An individual's relative position in comparison to her reference groups is an indicator for a person's sense of deprivation and social justice (Runciman 1966). When inequality in a society rises, the relative distance to people with higher income increases as well. This may have an impact on the degree of relative deprivation and further influence an individual's subjective wellbeing (Yitzhaki 1979).

Wellbeing is closely related to older age (Wong et al. 2019). While we know that physical health and nutritional status play important roles in the wellbeing of the elderly,

subjective wellbeing correlates differently with age in various cultural settings. While a U-curve relationship between age and wellbeing was observed in the Gallup World Poll, wellbeing does not vary with age in sub-Saharan Africa. In Eastern Europe and Latin America, wellbeing drops when people get older (see Steptoe et al. 2015).

Age-related changes in wellbeing can also be discussed in light of the objective and subjective concepts of wellbeing. While an objective approach to wellbeing largely relies on measures of poverty and inequality, subjective wellbeing captures people's subjective overall life evaluation (D'Acci 2011; Western and Tomaszewski 2016). Compared to younger people, older adults' objective wellbeing might be lower, but they may mainly focus on a more limited range of experiences and social circumstances. Therefore, older adults may experience less stress and thus maintain or even increase subjective wellbeing (Steptoe et al. 2015).

The relationship between objective and subjective wellbeing can also be explained by adaptive expectations. Adaptive expectation is the 'adjustment of people's aspirations to feasible possibilities' (Elster 1982, p. 219). This term takes into account an individual's life situation in adjusting his/her expectations, and it may have an important impact on subjective wellbeing (Sen 1987; Nussbaum 2001). When a society is experiencing tremendous changes, individuals may also have to adjust their expectations. Subjective wellbeing can therefore be influenced by objective circumstances, such as changes in one's income (Burchardt 2005).

Furthermore, culture may play an important role. Compared to the West, collectivism in terms of group loyalty and group identity seems to play a more important part in promoting individual wellbeing in East Asia (Yuki 2003). This may be even more important for older adults who grew up under a stronger tradition of collectivism. China is transforming towards a more individualistic society. Nuclear families are on the rise, and the labour market has become more significant than clan- or collective-based forms of production. Scholars have found that while both individualist and collectivist factors have major impacts on subjective wellbeing in China, individual factors have become more essential over time (Steele and Lynch 2013).

2.2 Income, Inequality and Wellbeing

Many studies have examined how economic conditions affect subjective wellbeing and happiness. A positive association between absolute income and happiness seems to be fairly robust (Easterlin 2001; Firebaugh and Schroeder 2009). Empirical studies have confirmed this association in many contexts—including in European countries (Di Tella et al. 2003; Caporale et al. 2009), in the United States (to a certain threshold) (Kahneman and Deaton 2010), and in China (Appleton and Song 2008; Knight and Gunatilaka 2011). Some suggest that this is a universal phenomenon (Easterlin 2001; Deaton 2008). Some others point out that the positive association might be due to reverse causation (Diener et al. 2002; Graham et al. 2004) or unobserved individual characteristics (Ferrer-i-Carbonell and Frijters 2004).

Wellbeing, however, is not necessarily connected to an increase in per capita income. Accordingly to Easterlin (2001), satisfaction is derived from having more compared to one's reference group. Some scholars suggest that when inequality rises, the income of rich groups rises comparatively more. This may explain why the degree of happiness in the US has not risen in parallel with its economic growth (Fischer 2007). Although this

interpretation has met with some critique (Firebaugh and Schroeder 2009), it draws upon the importance of relative income and income inequality on wellbeing.

While many have accepted that income inequality may have an important impact on subjective wellbeing, questions arise as to how these factors are connected.

One approach is to identify higher income inequality as an indicator for a higher degree of economic development and greater employment opportunities. This is called the *tunnel effect*: The effects of income inequality vary according to people's perceptions of mobility, especially when inequality is interpreted as a signal for opportunity (Hirschman and Rothschild 1973). When people observe upward mobility for others, their expectations for their own future social mobility increase, which makes them happier. Inequality, accordingly, is therefore correlated with higher individual wellbeing (e.g., Marshall and Firth 1999; Clark and Senik 2011). Clark (2003) found that inequality increases wellbeing for some social groups in Britain. Alesina et al. (2004) observed that for the poor and those on the political left in Europe, the level of happiness decreases with rising inequality. Yet, there is no correlation between inequality and happiness for the poor and the political left in the US.

However, this interpretation has been criticised for disregarding diversity between different social groups. Although some may have a higher expectation for mobility in a more unequal society, others may not (Verme 2011). According to the income inequality hypothesis, changes in socioeconomic position and increased inequality may lead to psychological stress and relative deprivation, and hence reduce an individual's wellbeing (Wilkinson 1996; Zhao 2012; Layte and Whelan 2014; Wilkinson and Pickett 2017).

In the study mentioned above, Alesina et al. (2004) also found that generally, people are less likely to describe themselves as happy when inequality is at a higher level, even controlling for individual income, individual characteristics, year and regional differences. Similarly, using aggregated European and World Values Surveys between 1981 and 2004, Verme (2011) found that income inequality has a consistent, negative and significant effect on life satisfaction worldwide.

3 The Chinese Context and Research Hypotheses

Both economic development and income inequality in China have increased dramatically since economic reforms were implemented in the 1980s. Since the economic reform, the elderly welfare was cut down, and there is a lack of welfare support for older people, especially for those who worked outside state-owned enterprises and in rural areas (Chan et al. 2008). This has contributed to the high rate of work participation among older adults. Giles et al. (2012) found that in 2008, 45% of urban men and 86% of rural men aged 60–64 were still working.

The Gini coefficient is an indicator measuring the degree of inequality in a society. It is ranged from 0 (total equality) to 1 (maximal inequality). This index has risen from .2 to .3 in the 1970s (Chen and Zhou 2005) to .47 in 2012 (NBSC 2013). The degree of inequality for Chinese elderly was also at a high level. Based on a nationwide household survey conducted by China's Elderly Scientific Research Centre, the Gini coefficients for the elderly in rural and urban areas were estimated to be .50 and .35, respectively (Costa and Ji 2004). Chinese authorities have given priority to economic development, and regarded inequality as an unfortunate but necessary consequence of economic growth. Following rising income inequality, one particular challenge is China's public health and wellbeing (Chan et al. 2008; Zhao 2012).

There have been studies that have focused on elderly Chinese and their wellbeing in general. The wellbeing of older people in China is related to family structures and households size, as well as access to social contact and social activities (Silverstein et al. 2006; Li and Liang 2007; Yeung and Xu 2011). Economic and financial strain have been recognised as one of the most important factors (e.g., Li and Liang 2007, Li et al. 2007).

Studies on the general relation between inequality and wellbeing in China have emerged in recent years. Wang and VanderWeele (2010) have suggested that dramatic change, competition and increasing inequalities are threatening current subjective wellbeing. Lu and Wang (2011) found that income inequality at the province level has a negative effect on subjective wellbeing. Similarly, Wu and Li (2017) found that local income inequality has a negative influence on wellbeing. According to Knight et al. (2009), the level of absolute income is not a determinant for happiness, whereas relative income—both within village and over time—is important for an individual's happiness. Some others have found that individual income is positively correlated with wellbeing, but this effect decreases with the level of local economic development, and local income inequality has a negative influence on wellbeing (Wu and Li 2017).

3.1 Transitional Society and Inequality

The market transition period and the process of privatisation brought new challenges of uneven distribution and higher income inequality (cf. Bakkeli 2017). This may have a further impact on people's well-being. Evidence from previously communist countries suggests that people in transitional societies report a decline in wellbeing over the years (Bjørnskov 2003; Gruen and Klasen 2005). This can be caused by sudden change and inability to adapt the unsecure life the social transition created. During the transition from socialism to capitalism, wellbeing may be increased with material living standard, but reduced because of changes in work conditions, health and family structure (Easterlin 2008).

Rapid transitions might affect elderly people in a way that influences their perceived wellbeing, since '…people most often compare their present situation with that of others, with their own situation in the past or with their expectations for the future' (Górniak 2000, p. 152).

In a transitional period, subjective perceptions of wellbeing are likely to be influenced, particularly if people compare their present situations to those of the past. Chinese people born in and before the 1950s have spent more than 25 years of their lives under socialism, and experienced rapid social changes. On the one hand, the market reforms may have brought improvements in nutrition and living conditions that are critical to maintaining their wellbeing. On the other hand, they may be unprepared for the new, unpredictable and competitive market-oriented society. As adults, they may have difficulties adjusting to the change, and their wellbeing may be compromised. Therefore, older adults' wellbeing may be impacted by the contrast between an egalitarian past and an unequal present.

Scholars have noted that dramatic changes in society result in increased income inequality, seemingly having a negative effect on older adults' subjective perceptions of wellbeing. A previous cross-national study shows that the sharpest declines in wellbeing with age were found in Eastern Europe and former countries of the Soviet Union (Deaton 2008), where major societal transitions have occurred. Life evaluation is particularly low among elderly in transitional countries in which people have lost the systems providing pensions and healthcare that were once important parts of the social safety net (Steptoe et al. 2015).

There is a large body of literature addressing the negative effects of income inequality on population health (Wilkinson 2006; Fang and Rizzo 2011). In a society with increased inequality, older adults are more seriously affected by health problems, in addition to a more stressful lifestyle, a lower level of social cohesion, and a lower degree of welfare support. We may, therefore, expect wellbeing to decrease with rising inequality in China:

H1a Income inequality is negatively associated with wellbeing for older adults, net of individual income.

3.2 Regional Heterogeneity

The widening regional gap has become one of the most important aspects of inequality in China (Xie and Hannum 1996; Chow 2007). There are huge political, structural, and socioeconomic varieties between and within regions, as well as large regional variations in terms of natural and social resources. These factors can also contribute to variations in economic activities and economic inequality among different regions.

One particularly important factor is the degree of economic development in a region. Economic development may also indicate a better-developed infrastructure such as higher level of welfare provision and robust societal infrastructure. It may also be viewed by Chinese people as a signal for better opportunities in the future, which may even offset the negative impact of income inequality on subjective wellbeing (Xie et al. 2012). We may thus expect that adding regional level control variables of economic growth and inequality may reduce the effect of individual characteristics on subjective wellbeing.

Some scholars have found a positive relationship between income inequality and wellbeing in different regions in China, and argued that this is an evidence of the tunnel effect, meaning that economic growth elevates the general level of living standards and therefore happiness levels (Knight and Gunatilaka 2010). If this were true, then regional differences in regional factors would capture much of the variation in wellbeing.

When assessing the impact of inequality, it is important to control for structural and/or regional factors that are correlated with inequality. Potential confounders can be for example economic development, social policy and the urban–rural division. These factors can be correlated with large degrees of inequality, and can influence individuals' subjective wellbeing.

In empirical studies, a simple way of controlling for regional heterogeneities is to include county varieties in the analytical models (Wang et al. 2015; Bakkeli 2016). The county is the third administrative level in China, after provinces and prefectures. It includes both urban and rural areas and is the most used basic statistical unit in analyses. See e.g., Wu et al. (2014, Figure 1) for a schematic diagram of China's administrative units.

By taking care of the regional heterogeneities, we are also removing the partial effects of the county-level variables. Therefore, we may expect to observe the 'true' impact of income inequality on wellbeing. This leads to our next hypothesis:

H1b Controlling for regional heterogeneity can reveal a stronger negative effect of income inequality on subjective wellbeing.

3.3 Group Varieties: Individual Income and the Urban–Rural Divide

The relationship between income inequality and wellbeing may be different for the poorer and more disadvantaged. For richer people, their privileged economy may help to eliminate the negative stress factors that are caused by inequality (Alesina et al. 2004). For the poor, their wellbeing can be harmed even more because inequality reflects the phenomenon of unfairness—not that the poor are getting poorer, but that the rich are getting richer. The feeling of injustice and lower levels of trust thus reduce wellbeing for people with lower incomes (Oishi et al. 2011). People tend to feel depressed if they are worse off than similar others (i.e., upward comparison). Increasing income inequality can increase relative deprivation and therefore decrease wellbeing even more for the most deprived people with low incomes (Verme 2011).

One important structural factor that contributes to China's high inequality and unequal distribution of resources is the urban–rural divide (Xie and Zhou 2014). The household registration, *hukou* status, is given to each individual at birth. It systematically separates agricultural and non-agricultural citizens and their different welfare rights. Usually, only residents with local *hukou* registration have access to welfare benefits in their area, whereas people living outside their registered residency area do not have access to the same rights as local residents. Welfare policies differ greatly between urban and rural areas, and urban *hukou*-owners are entitled to much more privileged and generous social services (Whyte 2010).

There is a need to examine urban and rural older adults separately. Whereas the urban elderly rely more on their pension income, income from their own labour is the most important financial source for the rural elderly (Giles et al. 2012). Compared to urban citizens, older rural residents tend to have much longer working lives. In fact, they work as long as they are physically able (Giles et al. 2012).

Based on six surveys concerning elderly's life quality, Feng (2011) found that the average monthly income of the urban elderly is about seven times higher than that of the rural elderly. The estimated Gini for Chinese aged 60 and above was as high as .49 in 2008 (Feng et al. 2012). According to the 2006 China national survey, about half of the urban respondents reported feeling happier when compared to others, but only one third of the rural respondents felt the same (Lou and Gui 2011).

Further, the effects of inequality on wellbeing may vary between urban and rural residents (Jiang et al. 2008). Subjective wellbeing depends more on relative income than on absolute income (D'Ambrosio and Frick 2007). Drawing upon the social comparison perspective, older adults with a rural household registration may feel depressed by upward comparison with their urban peers, who have access to more generous healthcare services and old-age pension benefits. When using urban older adults as their income reference group, the higher aspiration led to unhappiness (Knight and Gunatilaka 2010).

However, comparisons do not solely occur between different social groups; they can also be made by an individual between her own past and present. Whyte and Im (2014) revealed that rural respondents indeed have less negative perceptions of inequalities than urban citizens, despite their disadvantaged status. They explained the rural optimism as caused by the contrast between 'the perspective of past history and relative expectations': the changing form of agricultural production from socialist collective cultivation to family farming. This change brought about substantial progress in reducing rural poverty, which contributed to rural citizens' optimism about market reforms,

as well as a higher level of acceptance of inequalities. One may therefore explain this phenomena with the 'tunnel effect': the perception (not necessarily the reality) of living in a society with greater possibilities of moving up in the income hierarchy may increase rural residents' wellbeing (cf. Hirschman and Rothschild 1973). Therefore, the effect of inequality on wellbeing may not necessarily be stronger for rural households than for urban households.

Moreover, market reforms are correlated with greater income inequality (Bakkeli 2017). Urban Chinese have experienced a larger scale of market transformation and steeper increase in income inequality. According to the income inequality hypothesis, rising inequality may lead to a lower degree of cohesion, which is further linked with lower wellbeing. Therefore, urban citizens may experience even more stress followed by increasing inequality, compared to rural residents. Based on these arguments, our second research hypothesis is as follows:

H2 There is a stronger association between income inequality and wellbeing among people with urban household registration than among those with rural household registration.

Notice that moving further from regional heterogeneity and geographical locations; here, we focus on differences created by the household registration system in China. The terms 'urban' and 'rural' refer to the *hukou* system, rather than to urban or rural residential areas.

4 Methods

4.1 Data

The empirical analysis is based on Chinese Health and Nutrition Survey (CHNS) from 2006, 2009, and 2011. The survey draws a sample from 72 counties in nine provinces, and covers a wide and highly diversified range of regions, both geographically and socioeconomically. The term 'county' is used here for both counties/townships in rural areas, and cities in urban areas. Among all counties, 54 counties had repeated measures for all three waves. We focus only on respondents between 60 and 90 years old in each of the three waves in order to capture the relation between income inequality and wellbeing for this specific age group. The restriction to this age group in all three waves leaves a total of 10,126 observations.

4.2 Dependent Variable: Wellbeing

Psychologists look at subjective wellbeing as a broad category that includes different components, such as people's emotional responses (positive or negative affects), domain satisfactions, and life satisfaction (Diener et al. 1999, 2003). Therefore, subjective wellbeing includes both emotional experiences and cognitive evaluations (life satisfaction). Veenhoven (2008) referred to two sources of information when considering subjective wellbeing: 'cognitive comparison with standards of the good life (contentment), and affective information from how one feels most of the time (hedonic level of affect)'. Adopting this viewpoint, subjective wellbeing refers not only to a cognitive evaluation, but also to an overall appraisal of life (Veenhoven 2008).

The main focus here is on individuals' perceptions of their life quality and how they may be affected by income inequality. Three components are involved in the question we ask. First, it concerns individuals' subjective perceptions of their life situations instead of an objective measure of living standard. Second, subjective wellbeing includes the perspective of overall life satisfaction (Veenhoven 2008). Third, one element of wellbeing in this study is the long-term comparison of life situations by a person. Therefore, the comparison between one's past and present life situation should not be taken for granted.

Following these arguments, the variable of *wellbeing* in this study was constructed based on four survey questions: (1) How do you rate your life at present? (2) I have as much pep as I did in [last survey year]. (3) I am as happy now as I was younger. (4) As I get older, things are better than I thought they would be. All variables have five values: Respondents could choose between 'very good', 'good', 'OK', 'bad' and 'very bad' in response to the first question. The other three questions contain the following answers: 'strongly disagree', 'disagree', 'neutral', 'agree', and 'strongly agree'. The Cronbach's alpha coefficient for these variables is high (.85), indicating a high reliability of the index of subjective wellbeing.

We coded all four variables consistently from one to five, where one represents the lowest degree of wellbeing and five represents the highest degree of wellbeing. The scores were then added up and together formed a new indicator of wellbeing. This indicator has values ranging from 4 to 20, where an individual with a score of 4 would be the least satisfied, and would have maximum wellbeing with a score of 20. The minimum value was subtracted to make the indicator start at 0, with a range from 0 to 16, in order to make the analytical procedure more straightforward. The variable is standardised into z-scores, with a mean of zero and a variance of one across the entire sample.

4.3 Control Variables

Individual income was constructed by the CHNS' research team. It is the sum of all individual income sources and individual revenue, subtracted by expenditures for one household member. The individual income measure is a sum of different sources of income, both from individual gains and individual proportion of net household income. Therefore it is not a division of household income distributed evenly among household members, but is built by adding each person's income source. For rural citizens, an individual's proportion of net household income from household farming is based on the reported hours spent on farming. For urban citizens, pensions are an important source of individual income for the elderly.

Income inequality was measured by the Gini coefficient at the county level for each wave, calculated by individual income from all observations in the survey. Income inequality was measured by the Gini coefficient in the main analysis and by the generalized entropy (Theil) indices when testing robustness. These measures are complementary. Whereas the Gini coefficient is particularly sensitive to changes at middle income levels, Theil L and Theil T are sensitive to changes at the bottom and upper income levels, respectively.

County-average income is a control variable made in order to capture the degree of economic development in a county-level unit, calculated by averaging individual income in a county/city for each wave in the CHNS. Both income inequality and county-average income were calculated based on all observations in a county in each wave, instead of only those who were aged 60–90. All observations were included to provide contextual information concerning the economic development in each county.

All continuous income-related variables were log transformed in the analysis.

We also control for numbers of household members (household size) and numbers of older adults living in the same household. These are used to approximate *family structure* for older adults. We suppose that a larger family is an indicator of a higher level of family solidarity, and that several older adults living together means that they can have more time to accompany others, even when younger family members have to spend their time at work. Studies show that emotional support from a spouse can be more important for a person's wellbeing than support from children and friends (Venkatraman 1995; Okabayashi et al. 2004). Therefore, older family members may be important for older adults' wellbeing. Previous studies have also used age gaps and patterns of co-residency in a household as measurements for family structure, in addition to household size (Rim 1993; Raymo et al. 2008; Zhang et al. 2014).

Other individual control variables include age, gender, marital status, ethnic majority, years of education, household registration, employment status, and whether a person has been sick or injured, or suffers from a chronic or acute disease (Table 1).

4.4 Analytic Strategy

The study was carried out in the following steps: First, a simple ordinary least squares (OLS) regression was conducted in Model 1 to map the relationship between wellbeing and income inequality. In this step, only individual income and county-average income were included as control variables.

Second, In Model 2, we included only control variables at the individual level. Model 3 combined Models 1 and 2; all other individual control variables were added to the OLS regression, together with county average income and the Gini coefficient. We also

Table 1 Descriptive statistics

Variables	N overall (within)	Mean (s.d.)	Min/max
Wellbeing	8513 (4625)	8.58 (2.61)	0/16
Gini	10,126 (5240)	.46 (.10)	.25/.77
Theil L	10,126 (5240)	.47 (.22)	.10/1.36
Theil T	10,126 (5240)	.42 (.20)	.11/1.31
Theil V	10,126 (5240)	.80 (.71)	.15/3.96
County income	10,126 (5240)	15,994 (7126)	3013/50,059
Individual income	6069 (3710)	14,481 (14,996)	0/399,912
Age	10,126 (5240)	69.48 (7.35)	60/90
Women	10,126 (5240)	.52 (.50)	0/1
Single	6712 (3735)	.02 (.13)	0/1
Majority	10,097 (5219)	.88 (.32)	0/1
Years of education	8809 (4716)	5.09 (4.58)	0/1
Urban	8842 (4720)	.49 (.50)	0/1
Household size	8834 (4719)	4.04 (1.73)	1/11
# of elderly in hh	5669 (3430)	1.98 (.77)	1/9
Sick	8827 (4716)	.27 (.52)	0/1
Employed	8841 (4720)	.24 (.43)	0/1

controlled for economic development at the county level, measured by the mean income of a county.

Third, we used the fixed-effects model at the county level to control for time-invariant heterogeneity at the county level in order to capture many of the structural differences in counties. This step of the analysis adds 0/1 dummies for each county.

The estimations by adding county dummies are typically referred to as 'county-level fixed-effects'. The fixed-effects equation for Model 3 can be written as follows: $Wellbeing_{ijt} = \beta_0 + \beta_1 Income_{ijt} + \beta_2 Countyincome_{jt} + \beta_3 Gini_{jt} + \beta_4 X_{ijt} + \beta_5 F_j + \alpha_j + u_{ijt}$, where $countyincome_{jt}$ and $Gini_{jt}$ are time-varying county-level variables, X_{ict} is the vector of individual time-varying characteristics, α_j is the unknown intercept for each entity and u_{ijt} is the error term. F_j denotes a vector of county dummies, and β_4 is the effect vector for F_j. In this model, there is one dummy for each county except the reference county that was arbitrarily chosen. By including F_j, we account for the unobserved time-invariant county factors that may affect both the average Gini and individual levels of wellbeing.

The first three steps were to test our first hypothesis, *H1a* and *H1b*. To make the models comparable, all four models were estimated with a consistent set of cases, restricted by the same sample used for the fixed-effects model (Model 4). The standard errors were clustered at the county-level units in Models 1 and 2. Two-way cluster-robust standard errors were applied to both individual and county-level units in Model 3.

The fourth step of the analysis was to examine whether income and income inequality are associated differently with wellbeing for urban and rural citizens (*H2*). This was carried out to test the fixed-effects models for urban and rural *hukou*-owners separately, and we limited the sample to income groups below and above the 50% income decile to detect potential differences between rich and poor social groups. The 50% decile was calculated in urban and rural China separately.

We applied several robustness checks, including models replacing the Gini coefficient with the generalised entropy, a model including additional occupational variables and models to check missingness. One potential problem is whether values are missing at random or due to selection bias. In our last step of the robustness test, we performed a quick check by imputing the income variable to determine whether the relationship between inequality and wellbeing remained negative and significant.

A better solution is to carry out a sensitivity test, in which the missing income is replaced by a low value, randomly selected among 0 and 420 yuan (the lowest 5% decile in income distribution). By including these values, the same analysis (Models 1–3) was carried out to determine whether the relationship between income inequality and wellbeing changed significantly. Finally, maximum likelihood estimation was used as an additional check for the relationship between income inequality and wellbeing.

5 Results

5.1 Inequality and Wellbeing

A brief overview in Fig. 1 shows that the Gini coefficient is negatively correlated with wellbeing.

Model 1–4 in Table 2 were based on the same sample in order to be comparable.

Model 1 includes two control variables in addition to income inequality: individual income and general economic development in a county. In this model, individual income

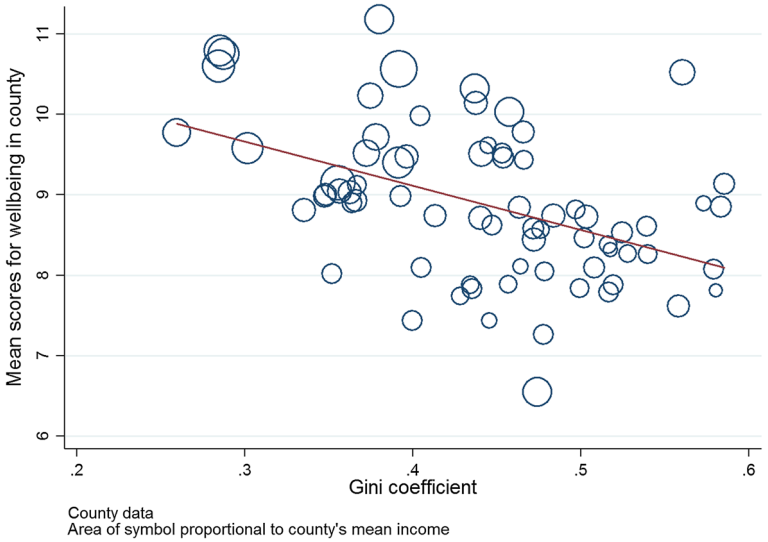

Fig. 1 Relation between Gini coefficient and wellbeing

Table 2 Regression on subjective wellbeing

	1	2	3	4
Individual var.				
Age		− .010 (.310)	− .089 (.288)	− .115 (.290)
Age squared		.000 (.002)	.001 (.002)	.001 (.002)
Women		.070 (.032)*	.025 (.030)	.031 (.030)
Single		.068 (.200)	.135 (.191)	.162 (.159)
Majority		.117 (.072)	.074 (.073)	.008 (.101)
Education		.009 (.006)	.007 (.006)	.010 (.006)†
Urban		.080 (.078)	.056 (.069)	.182 (.067)**
# Elderly		.031 (.015)*	.029 (.030)	.034 (.027)
Household size		.041 (.030)	− .005 (.015)	.004 (.014)
Sick		− .118 (.037)**	− .141 (.037)***	− .114 (.035)***
Employed		.093 (.062)	.124 (.062)*	.094 (.058)
ln Ind. income	.042 (.018)**	.126 (.024)***	.032 (.021)*	.020 (.018)
County variables				
ln Gini	− .058 (.158)		− .035 (.161)	− .540 (.223)**
ln county income	.557 (.077)***		.565 (.079)***	.745 (.114)***
Intercept	− 5.815 (.665)***	− .762 (9.957)	− 3.059 (9.148)	− 4.629 (9.036)
Fixed-effects	No	No	No	Yes
N of obs.	3311	3311	3311	3311
N of groups	72	72	72	72

N = 3311, 72 counties

*** < .001; ** < .01; * < .05; † < .10

and mean income in a county are positively correlated with older adults' subjective wellbeing, but the coefficient for log Gini is not significant.

Model 2 controls for individual characteristics. Higher individual income is still strongly associated with better subjective wellbeing. The level of wellbeing is higher for women than for men, and having a higher number of older adults inside a household is correlated with higher degrees of wellbeing. Finally, illness is negatively associated with wellbeing.

Model 3 combines variables from Model 1 and Model 2. Surprisingly, we do not observe that individual variables have significant impact on wellbeing. The only variables that matter are individual income, county-level income and whether a person has been sick. For each one per cent increase in individual income, wellbeing is expected to increase by approximately three per cent. The correlation between county-level income and wellbeing is also significant: Each one per cent increment in county-level income corresponds to a higher wellbeing of .57 standard deviations. Finally, a person that has been sick or injured has a lower wellbeing of .14 standard deviations.

Model 4 is a full model that utilises fixed-effects estimations, which control for all individual and county-level covariates. In this model, individual income is no longer associated with wellbeing. Income inequality turns out to have a significant association with wellbeing when county-level heterogeneity is taken into account. An increment of 1% in the Gini coefficient will reduce wellbeing by .54 standard deviations. The coefficient of county-average income has increased in size, predicting an increase in wellbeing by .75 standard deviations when the county-average income increases by 1%.

Furthermore, the coefficient of urban household status turns out to have an impact on wellbeing. Those who have an urban household registration are .18 standard deviations higher in wellbeing than people registered with rural households. The coefficients from other individual variables are more or less the same, but some of the estimators have changed size. Levels of wellbeing for those who are sick are on average .11 standard deviations lower than those of healthy respondents. Other individual control variables do not appear to influence subjective wellbeing for older adults.

5.2 Variations: Income Groups and *hukou*

Table 3 outlines the fixed-effects models carried out within different income groups. The threshold was defined as the 50% of the income distribution. For people with urban household registration, the 50% decile is 16,800 yuan, and for rural people the threshold is 4800 yuan. Income inequality is negatively associated with wellbeing for the urban population, but does not matter for the rural household registers. The correlation is strongest for the highest 50% urban income decile. For the urban income groups above and below the median, a 1% increment in Gini decreases wellbeing by 1.3 and .74 standard deviations, respectively. This indicates that the impact of income inequality on wellbeing varies between urban and rural citizens, and between richer and poorer people.

For the richer urban income group, the coefficient for individual income is positive and significant. The effect size is also relatively large, with a coefficient equal to .25. The relationship between individual income and wellbeing is much stronger for urban individuals with income above the 50% decile than for all other groups. For the urban poor and rural rich, higher income is not significantly associated with higher wellbeing. Individual income turns out to have a negative effect on the poorest group of rural people, with an effect size of .06 standard deviations.

Table 3 Fixed-effects estimation for different income groups

[Urban] Income (Yuan)	< 16,800	≥ 16,800
Individual variables		
Age	− .092 (.540)	.247 (.533)
Age squared	.001 (.004)	− .002 (.004)
Women	− .047 (.056)	.152 (.063)**
Single	− .115 (.183)	− .268 (.351)
Majority	− .017 (.157)	− .016 (.187)
Years of education	.000 (.012)	− .005 (.010)
Household size	.036 (.033)	− .033 (.034)
# Elderly in household	− .056 (.056)	.003 (.054)
Sick	− .026 (.052)	− .144 (.079)*
Employed	.048 (.133)	− .008 (.077)
ln Individual income	.021 (.061)	.253 (.080)***
County variables		
ln Gini	− .739 (.393)*	− 1.341 (.365)***
ln County-average income	1.062 (.159)***	1.516 (.240)***
N of obs.	820	859
[Rural] Income (Yuan)	< 4800	≥ 4800
Individual Variables		
Age	− .222 (.554)	− .395 (.607)
Age squared	.002 (.004)	.003 (.005)
Women	.015 (.051)	.033 (.071)
Single	.665 (.238)***	.350 (.213)
Majority	.323 (.172)*	− .138 (.165)
Years of education	.004 (.012)	.083 (.055)
Household size	.026 (.056)	.097 (.051)*
# Elderly in household	.014 (.026)	.029 (.029)
Sick	− .111 (.084)	− .341 (.103)***
Employed	.088 (.093)	.017 (.107)
ln Individual income	− .064 (.034)*	− .017 (.059)
County variables		
ln Gini	− .011 (.360)	− .456 (.297)
ln County-average income	.324 (.106)***	.764 (.138)***
N of obs.	729	882

*$p < .10$; **$p < .05$; ***$p < .01$

Furthermore, economic development in a county, measured by the average income level of a county, is associated with higher wellbeing for all urban and rural income groups. However, the more privileged the group an older adult belongs to, the more benefits that person gains from economic development. For older adults among the urban rich, the urban poor, the rural rich and the rural poor, a 1% increase in average county income increases wellbeing by 1.5, 1.1, 0.8 and 0.3 standard deviations, respectively. The results show that economic development clearly benefits richer groups and urban citizens the most.

5.3 Robustness Checks

We performed a robustness check of our inequality measurement, in which we substituted the Gini coefficient with Theil's indices (see Table 4). These tests correspond highly with our original findings. The only difference is that for all Theil's indices, the number of elderly people in a household is significantly associated with higher wellbeing, which indicates that family solidarity inside a household is important for older adults' subjective wellbeing.

A separate test was also performed, in which variables of occupation and sector were added (with reference group farmers and farming sector; see "Appendix 1"). In this test, the results did not change significantly. In other words, even when the sample size is reduced to only include those who reported their occupation, the results are still robust. The estimations are very similar to those in Table 2, which strengths our results.

When considering missingness, the sensitivity test for Models 1–3 can be found in "Appendix 2", where a random number between 0 and 420 yuan replaced missing individual income. The coefficient for income inequality is estimated at − .495 in the fixed-effects model. Although the size of the coefficient has decreased, the Gini coefficient is still negatively associated with wellbeing. Most of the other coefficients did not change much, and our conclusion remains solid. Employment status turned out to be significant. When dealing with the original data with missing values for older adults that have not given that employment status, the prediction power is reduced because of missingness.

Some other quick checks were also conducted to determine whether the relationship between income inequality and wellbeing remains significant if the omission is taken into

Table 4 Fixed-effects models on wellbeing with Theil's indices in 72 counties

	Theil L	Theil T	Theil V
Individual variables			
Age	− .124 (.291)	− .111 (.290)	− .107 (.290)
Age squared	.001 (.002)	.001 (.002)	.001 (.002)
Gender	.031 (.030)	.031 (.030)	.031 (.030)
Single	.160 (.158)	.160 (.158)	.158 (.158)
Majority	.006 (.100)	.005 (.099)	.007 (.101)
Years of education	.010 (.006)*	.010 (.006)*	.010 (.006)*
Urban hukou	.184 (.066)***	.181 (.066)***	.179 (.066)***
# Elderly	.034 (.027)	.035 (.027)	.035 (.027)
Household size	.003 (.014)	. 003 (.014)	. 003 (.014)
Sick	− .115 (.035)***	− .115 (.035)***	− .116 (.035)***
Employment	.096 (.059)	.094 (.059)	.093 (.059)
ln Individual income	.017 (.018)	.020 (.018)	.022 (.018)
County variables			
ln Theil	− .352 (.117)***	− .203 (.085)**	− .099 (.050)**
ln County income	.719 (.116)***	.779 (.112)***	.799 (.110)***
N of obs.	3311	3311	3311
N of. groups	72	72	72

N = 3311

*$p < .10$; **$p < .05$; ***$p < .01$

account ("Appendix 3"). These include a model in which individual income is imputed 20 times using linear regression with available predictors of income, and a model that estimates the relationship with maximum likelihood with missing values (MLMV). Although the effect size and significance of the Gini coefficient were reduced in the MLMV model, both methods indicate a negative correlation between inequality and wellbeing.

In addition, we have controlled for proxy variables for adaptive preferences, measured by income changes over time. Including these variables does not influence our result. See "Appendix 6" for detailed information.

6 Discussion and Conclusion

6.1 Inequality and Wellbeing

This paper examines the relationship between income inequality and subjective wellbeing for older adults in China, using CHNS data from 2006, 2009, and 2011. We found that increased income inequality is correlated with lower levels of subjective wellbeing; this confirms our first hypothesis (*H1a*). We also found that the effect of income inequality on subjective wellbeing varies across income groups among older adults with urban and rural household registrations.

The effect of inequality on wellbeing is observed when using the fixed-effects estimation, which confirms that by removing time-invariant heterogeneities in counties, we also removed some of the time-constant structural factors associated with the Gini coefficient. It also confirms our second hypothesis (*H1b*): The effect of inequality on wellbeing increases when we control for county characteristics. This means that structural-level characteristics in a county are important when considering the relationship between income inequality and subjective wellbeing. The fixed-effects remove the time-constant heterogeneities in counties, i.e., some of the structural factors that are correlated with the Gini. The stable county-level traits can be different social policies, migrant policies, and labour market relations for people with different *hukou* in a county.

When the sample was separated into subgroups of people with urban versus rural household registrations and different income levels, a negative correlation between inequality and wellbeing was found for urban citizens. The impact of income inequality on wellbeing is stronger among richer urban older adults than among poorer urban older adults. One explanation may be that for the urban Chinese, wellbeing is not as much an issue of actual living conditions as it is for rural Chinese, but more a question of social comparison and weaker social cohesion caused by increased income inequality.

6.2 Regional Heterogeneity

One explanation for that the Gini turned out to be significant when applying fixed-effects is that when controlling for time-invariant county-level characteristics, much of the effects from disturbance variables are removed. These variables may have different impacts on wellbeing, creating statistical noise that may, for example, reduce the size of county-level coefficients. Another explanation is that inequality is significantly associated with some of the time-invariant county characteristics (omitted variables), and therefore coefficients for in inequality in Models 1–3 in Table 2 reflect the effect of the omitted variable in addition to its own effect on wellbeing. When we add the county dummies into Model 4 (in

Table 2), the Gini no longer captures the partial effect of the time-invariant county characteristics; it now reflects its true effect on wellbeing.

Similarly, the coefficient of urban household status turns out to have an impact on wellbeing in the fixed-effect model. Again, this change is expected because the fixed-effects remove the time-invariant heterogeneities in counties, and some of these structural factors may be correlated with the Gini. Household registration status may, to a large degree, reflect structural factors.

6.3 Group Variations

No correlation was found between individual income and wellbeing when all older adults were included in our sample. However, by performing fixed-effects estimations for 50% income deciles in rural and urban China separately, we found that increased income is correlated with higher subjective wellbeing for richer urban and poorer rural older adults. Drawing upon an explanation from the comparative reference group perspective, people in the higher ranks of the income distribution may experience positive feelings when comparing themselves with those who are poorer; downward comparison may bring about higher self-esteem, and thus higher income may correlate with higher levels of wellbeing (Festinger 1954).

For urban people, they may also have positive feelings even when comparing themselves to richer individuals in their own group, since they anticipate becoming as rich as these people (Hirschman and Rothschild 1973). This is also the case for urban citizens with higher income. Higher income may bring about higher status and material privileges; hence, income still has a positive association with wellbeing.

For the poorest income group, it becomes more likely for them to compare their income upwards with a group with a higher income level. Therefore, the higher income, the closer they come to the borderline of a comparison group with higher income group. This may result in lower levels of wellbeing for the most socioeconomically disadvantaged rural older adults. This also suggests a negative association between income and wellbeing for the rural poor.

Furthermore, the idea that the poor suffer more from high inequality suggests that the reference group is constituted by people with a higher income. However, the tendency to compare oneself with others decreases as the difference between oneself and others increases (Festinger 1954), and people at middle or lower income levels may choose other comparison groups. For example, lower urban income groups may compare themselves with higher status urban groups and/or with lower status rural groups. Thus, the effects may even out. The effect of inequality on wellbeing varies more among poorer individuals, which also confirms earlier studies. For example Verme (2011) found that the wellbeing of both the poor and the rich is lowered by inequality, but the effect on poorer individuals are more sensitive.

Finally, the association between income inequality and wellbeing is strong and significant for urban citizens, but not for rural residents. This is in line with Whyte and Im's (2014) findings, indicating that rural residents have a less negative attitude towards inequality, likely due to rapid poverty reduction and income improvement during the market reforms. At the same time, rapid urbanisation, market transition, and increasing inequality in urban China may also cause more stress and hence lower wellbeing for urban citizens.

This also confirms that wellbeing is not only influenced by comparisons made to other people but also to comparisons between one's past and present. In our data, county income

is used as an approximation of economic development. This variable has the most important and robust effect on wellbeing. In other words, the contrast between living conditions under socialist cultivating and family farming may bring about a positive perception of market reforms among rural residents, and this may counteract negative feelings caused by inequality.

6.4 Welfare Support and Economic Development

Other factors may have more important impact on older adults' perceptions of wellbeing. For example, a central difference between rural and urban China is the amount and coverage of welfare services. For rural residences, due to low healthcare provision and the absence of old age pensions, older adults are more socioeconomically disadvantaged. In addition, due to rural-to-urban migration, many older rural adults may have weaker social and family networks than in the past. Higher income is not necessarily one of the most important indicators of higher wellbeing, because an older adult is more likely to have health problems or to be lonely.

We controlled for the average income in a county in the years 2006, 2009, and 2011 as a measure to indicate the economic situation in all counties. County-average income is positively correlated with subjective wellbeing, and benefits more for the more economically privileged social groups. Some earlier studies have argued that because a higher degree of inequality signals better economic development, inequality may therefore have a positive effect on wellbeing (Clark and Senik 2011). Our findings support the idea that economic development contributes to higher levels of wellbeing. However, higher income inequality is still correlated with lower levels of wellbeing, even after controlling for economic development.

Although older adults have experienced rapid social changes to wealthier living conditions, they have also experienced increasing income inequality throughout their lives. Our definition of wellbeing in this study is based on how older adults view their life at present, in addition to how they feel about their current condition compared to the past. Although economic development may indicate higher income and better standard of living, increased income inequality may be an indicator for what older adults' might miss compared to the conditions of the past: a relatively egalitarian society, an ideology that they may find meaningful and generous welfare support.

6.5 Study Limitations

Although we have identified a relationship between income inequality and subjective wellbeing, this does not necessarily mean that the relationship is causal. The estimations take into account all observed and unobserved stable characteristics of the counties, thereby eliminating potentially large sources of bias. By doing this, we can reduce sampling variability and take care of the repeated observations. However, there might be some stable but unobserved variables that are important for wellbeing and inequality. There might also be time-variant factors that are related to both inequality and wellbeing. For example, if the welfare policy has been changed in a county, it may have an equalising effect on income and generate higher levels of wellbeing.

Furthermore, the relationship between inequality and wellbeing may be retro-causal, meaning that wellbeing may also influence inequality (e.g., via selective migration). Such a situation can be relevant when, for instance, people with high levels of wellbeing choose to

move to a county with a higher level of income inequality. Internal migration in China has become one of the most extensive in the world (ILO 2015). In-depth research of selective migration may be needed in future studies, which may advance the understanding of how inequality is connected with subjective wellbeing.

The four variables included in the wellbeing indicator have high index reliability, and there were solid relationships between inequality and these separate variables. However, mixing rather different variables makes interpretation of the connection between inequality and wellbeing less straightforward. Three of the four variables measures respondents' comparison between past and present and therefore have long-term characteristics. The fourth variable measures overall life situation, and can be a short-term, mood-related measure. It can therefore be difficult to conclude whether inequality has a short- or long-term effect on wellbeing. Mixing different time frames can also make it difficult to determine intermediate mechanisms that explain the inequality-wellbeing relationship. Further studies may construct wellbeing measures with a sharper focus on specific explanatory mechanisms of interest.

Moreover, rather than examining individuals' capabilities, we only focused on people's subjective perceptions of their lives. The construction of the wellbeing indicator in this study is practically adapted based on the approachable information in the data set. Future studies may also test the relationship between income inequality and wellbeing using a more comprehensive indicator of wellbeing that covers a wider range of factors measuring both psychological and physical conditions of older adults.

Finally, social comparison theory is referred to when explaining the relationship between wellbeing and inequality, but is not directly measured or tested in this study. This is because comparison includes aspects of subjective evaluation and individual adaption to the current situation, and CHNS does not contain sufficient information about individual cognitive processes, such as choice, expectations, evaluations, and adaptations. Therefore, although we may conclude that the connection between inequality and wellbeing is solid, we cannot identify all explanatory mechanisms. Neither can we account for social comparisons as the only explanatory mechanism intermediating between wellbeing and income inequality. As cognitive aspects are vital to studying wellbeing, this merits further investigation to develop more accurate indicators when assessing cognitive-related behaviours, such as social comparisons.

Appendix 1

See Table 5.

In this analysis, six groups of occupational positions are constructed based on CHNS' original occupation variable (B4). They are:

1. The service class includes "senior professional/technical" (1), "administrator/executive/manager" (3), and "army officer/police officer" (8).
2. The non-manual worker category include "junior professional technical" (2) and "office staff" (4).
3. The group of skilled workers/supervisor include "skilled worker" (6), "ordinary soldier, policeman" (9), "driver" (10) and "athlete, actor, musician" (12).
4. The category of semi-skilled/non-skilled workers includes "non-skilled worker" (7), "service worker" (11).
5. Farmers are as originally defined, coded 5 in the original CHNS data.

6. Other occupation includes the rest of the original occupation: 13–16.

The constructed variable of sector in the analysis has grouped the 8 values in CHNS' original sector variable (B6) into 6 groups:

1. The state sector includes "government" (1), "state service/institute" (2) and "state-owned enterprise" (3).
2. The collective sector includes "small collective enterprise" (4) and "large collective enterprise" (5).
3. The sector of family farming is the origin variable of "family contract farming" (6).
4. The individual enterprise sector is the origin variable "private, individual enterprise" (7).
5. Three-capital enterprise remained the same, coded from (8).
6. Others includes "unknown" (9).

Table 5 Fixed-effects models on wellbeing. Including occupational class and employment sector

	FE model
Individual variables	
Age	− .170 (.387)
Age squared	.001 (.003)
Gender	− .022 (.050)
Single	.663 (.217)***
Majority	.031 (.110)
Years of education	− .005 (.008)
Urban hukou	.012 (.161)
Household size	.043 (.022)*
# elderly in household	.044 (.049)
Sick	− .144 (.060)**
ln Individual income	.006 (.029)
Occupation (ref. = farmer)	
Service class	.192 (.200)
Non-manual worker	.329 (.292)
Skilled-workers/supervisors	− .134 (.279)
Semi-/non-skilled workers	− .036 (.221)
Others	.022 (.234)
Sector (ref. = family farming)	
State	.190 (.188)
Collective	− .074 (.251)
Individual enterprise	− .099 (.196)
Private three-capital enterprise	− 1.091 (.226)***
Others	.191 (.182)
County variables	
ln Gini	− .544 (.302)*
ln County income	.516 (.129)***
N of obs.	1338
N of groups	72

*$p < .10$; **$p < .05$; ***$p < .01$

Appendix 2

See Table 6.

Table 6 Sensitivity test with missing income variable replaced by random value between 0 and 420 yuan

	1	2	3	4
Individual var.				
Age		− .046 (.292)	− .0023 (.277)	− .086 (.275)
Age squared		− .000 (.002)	.000 (.002)	.001 (.002)
Women		.057 (.028)**	.032 (.027)	.033 (.027)
Single		− .144 (.151)	− .052 (.149)	− .060 (.131)
Majority		.113 (.077)	.083 (.071)	.038 (.091)
Education		.014 (.005)**	.009 (.005)*	.013 (.005)**
Urban		.136 (.061)**	.082 (.054)	.145 (.048)***
# Elderly		.027 (.024)	.019 (.025)	.021 (.023)
Household size		.038 (.014)***	− .008 (.014)	004 (.013)
Sick		.142 (.034)***	− .162 (.034)***	− .145 (.033)***
Employed		.073 (.058)	.137 (.056)*	.088 (.051)*
ln Ind. income	.032 (.013)**	.049 (.013)***	.017 (.013)	.012 (.013)
County variables				
ln Gini	− .125 (.137)		− .076 (.137)	− .495 (.247)**
ln County income	.505 (.074)***		.508 (.076)***	.623 (.115)***
Intercept	− 5.275 (.637)***	− 1.815 (9.401)	− 3.059 (9.148)	− 4.079 (8.108)
Fixed-effects	No	No	No	Yes
N of obs.	4252	4252	4252	4252
N of groups	72	72	72	72

Regression on subjective wellbeing (N = 4254, 72 counties)

*$p < .10$; **$p < .05$; ***$p < .01$

Appendix 3

See Table 7.

Table 7 County fixed-effects with multiple imputation (MI) and maximum likelihood with missing value (MLMV)

	MI	MLMV
Individual variables		
Age	− .057 (.251)	− .075 (.112)
Age squared	.001 (.002)	− .000 (.001)
Women	.034 (.031)	.037 (.134)***
Single	− .066 (.133)	− .464 (.055)***
Majority	.032 (.075)	.097 (.031)***
Years of education	.013 (.004)***	.010 (.003)***
Urban	.137 (.045)***	.019 (.002)***
#Elderly	.021 (.022)	.011 (.005)
Household size	.004 (.011)	− .012 (.009)
Sick	− .145 (.031)***	− .247 (.015)***
Employed	.086 (.037)**	.023 (.019)
ln Individual income	.019 (.017)	.001 (.006)
County variables		
ln Gini	− .477 (.129)***	− .278 (.055)***
ln County income	.615 (.043)***	.293 (.018)***
N of obs.	4297	10,126
N of groups	72	72

In the MI model, missing values for individual income were imputed using linear regression. The variables were age, gender, marital status, education, household registration, health status, and employment status. The regression with these variables accounted for 33% of the variance of log income. The imputation was repeated 20 times

The MLMV model uses structural equation modelling with maximum likelihood estimation with robust standard errors and a mean- and variance-adjusted test statistic

The numbers of observations in the MI and MLMV models are different. This is because while the MI-model takes income missing values into account, the MLMV-model is estimated when all missing values for all variables are included. Note that we are not interested in comparing coefficients across the two models. The point for these checks is to examine whether the negative correlation between Gini and well-being remains significant when missing values are taken into account

*$p < .10$; **$p < .05$; ***$p < .01$

Appendix 4: Individual Income Versus Household Income?

In this study, we chose to use individual income instead of household income for several reasons. First, the rapid process of urbanisation in China has diversified the economy, including the occupational structure in rural areas. Although a large proportion of rural people work in the agricultural sector, many also receive individual income, working in townships and other non-agricultural sectors. This is also the case for older adults. Among surveyed individuals in rural areas, 20% were working with 'family contract farming', whereas others worked in the state (20%), collective enterprises (47%), private enterprises (11%) and a few in three-capital enterprises (.3%). For urban older adults, pensions are the most important source of income. For rural elderly, income from their own labour is the most important financial source.

Second, household income may also contain an indirect measure of social support or family network. Because our main interest is in income, we chose to examine how

Table 8 County fixed-effects with individual versus household income

	Individual income	Household income
Individual var.		
Age	−.115 (.290)	−.107 (.280)
Age squared	.001 (.002)	.001 (.002)
Women	.031 (.030)	.026 (.034)
Single	.162 (.159)	.176 (.151)
Majority	.008 (.101)	.009 (.081)
Education	.010 (.006)*	.010 (.005)*
Urban	.182 (.067)***	.180 (.053)***
# Elderly	.034 (.027)	.031 (.025)
Household size	.004 (.014)	.001 (.012)
Sick	−.114 (.035)***	−.119 (.031)***
Employed	.094 (.058)	.099 (.043)
ln income	.020 (.018)	.039 (.022)
County variables		
ln Gini	−.540 (.223)***	−.363 (.131)***
ln County income	.745 (.114)***	.766 (.055)***
N of obs.	3311	3311
N of groups	72	72

In the model to the left, the log Gini is generated based on individual income. In the model to the right, the log Gini is generated based on household income

We limit the analysis to the same sample size in order to make the models comparable

*$p < .10$; **$p < .05$; ***$p < .01$

much money individual older adults earn, as well as control for household size, which provides an approximation for the size of an individual's family network.

We have also tested models based on controlling for individual and household income (see Table 8). The results are very similar. This has also improved the robustness of our models, showing the importance of income inequality on older adults' subjective wellbeing.

Appendix 5: County Fixed-Effects with Different Samples

We have included analysis with separated samples: see Tables 9, 10, 11, 12 and 13. In all models, log Gini is correlated significantly with income inequality. For women, people with lower education, and people with rural household registration, this correlation is significant at 10%. The size of the coefficient does not significantly vary. For models including different samples in Tables 12 and 13, the coefficient does not differ significantly from the original model. The effect is particularly strong for people with high education, and people with an urban household registration, meaning that income inequality is even more harmful to the wellbeing of these two social groups.

For all models, county average income is significantly correlated with wellbeing, indicating the importance of economic development on wellbeing. Being healthy is correlated with better health, but for people with urban household registration the association is not significant. This may be due to the privileged healthcare programmes for urban citizens.

When excluding people with the lowest level of wellbeing, the effect of health also loses its significance.

Finally, individual income only has an impact on wellbeing for women, for those with higher education, for those with urban household registration, when excluding the lowest scores for wellbeing, and excluding those with the lowest income.

Table 9 Gender

	Women	Men
Individual var.		
Age	− .502 (.426)	− .231 (.347)
Age squared	.004 (.003)	.002 (.003)
Single	.200 (.258)	.393 (.170)***
Majority	.130 (.118)	− .044 (.123)
Education	.012 (.010)	.007 (.008)
Urban	.086 (.104)	.254 (.073)***
# Elderly	.044 (.042)	.029 (.022)
Household size	− .013 (.021)	.022 (.016)
Sick	− .096 (.050)*	− .124 (.044)***
Employed	.050 (.084)	.137 (.062)**
ln income	.046 (.025)*	.007 (.023)
County variables		
ln Gini	− .446 (.250)*	− .585 (.243)**
ln County income	.572 (.132)***	.869 (.112)***
N of obs.	1431	1878
N of groups	71	72

*$p < .10$; **$p < .05$; ***$p < .01$

Table 10 Education

	Lower education (0–6 years)	Higher education (> 6 years)
Individual var.		
Age	− .258 (.399)	.112 (.396)
Age squared	.002 (.003)	− .001 (.003)
Gender	− .001 (.039)	.085 (.044)*
Single	.420 (.233)*	− .143(.223)
Majority	.172 (.142)	− .119 (.090)
Urban	.142 (.143)	.145 (.078)*
# Elderly	.047 (.033)	.011 (.040)
Household size	.011 (.019)	.007 (.022)
Sick	− .108 (.054)**	− .117 (.041)***
Employed	.119 (.065)*	.069 (.072)
ln income	.000 (.021)	.078 (.030)**
County variables		
ln Gini	− .461 (.271)*	− .709 (.253)**
ln County income	.527 (.123)***	1.127 (.131)***
N of obs.	1741	1562
N of groups	64	71

*$p < .10$; **$p < .05$; ***$p < .01$

Table 11 Household registration

	Rural	Urban
Individual var.		
Age	− .223 (.415)	.182 (.351)
Age squared	.002 (.003)	− .001 (.003)
Gender	.044 (.048)	.056 (.037)
Single	.476 (.165)***	− .160 (.208)
Majority	.069 (.155)	− .020 (.124)
Education	.013 (.008)*	.001 (.009)
# Elderly	.049 (.034)	− .012 (.040)
Household size	.020 (.018)	− .003 (.026)
Sick	− .234 (.071)***	− .057 (.046)
Employed	.093 (.076)	.086 (.078)
ln income	.006 (.022)	.129 (.037)***
County variables		
ln Gini	− .433 (.250)*	− .842 (.283)***
ln County income	.466 (.115)***	1.175 (.148)***
N of obs.	1619	1686
N of groups	59	69

*$p < .10$; **$p < .05$; ***$p < .01$

Table 12 Wellbeing

	(a) Wellbeing score (> 5)	(b) Wellbeing score (< 12)	(c) Wellbeing score (6–11)
Individual var.			
Age	− .341 (.256)	− .043 (.275)	− .039 (.271)
Age squared	.003 (.002)	.000 (.002)	.000 (.002)
Women	.020 (.026)	.030 (.032)	.033 (.031)
Single	.290 (.134)**	.163 (.143)	.157 (.142)
Majority	.007 (.077)	− .007 (.084)	− .006 (.084)
Education	.004 (.006)	.005 (.006)	.006 (.006)
Urban	.139 (.056)**	.082 (.067)	.076 (.067)
# Elderly	.043 (.027)	.013 (.023)	.012 (.023)
Household size	.017 (.013)	.008 (.013)	.009 (.013)
Sick	− .106 (.029)***	− .049 (.032)	− .047 (.032)
Employed	.050 (.051)	.095 (.055)*	.091 (.056)
ln Ind. income	.035 (.019)*	.001 (.017)	.002 (.017)
County variables			
ln Gini	− .498 (.202)**	− .537 (.191)***	− .534 (.191)***
ln County income	.672 (.098)***	.394 (.086)***	.389 (.086)***
N of obs.	2982	2682	2679
N of groups	72	72	72

The model to the left (a) includes people with wellbeing score 6–16

The model in between (b) includes people with wellbeing score 0–11

The model to the right (c) includes people with wellbeing score 6–11

*$p < .10$; **$p < .05$; ***$p < .01$

Table 13 Income

	(a) Income > ¥1200	(b) Income < ¥29,943.28	(c) Income ¥1200–29,943.28
Individual var.			
Age	− .027 (.280)	− .118 (.303)	− .033 (.291)
Age squared	.000 (.002)	.001 (.002)	.000 (.002)
Women	.035 (.032)	.023 (.031)	.027 (.033)
Single	.143 (.170)	.189 (.157)	.171 (.168)
Majority	− .005 (.100)	− .034 (.103)	− .025 (.101)
Education	.008 (.006)	.005 (.006)	.003 (.007)
Urban	.190 (.067)***	.165 (.065)**	.162 (.065)**
# Elderly	.045 (.028)	.041 (.029)	.053 (.030)
Household size	.006 (.015)	.003 (.015)	.005 (.015)
Sick	− .113 (.038)***	− .105 (.037)***	− .102 (.040)**
Employed	.096 (.060)	.078 (.062)*	.082 (.065)
ln Ind. income	.085 (.026)***	.023 (.020)	.106 (.032)***
County variables			
ln Gini	− .566 (.229)**	− .543 (.218)**	− .557 (.226)**
ln County income	.780 (.114)***	.699 (.111)***	.723 (.113)***
N of obs.	3043	2988	2721
N of groups	72	72	72

The model to the left (a) includes people with income above the lowest 10% (1200 yuan)

The model in between (b) includes people with income below the highest 10% (29,943.28 yuan)

The model to the right (c) includes people with income between 1200 and 29,943.28 yuan

*$p < .10$; **$p < .05$; ***$p < .01$

Appendix 6: Control for Adaptive Expectations

Adaptive preferences can have important impact on wellbeing. This robustness check tests the relation between inequality and wellbeing when controlling for adaptive preferences, using changes over time as a proxy.

Model A in Table 14 shows the fixed-effects model with standardised wellbeing as the outcome variable. In this model, we added a variable of income change between waves ($\Delta income = income_{t+1} - income_t$). Both inequality and income changes correlate significantly with wellbeing. Although controlling for income change, the association between income inequality and wellbeing remains solid.

The coefficient of inequality (− .715) has increased in size, compared to the original coefficient (− .540). One explanation is that income changes have reduced the unexplained variability. Another explanation of the increased Gini is multicollinearity. Income change is highly correlated with individual income, with a Pearson's R equals to .81. This violates the assumption of instance independence and may raise serious problems.

Therefore, we have also constructed a set of dummy variables to measure income development throughout the three waves See Table 15. If income has increased from a previous wave to a subsequent wave ($Income_{t+1} - Income_t > 0$), the income change is then defined as positive. Similarly, a negative change means that income has decreased between two

Table 14 Fixed-effects models with income changes and income development included as controls

	(A)	(B)	(C)
Individual var.			
Age	− .115 (.290)	− .378 (.415)	− .089 (.291)
Age squared	.001 (.002)	.003 (.003)	.001 (.002)
Women	.031 (.030)	.105 (.049)**	.030 (.030)
Single	.162 (.159)	.132 (.236)	.192 (.155)
Majority	.008 (.101)	− .024 (.148)	− .023 (.101)
Education	.010 (.006)*	.013 (.009)	.010 (.006)*
Urban	.182 (.067)**	.207 (.098)**	.178 (.067)***
# Elderly	.034 (.027)	.026 (.041)	.034 (.027)
Household size	004 (.014)	.003 (.027)	.005 (.014)
Sick	− .114 (.035)***	− .119 (.044)***	− .112 (.034)***
Employed	.094 (.058)	.053 (.078)*	.095 (.059)*
ln Ind. income	.020 (.018)	.311 (.126)**	.020 (.018)
County variables			
ln Gini	− .540 (.223)**	− .715 (.345)**	− .525 (.223)**
ln County income	.745 (.114)***	1.160 (.149)***	.733 (.115)***
Adaptive preferences			
Income change		− .089 (.043)**	
Income development (reference: Group 1)			
Group 2			− .035 (.100)
Group 3			− .021(.045)
Group 4			− .565 (.254)**
Group 5			.115 (.132)
Group 6			− .232 (.032)***
Group 7			− .194 (.053)***
Group 8			− .736 (.067)***
Group 9			.127 (.098)
N of obs.	3043	1255	3310
N of groups	72	72	72

Model A: The original fixed-effects model (see Model 4 in Table 2)

Model B: Fixed-effects model controlling for income changes

Model C: Fixed-effects model controlling for income development

*$p < .10$; **$p < .05$; ***$p < .01$

waves ($Income_{t+1} - Income_t < 0$). A constant income development is indicated by a stable income ($Income_{t+1} - Income_t = 0$). Changes in income between waves are divided into the following categories:

These dummies illustrate the development of income changes. The development can be stable without a turning point, for example, for those whose income increased both in the 2006–2009 and 2009–2011 periods. Some other individuals experienced unstable development with a turning point, as, for example, those whose income increased in 2006–2009, but flattened in 2009–2011.

Table 15 Income development: changes in income in period 2006–2009 and 2009–2011

Group	$Income_{09} - Income_{06}$	$Income_{11} - Income_{09}$	Summary: changes 2006–2009–2011	Turning point
1	Positive (↑)	Positive (↑)	2006 ↑ 2009 ↑ 2011	No
2	Positive (↑)	Constant (→)	2006 ↑ 2009 → 2011	Yes
3	Positive (↑)	Negative (↓)	2006 ↑ 2009 ↓ 2011	Yes
4	Constant (→)	Positive (↑)	2006 → 2009 ↑ 2011	Yes
5	Constant (→)	Constant (→)	2006 → 2009 → 2011	No
6	Constant (→)	Negative (↓)	2006 → 2009 ↓ 2011	Yes
7	Negative (↓)	Positive (↑)	2006 ↓ 2009 ↑ 2011	Yes
8	Negative (↓)	Constant (→)	2006 ↓ 2009 → 2011	Yes
9	Negative (↓)	Negative (↓)	2006 ↓ 2009 ↓ 2011	No

By using these dummies, we can assess the eventual adaptive preference change. If adaptive expectation plays a significant role in wellbeing, we may assume that, if the income development has been consistent over all three waves, people would have less reason to adjust their expectations/preferences based on economic reasons. On the other hand, if a turning point is observed, the expectations/preferences of the corresponding group of people are more likely to change, in order to face uncertain economic situations.

Incorporating the dummy variables into the fixed-effects model does not influence the relationship between Gini and wellbeing (Model C in Table 14). The size of the coefficient has been reduced minimally. In fact, model C and model A are very similar (almost identical). Compared to people with continuously increased income during all three waves (the reference group), wellbeing decreased significantly for people with constant or decreased income during the first two waves, but experienced changes (both positive and negative) in the third wave (categories 4, 6, 7, and 8).

A final sensitivity test is to separate the sample into two groups: people who have experienced a turning point (categories 2, 3, 4, 6, 7, and 8 in Table 15), and those who have not (categories 1, 5, and 9 in Table 15). Fixed-effects models are carried out to test the relation between inequality and wellbeing separately for these two samples. In Table 16, Model D is the fixed-effects model with the sample for people experiencing changes/turning point, while Model E is estimated for people with the same development trend throughout the three waves. The log Gini is stronger for people with stable income development, which may confirm the effect of adaptive preferences on wellbeing. However, the relation between inequality and wellbeing remains strong and significant for both samples, which is in line with our findings.

One alternative is to divide the sample further, into people with a top turning point (upward curve) and people with a bottom turning point (downward curve). However, less than four percent of the observations experienced an upward curve. With such a small sample size, it is difficult to incorporate the fixed-effects models.

Nevertheless, we have tested two subgroups that had sufficient sample observations. Most of the observations have experienced continuously increased income throughout all three waves (83.76%). For this group, wellbeing decreases with .63 standard deviations with one percent increment of the Gini coefficient, controlled for all other covariates. The next largest group is people who have experienced increased income in 2006–2009, but decreased income in 2009–2011 (10.30%). In other words, a group of people experienced a downward curve in income development. For this group, wellbeing decreases by .60 standard deviations with each percentage increment of Gini, holding all other variables constant.

Table 16 Fixed-effects models with separated samples of income changes

	(D)	(E)
Individual var.		
Age	1.436 (.746)*	– .343 (.424)
Age squared	– .011 (.006)*	.003 (.002)
Women	– .089 (.072)	.067 (.036)*
Single	.249 (.213)	.085 (.186)
Majority	– .186 (.185)	.087 (.116)
Education	.008 (.011)	.011 (.006)
Urban	.036 (.145)	.209 (.076)***
# Elderly	.080 (.073)	.015 (.028)
Household size	– .026 (.035)	015 (.028)
Sick	– .167 (.079)***	– .103 (.039)***
Employed	.101 (.114)	.083 (.067)
ln Ind. income	.046 (.044)	.015 (.020)
County variables		
ln Gini	– .457 (.251)**	– .576 (.245)**
ln County income	.698 (.140)***	.772 (.116)***
N of obs.	735	2574
N of groups	72	53
N of distinct obs.	354	1917

Model D: With sample of people who have experienced a turning point in income development throughout the three survey waves

Model E: With sample of people who have NOT experienced a turning point in income development throughout the three survey waves

*.10; **.05; ***.01

Appendix 7: Control for Household Assets

Wealth is an important factor for an individual's subjective wellbeing. Three variables are constructed to approach wealth in this robustness test. These are: (a) total value of items (that are available from the survey) owned by the household; (b) value of the dwelling a person currently lives in, if it is also owned by her/him (minus bank loan); and (c) the sum of (a) and (b).

The items owned by the household are:

1. Household electrical appliances, including VCR, television, washing machine, refrigerator, air conditioner, sewing machine, electric fan, computer, camera, microwave oven, electric rice cooker, pressure cooker, telephone, cell phone, VCD or DVD player, and satellite dish;
2. Means of transportation, including tricycle, bicycle, motorcycle, moto-tricycle, and automobile;
3. Farm machinery, including tractor, garden tractor, irrigation equipment, power thresher, household water pump, and others;
4. Household commercial equipment, including cooking equipment, carpentry equipment, haircutting equipment, sewing machine, small machine shop tools or equipment, and others.

Table 17 Descriptive statistics for the wealth variables

Variable	Mean (SD)	Min/Max	N
Wealth	.027 (.252)	0/9.191	60,371
House	.025 (.246)	0/9	60,371
Household items	.002 (.019)	0/.928	60,860

Table 18 Fixed-effects models predicting wellbeing, controlled for wealth

	(a)	(b)	(c)
Individual var.			
Age	− .150 (.310)	− .145 (.310)	− .142 (.286)
Age squared	.001 (.002)	.001 (.002)	.001 (.002)
Women	.024 (.029)	.024 (.029)	.031 (.030)
Single	.270 (.147)*	.269 (.147)*	.171 (.159)
Majority	.034 (.107)	.034 (.107)	.009 (.102)
Education	.006 (.006)	.006 (.006)*	.009 (.006)*
Urban	.170 (.071)**	.171 (.071)**	.183 (.067)***
# Elderly	.011 (.029)	.012 (.029)	.031 (.027)
Household size	.008 (.014)	.009 (.014)	.001 (.014)
Sick	− .119 (.040)***	− .119 (.040)***	− .117 (.035)***
Employed	.097 (.061)	.096 (.061)	.096 (.059)
ln Ind. income	.023 (.019)	.023 (.019)	.019 (.018)
County variables			
ln Gini	− .513 (.232)**	− .517 (.233)**	− .529 (.221)**
ln County income	.711 (.110)***	.713 (.111)***	.739 (.113)***
Wealth variables			
Wealth	.092 (.029)***		
House		.089 (.029)***	
Household items			.661 (.342)*
N	3043	3043	3310

Model a: Fixed-effect estimation of standardised wellbeing by including total wealth

Model b: Fixed-effect estimation of standardised wellbeing by including the house value

Model c: Fixed-effect estimation of standardised wellbeing by including total values of household items

*.10; **.05; ***.01

The descriptive statistics are shown below. Notice that, in order to provide a more intuitive interpretation of the coefficient, we have divided the wealth-related variables by 1,000,000 (Table 17).

These proxies for wealth are tested as control variables with fixed-effects estimations. These variables do not influence the relation between wellbeing and inequality, and the results are very similar to the original model in the manuscript (see Table 18). Therefore, it strengthens our conclusion.

Appendix 8: Some Additional Discussions

Marital Status

In Model 2 (Table 2 in the article), marital status is not significantly associated with wellbeing, and this may be caused by the small sample size for the group of single older adults. Out of a total of 3311 observations included in the models, only 112 observations (87 distinctive individuals) are single. This is only one per cent of the total sample size. With so few observations, estimations lose power. Because of the small sample size, there are also large variations within this group of single people. The standard error for the single group (.44) is more than ten times larger than that for the group of married people. Therefore, there is no significant difference between single and married people in terms of their level of wellbeing.

It is worth noting that in the robustness check (Table 4), although marital status is still not significant, the effect size of this variable seems to be more correct—the coefficient of having a single status turned out to be negative.

The Family Structure

In this study, we did not find a significant correlation between household size and older adults' wellbeing. One hypothesis is that income inequality may confound this relationship. Income inequality can cause higher levels of stress for older adults because it contributes to more pressure, a more fast-paced lifestyle, competition at work and lower levels of social cohesion (Wilkinson 2006). At the same time, bonds among household members may be weakened by greater inequality (Ge and Shu 2001).

Family members living in a place with high inequality may also face more pressure from an increasingly competitive work environment and thus spend less time with the elderly. For urban citizens, inequality means a high-tempo, stressful lifestyle and a competitive labour market. For rural residents, higher inequality may symbolise a higher degree of neoliberal thought and greater workforce mobility. In places where inequality is high, more younger family members in poorer rural households may find work in nearby cities and thus spend less time with the elderly.

Furthermore, family structures have changed; nuclear families are on the rise (Whyte 2003), a large population of rural migrant workers has moved away from their older parents (Whyte 2010), and there is a decline in patrilocal and multigenerational co-residence (Zeng and Wang 2004; Hu and Peng 2015). Increasing inequality has brought about enormous changes for older adults, not all of which are positive. It would be interesting for further studies to examine how inequality correlates with wellbeing for different types of households, taking migration into account.

Finally, how much time children spend with their parents could be an important indicator for measuring the effects of older adults' social networks. Questions about contact hours were included in the survey, but there are important limitations that prevented us from using this data in the analysis. Only women under 52 years old who were 'married, widowed, or divorced' were asked about how much time they spend taking care of their parents. This has excluded all men's contact with their parents, as well as data about older women. It is also difficult to calculate the total amount of time each older adult has received from all children and children-in-law, since the data can only identify family relationships *within* each household.

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