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DOES MIGRATION MATTER? THE IMPACTS ON SENIOR FOOD AND NUTRITION SECURITY IN RURAL CHINA

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Abstract

Dramatic economic development in China has been associated with increasing rural-urban migration in the past decades. However, while most elders were left behind in rural hometowns, it is unclear whether the family members' migration impacts their food and nutrition security. Drawn from the panel data from the China Health and Nutrition Survey between 2000 and 2011, this is the first study conducted in China to explore these impacts, specifically on rural elders. The results highlight some degree of improvement in elders' food quantity, but not overall quality. Therefore, it is suggested that more attention needs to be paid to disadvantaged seniors' food and nutrition security in rural China.
Keywords: *senior, food security, migration, nutrition, China.*
JEL Codes: J14, Q18.

1. Introduction

Since the 1980s, China has experienced mass rural-urban migration. With the rapid development of industrial and commercial industries in the coastal areas, the demand for labor has driven farmers' migration both interprovincially and intraprovincially from central and western regions. In 2018, China was home to an estimated 288.36 million rural migrant workers, more than one-third of the entire working population (National Bureau of Statistics, 2019).

This migrant pattern has generated impacts on household members. Due to high urban living and childcare costs, migrant workers often leave children behind with relatives, most often grandparents, for years. Evidence pointed out that adult members' migration not only negatively affects children's health outcomes (Wen and Lin 2012; Gao et al. 2010; Lee 2011) and educational attainments (Meyerhoefer and Chen 2011; Hu 2012) but also has placed added burdens on the growing number of rural elders. China is facing a period of accelerated aging, and the elderly population aged 60 and above reached 249 million in 2018 (National Bureau of Statistics of China, 2019). While one-fourth of elders' income relied on the children's financial support, this income source is essential for the rural elders, which takes up 39.4%, compared to 7.4% of the urban ones (China Longitudinal Aging Social Survey 2014).

The prevalence of undernourishment in China has dropped from 15.5% (in 2004) to 8.5% (since 2016). However, the overall number of undernourished, 122.4 million, remains a challenge (FAOSTAT, 2018). While the number of migrant workers has increased, the impact on household food expenditure in China is mixed (Démurger and Wang 2016; Snyder and Chern 2008). It is unclear, though, whether the offspring's migration affected the elders' food security in terms of nutritional status in particular.

Using data from the China Health and Nutrition Survey (CHNS) between 2000 and 2011, this paper contributes to bridging the current research gap in examining the causal effects of

rural-urban migration on food and nutrition security. To the best of my knowledge, this study is the first conducted in China to explore these impacts, specifically on rural elders. The results indicated that migration positively affects the elders' food intake in quantity but has no impact on overall diversity. This finding adds to the growing body of research that indicates the underlying impacts of migration on the Chinese elders' physical and mental health (Ao, Jiang, and Zhao 2016; Song 2017; Guo, Aranda, and Silverstein 2009; Yi, Liu, and Xu 2019). Moreover, while previous studies demonstrated mixed effects of international remittances on household food security (Regmi and Paudel 2016; Babatunde 2018; Mabrouk and Mekni 2018), the findings offer some critical insights into understanding the effects differ from dietary quantity to quality.

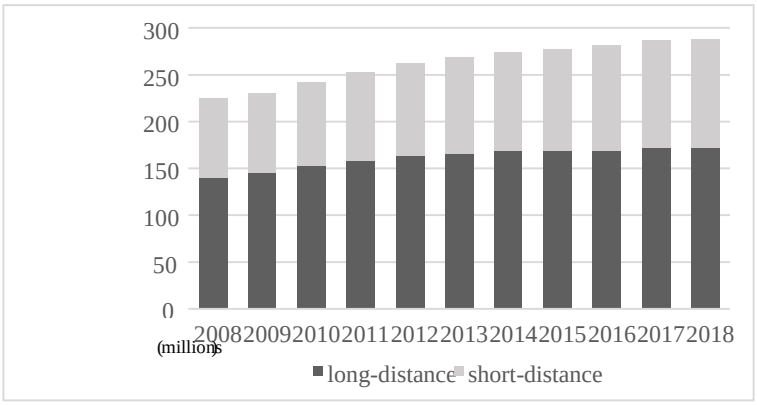
The remainder of this paper proceeds as follows. Section 2 describes the background of China's rural-urban migration and rural elders' food security status. Section 3 introduces the panel data and the summary statistics of observations in the analysis. Section 4 then presents the empirical framework. Next, section 5 discusses the primary results. The final section, section 6, concludes and provides policy implications.

2. Literature Review

2.1 Rural-Urban Migration in China

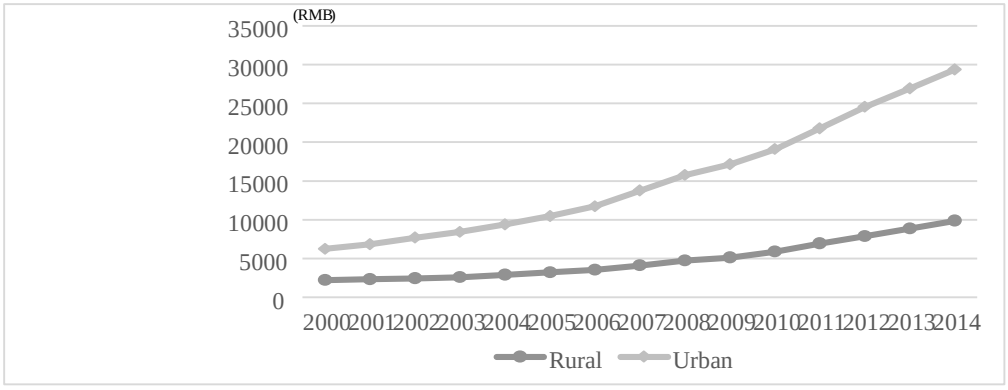
Aimed at regulating the flow of population and controlling the distribution of resources, China's household registration (hukou) policy allows residents to receive social welfare benefits within their respective registered locations, either rural or urban. Without transferring the hukou status but changing their residences, rural migrant workers are those with a rural hukou but who work and reside in urban areas. In the past decade, the number has increased by 62.9 million and is increasing at a stable rate[1](Figure 1). In 2018, 59.88% of total migrant workers were long-distance migrants, of which 75.94 million were moving to other provinces, and 96.72 million were moving within the province (National Bureau of Statistics of China, 2019). On average, the long-distance migrants, who migrated within the province or to other provinces, are younger than those migrating within the county (35.2 years old, compared to the overall average 40.2), of which 69.9% are less than 40 years old. In addition, the wage of the long-distance workers is higher than that of the short-distance workers. Rural migrant workers are most likely employed in manufacturing, construction, and repair and maintenance sectors.

The widening income gap between urban and rural areas partly explains why people migrate (Figure 2). Rural migrant workers cannot fully enjoy the same public services as urban residents in terms of labor insurance, social security, and medical insurance. Thus, most migrant workers have no choice but to leave their families behind – generally, the elders and children. Although the wage of migrant workers has increased steadily in the past decades, the wage ratio was only 55% to that of permanent employees[2] in 2008 (Lu, 2012), and the long-term trend showed a consistent wage gap. The lower wage will affect not only the life quality of the workers themselves but also their left-behind families in their hometowns via remittances.



Source: National Migrant Workers Monitoring Survey Report (National Bureau of Statistics of China)
Note: short-distance migrant workers refer to those migrating within the county, while long-distance ones are those moving within the province or to other provinces.

Figure 1 Number of Migrant Workers in China



Source: China Statistical Yearbook (National Bureau of Statistics of China)
Note: The data before 2014 were measured on the same basis, thus the most recent information was not reported.

Figure 2 Household Income per Capita in Urban and Rural Area

2.2 Food Security in China

China has recognized food security as a national issue[3]. Using the national-level data, Nie, Bi, and Zhang (2010) identified that poor rural counties, mostly concentrated in the country's western region, are the most vulnerable to food insecurity. The poor are more likely to have difficulties accessing food, and undernutrition is also more prevalent (Wong, Chan, Chui, Sutcliffe, & Wong, 2014; Zhou, 2010). For example, children in the poorest households are prone to nutritional deprivation and food insecurity (Hannum, Liu, and Frongillo 2014). In

addition, household dietary intake is generally more diverse in urban China than rural areas (Wang et al. 2016).

Income growth is one of the factors that can change diet behaviors and nutritional outcomes (Du et al. 2004; Garrett and Ruel 1999). Some found positive effects of remittances on food expenditures in China (Snyder and Chern 2008; Wang 2013), and it is crucial to the poor's welfare (Zhu et al. 2014). However, the relationship between international remittances income and household food security are mixed in developing countries. For example, while Regmi and Paudel (2016) presented an increase in household food security in Bangladesh, Babatunde (2018) showed the impacts only on calorie supply but no significant change on diet quality, micronutrient supply, and child nutritional status in Nigeria. Mabrouk and Mekni (2018) even proposed a negative link between remittances and food availability in African countries.

Elders' food security is worthy of attention since it relates to their health outcomes, a costly social issue. For example, Lee et al. (2011) showed that dietary diversity score is a well-predictive indicator for elders' mortality. In addition, while a handful of research uncovered that children's migration increases the risk of the left-behind elders being in poor health (Evandrou et al. 2017; Connelly and Maurer-Fazio 2016; Song 2017; Ao, Jiang, and Zhao 2016), impacts on the elders' food security are still considerably understudied.

2.3 Linking Migration and Food Security

The relationship between migration and food security has been discussed worldwide (FAO, 2018; Laborde, Bizikova, Lallemant, & Smaller, 2017). Both international and internal migration patterns are connected to the household's desire for economic and food security, either directly or indirectly. For instance, the entire household migrates to escape hunger directly; migrant workers seek better employment opportunities to indirectly help the household cope with income and food insecurity (FAO 2018). Azzarri and Zezza (2011) present a schematic framework of how migration affects household food security. The five main channels applied in the existing literature include income and remittances, household compositions, consumption smoothing, health and nutrition knowledge, and household time allocation.

Accounting for the limited information in the CHNS data, I am not going to explore the mechanisms in this paper. However, it is worthy of understanding how the channels exist before exploring the causal research question. On the one hand, direct income channels such as remittances and insurance enable the household to smooth their consumption and adjust their food availability (Snyder and Chern 2008; Wang 2013). On the other hand, the effects of the decision-making roles in the household seem to be more indirect. Previous studies have shown that after migrant men moved out for employment, the left-behind women tend to allocate the household resources differently (Powell and Ansic 1997; Quisumbing and Maluccio 2000; Kennedy and Peters 1992), such as increased expenditure on food. Taken together, these studies indicate that there is an underlying relationship through which migration affects rural food security.

3. Data and Summary Statistics

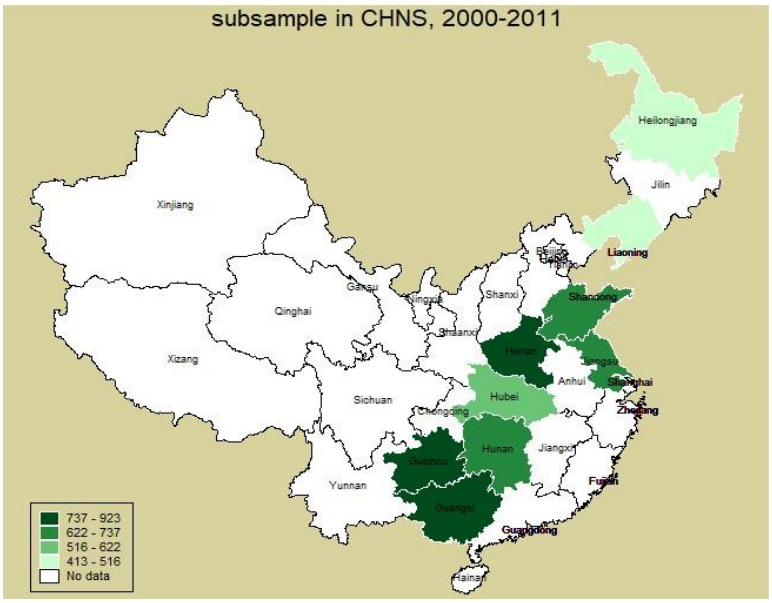
3.1 Data

The data used in this paper are from the CHNS, a longitudinal survey conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health at the Chinese Center for Disease Control and Prevention (CCDC). By adding new communities and households to replace those no longer participating

in the sample and expanding surveyed provinces in later waves, the survey covers nine provinces and three municipalities from 1989 to 2015.

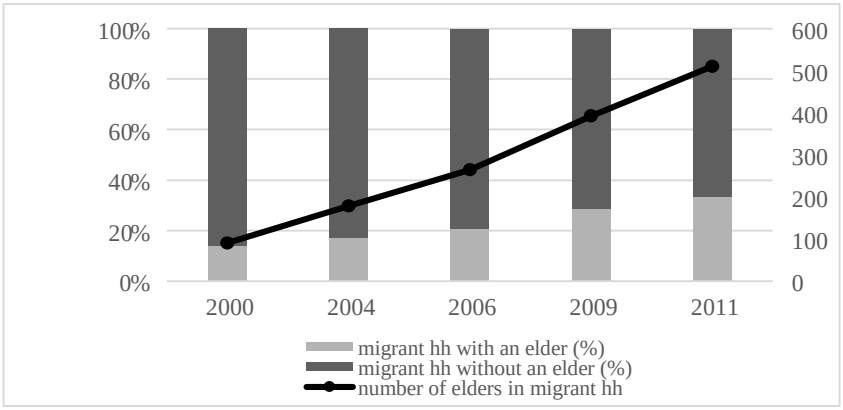
CHNS comprises a comprehensive design, including questions about individual health, nutritional status, and socioeconomic status at community, household, and individual levels. The survey employs a multistage and random cluster design in drawing the sample. The counties were stratified by income and randomly selected based on a weighted sampling scheme. A particular part of the CHNS is a three-day food dietary record of each household member, combining the food code from the Chinese Food Composition Table (FCT), which generates a great deal of information to address food security issues. Three versions of FCT were used to code the food intake in different survey waves.

The data used in this study were conducted in 2000, 2004, 2006, 2009, and 2011[4]. For this research, the elderly population (elders) is defined as citizens aged greater than or equal to 60 years old. The migrant household is recognized if at least a household member migrates for employment. In order to identify the effects of the household rural-urban migration, only rural elderly participants who were involved in at least two waves of the CHNS during this period were included in the study. In this case, the rural area is defined as a town, county capital city, or rural village. Also, I used the dietary records in the CHNS to derive food and nutrition security indicators. The demographic and other data allow me to support and elaborate on the findings.



Source: Author calculated with subsample in the research
Note: Different colors indicate the numbers of observations in the subsample.

Figure 3 Subsample in the CHNS



Source: Author calculated with subsample in the research
Note: There are 511 elders living in the migrant household in 2011. The number of migrant households having at least one elder has increased from 13.73% in 2000 to 33.55% in 2011.

Figure 4. Elders in migrant household

There are 6,136 observations for the rural elders across nine provinces in the subsample (Figure 3). The observations remaining in the subsample for two waves, three waves, four waves, and all waves are 7.7%, 10.9%, 16.4%, and 65.0%, respectively. During the period of this research, more than three-fourths of migrant households were composed of young family members only. However, the number of migrant households having at least one elder residing in the house has increased from 13.73% in 2000 to 33.55% in 2011 (Figure 4). The number of elders living in migrant households increased from 13.02% to more than 30.24% of the rural elderly population, which again intrigued the research interests whether there exists an impact on the elders who have migrant members in the household.

3.2 Measuring Food and Nutrition Security

Among a wide range of indicators to measure food security (Burchi and De Muro 2016; Leroy et al. 2015; Pérez-Escamilla and Segall-Corrêa 2008), this paper used the commonly applied methods proposed by the Food and Agriculture Organization of the United Nations (FAO) and the United Nations World Food Programme (WFP). The FAO suggested tracking food consumption over 24 hours to develop household and individual diversity scores (HDDS and IDDS[5], respectively). Similarly, based on a seven-day period, the WFP provided a weight on each type of food to calculate a composite food consumption score (FCS[6]). Both indicators were derived to capture food access and nutrient adequacy. The current research adjusts these indicators to fit into the available time units in the CHNS. For instance, an adjusted IDDS is the average intake within three days. Besides, total energy consumed is compared with elders' energy requirement proposed by World Health Organization (WHO, 1985) and the Chinese Nutrition Society (CNS, 2014) to determine if food availability is satisfied. In addition, caloric consumption from carbohydrates, protein, or fat is also included to measure their food intakes. Finally, dietary data are aggregated to show whether the individual food security status is consistent with that indicated at the household level. The above indicators are summarized in Table 1.

Table 1. Indicators of Food and Nutrition Security

Indicators	Components / Definitions	References
Individual level		
Individual Dietary Diversity Score (IDDS)*	12 food groups	FAO (2010)
Daily energy requirement	Energy requirements in kilocalorie, by gender, age, and activity level	WHO (1985)[7]; CNS (2014)
Total calorie intake	Kilocalorie consumed per day	De Brauw and Mu (2011)
Shares of carbohydrate, protein, or fat in total calories intake	Proportion of daily energy consumption from carbohydrate, protein, or fat	De Brauw and Mu (2011)
Household level		
Household Dietary Diversity Score (HDDS)*	12 food groups	FAO (2010)
Food Consumption Score (FCS)*	9 food groups	WFP (2008)

Source: Author collected from the listed references.

Table 2 presents the summary statistics of the main variables used in the analysis, separately for migrant and non-migrant households. Pairwise tests of differences between these groups were conducted. The elders in non-migrant households are slightly older than those in migrant households. Since China did not implement nine-year compulsory education until 1986, most rural elders did not finish school beyond primary education. Still, elders in non-migrant households have attained slightly higher education levels than the migrant households.

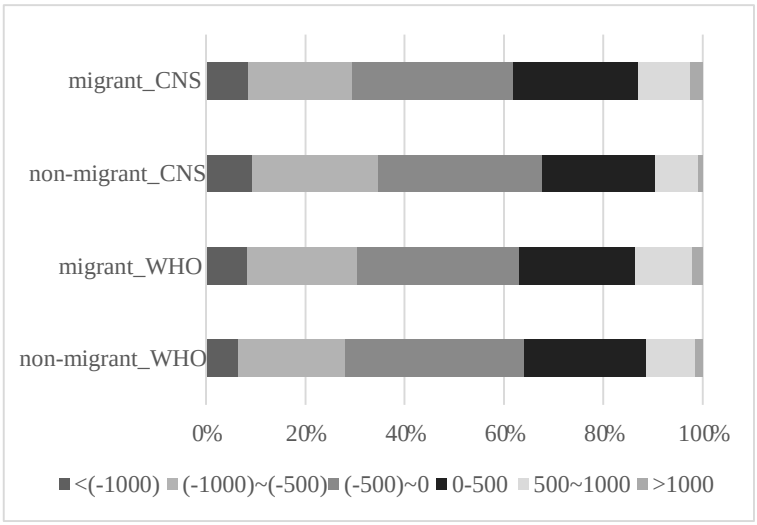
The non-migrant households have somewhat better household socioeconomic conditions than migrant households, implying negative-selection migration. Migrant households have a larger family size, with more children and working-age household members. While household assets are similar between the two groups, it is worth considering that migrant households have a somewhat larger family size, reflecting a relatively limited resource level for each migrant household member. Also, non-migrant households tend to have better water access and sanitary conditions at home. Among the survey regions, 84.29% of migrant households are located in rural villages, where a higher proportion of households engage in farming. While there are relatively limited employment opportunities in remote areas, it is expected that younger household members are more likely to migrate for better earning potential to raise the large household.

Table 2 is quite revealing that there exist differences in dietary outcomes between elders in migrant and non-migrant households. Regarding food availability, elders in migrant households consume more calories from carbohydrates, protein, fat, and total. This fact can be supported by Figure 5, where I measure the gap of actual food intake to energy requirement.

Table 2. Summary Statistics of Elders in Migrant and non-migrant Households

VARIABLES	Non-migrant households	Observations	Migrant households	Observations	t-Test
Individual Characteristics					
Age	68.315 (6.526)	4,697	67.398 (6.595)	1,439	4.656***
Gender (1=Male)	0.452 (0.498)	4,697	0.443 (0.497)	1,439	0.561
Educational years	4.043 (4.027)	4,604	3.562 (3.550)	1,420	4.041***
Married	0.733 (0.443)	4,697	0.703 (0.457)	1,439	2.234**
Household Characteristics					
Household size	2.807 (1.611)	4,590	5.097 (1.806)	1,419	-45.435***
Asset per capita (log)	6.413 (2.068)	4,619	6.460 (1.638)	1,420	-0.774
Number of children (age<16)	0.433 (0.723)	4,697	0.834 (0.944)	1,439	-17.037***
Number of working-age members (age 16-59)	0.710 (1.052)	4,697	0.905 (1.076)	1,439	-6.111***
Farm household	0.356 (0.479)	4,697	0.595 (0.491)	1,439	-16.441***
Access to tap water	0.740 (0.439)	4,697	0.715 (0.452)	1,439	1.892*
Access to flush toilet	0.344 (0.475)	4,697	0.293 (0.455)	1,439	3.597***
Dietary Outcomes					
Kilocalorie	1944.213 (602.432)	4,549	2055.887 (632.629)	1,390	-5.977***
ln(kilocalorie)	7.524 (0.318)	4,549	7.580 (0.318)	1,390	-5.735***
Kilocalorie from Carbohydrate	1125.48 (398.465)	4,566	1212.04 (421.942)	1,385	-6.984***
Kilocalorie from Protein	233.362 (82.514)	4,538	239.393 (84.281)	1,391	-2.373**
Kilocalorie from Fat	578.241 (293. 426)	4,535	586.881 (286.869)	1,383	-0.964
IDDS	3.700 (1.107)	4,638	3.532 (0.972)	1,411	5.125***
HDDS	3.983 (1.333)	4,638	3.853 (1.200)	1,411	3.265***
FCS	22326 (7.107)	4,638	21.556 (6.695)	1,411	3.610***

Notes: Standard errors in parentheses. Tests results report t-values.
Significance levels *** p<0.01, ** p<0.05, * p<0.1.



Source: Author calculated with subsample in the research
Note: The standard cut-off points, depends on each individual's activity level, gender and age, were derived by WHO (1985) and CNS, respectively. For instance, a negative value means that the elder's calorie intake is less than required.

Figure 5 Gaps to Standard Energy Requirement

The standard cut-off points, taking into account each individual's activity level as either light, moderate, or heavy, as well as gender and age, were derived by WHO (1985) and the Chinese Nutrition Society, respectively. The reason for applying different measurements is to demonstrate the worldwide standards and the ones explicitly derived from the Chinese elderly population. The figure presents an overall inadequacy of food consumption for the Chinese elders, with approximately 60% consuming less energy than the proposed daily calorie requirement. Both indicators also imply slightly higher deficits for elders in non-migrant households. However, the average IDDS is lower for the elders in migrant households. Furthermore, food security at household levels is also worse-off. The preliminary analysis indicates that although the elders from migrant households have slightly higher food quantities, they are still more deficient in diversified food intake.

4. Empirical Framework

Consider the elder i in the household h at a time t; the food security or nutritional status can be determined by:

$$FS_{iht} = \beta_0 + \beta_1 M_{ht} + \beta_2 A_{iht} + \beta_3 C_{ht} + \beta_4 D_t + \varepsilon_{iht} \quad (1)$$

The dependent variables, FS_{iht}, are continuous variables of the elder's food security status measured by different indicators. The primary variable of interest, M_{ht}, is a binary variable equal to 1 if at least a household member migrates for employment, and 0 otherwise. A_{iht} encompasses a vector of demographic characteristics, including the age, gender, educational background, and marital status of the elder. A vector of the age-squared term is also included to correct the non-linear effect. The vector C_{ht} represents household socio-economic characteristics that are likely to affect the elder's nutritional status. Specifically, the vector includes household size, the number of children (younger than 16), the number of working-

age household members (aged 16-59), whether the household engaged in farming, sanitary conditions such as access to in-house tap water and flush toilet, and household assets per capita. Finally, the time dummy variables, D_t, control for time-varying macroeconomic conditions. The regressions are estimated using clustered standard errors at the village level to control for heterogeneity and stratified sampling.

A critical concern is that the decision to migrate may be affected by time-variant unobservable household characteristics, not controlled for otherwise, thus inducing a bias in analyzing its impact on the outcome variable. To overcome the potential endogenous problem, an instrumental variable that affects the variable of interest – migration (M_{ht}) but is not correlated with ε_{iht} is proposed in the model. Thus, the two-stage least square random effects (IV) model is as follows,

$$M_{ht} = \beta_0 + \beta_1 Z_t + \beta_2 A_{iht} + \beta_3 C_{ht} + \beta_4 D_t + \varepsilon_{iht} \quad (2)$$

$$FS_{iht} = \beta_0 + \beta_1 \widehat{M_{ht}} + \beta_2 A_{iht} + \beta_3 C_{ht} + \beta_4 D_t + \varepsilon_{iht} \quad (3)$$

To account for the endogeneity of the migration decision, Mu and De Brauw (2015) proposed an interaction term between wage growth in provincial capital cities and initial village migrant networks as an instrumental variable. They argued that the wage growth in provincial capital cities could be a proxy for the signal of labor market demand while the migrants are considering whether to migrant for occupation. Similarly, the local migrant networks could also affect this information flow to the rural community. While carefully controlling for the migrant network size and province-year effect, the interaction term can be used to identify migration. They concluded that there is no significant effect of parental migration on children's height but an improvement in their weight.

Following Mu and De Brauw (2015), I constructed the interaction term as the instrument Z_t here. The first term, wage growth in the provincial capital city, may induce or discourage workers from migrating. Figure 1 partly supports this argument. In 2018, approximately 33% of total migrant workers moved within the province, and 40% stayed within the county; both might be affected by macroeconomic status. In addition, the second term, which is measured as the share of working-age people who had initially migrated at the village level, captured the general local migrant conditions that may also influence working-aged people's migration decisions. The initial year was set in 1997 when the household migration status was first interviewed in the CHNS[9]. The identifying assumption is that the increase of the variation in the interaction term does not independently affect the elders' nutrition and food security.

We should also be aware of the concerns of exclusion restriction when applying an instrumental variable approach. For example, it would be problematic if the interaction term affects the elder's nutritional outcomes via migrant workers' remittances. Since there is no remittance information available in the data, the household assets per capita were added as a proxy variable for household wealth that could be affected by remittances. With the full set of control variables, the first-stage regression results in Table 3 implied a strong explanatory power of the instrumental variable. The instrument also passes the standard Kleibergen-Paap rk Wald F-test that the maximum relative bias of the instrument is 10% (Stock and Yogo 2005). Finally, the estimate in the IV model is the local average treatment effect (LATE), which is the effect of the treatment for the subsample whose choice of migration was affected by the instrument (Imbens and Angrist 1994). In other words, those who migrate in response to the instrument will have more substantial effects on the magnitude of the estimate.

Table 3 First-Stage Regressions

Dependent Variables	(1) Kilocalorie	(2) ln(kilocalorie)	(3) Kilocalorie from Carbohydrate	(4) Kilocalorie from Protein
VARIABLES				
IV: wage growth in provincial capital city * initial village migrant networks	0.891*** (0.126)	0.877*** (0.125)	0.922*** (0.128)	0.897*** (0.129)
age	-0.075*** (0.013)	-0.075*** (0.013)	-0.074*** (0.013)	-0.074*** (0.013)
age square	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
gender	0.038*** (0.009)	0.038*** (0.009)	0.038*** (0.009)	0.039*** (0.009)
eduyr	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
married	-0.221*** (0.013)	-0.220*** (0.013)	-0.225*** (0.013)	-0.224*** (0.014)
hhsize	0.242*** (0.008)	0.241*** (0.008)	0.243*** (0.008)	0.242*** (0.008)
farmHH	0.018 (0.013)	0.018 (0.013)	0.017 (0.013)	0.019 (0.013)
child_number	-0.168*** (0.011)	-0.168*** (0.011)	-0.168*** (0.011)	-0.167*** (0.011)
numberofworker	-0.225*** (0.011)	-0.225*** (0.011)	-0.227*** (0.011)	-0.226*** (0.011)
assetpercapita	-0.005 (0.003)	-0.005 (0.003)	-0.004 (0.003)	-0.005 (0.003)
tapwater	-0.009 (0.015)	-0.010 (0.016)	-0.009 (0.015)	-0.011 (0.015)
toilet	-0.010 (0.014)	-0.010 (0.014)	-0.010 (0.014)	-0.009 (0.013)
wave_2004	-0.011 (0.022)	-0.011 (0.022)	-0.010 (0.021)	-0.010 (0.022)
wave_2006	0.030 (0.019)	0.030 (0.019)	0.031 (0.019)	0.029 (0.019)
wave_2009	0.037* (0.022)	0.037* (0.022)	0.037* (0.022)	0.037* (0.022)
wave_2011	0.066*** (0.022)	0.066*** (0.022)	0.066*** (0.022)	0.065*** (0.022)
constant	2.642*** (0.464)	2.648*** (0.463)	2.625*** (0.462)	2.599*** (0.452)
Observations	5,721	5,721	5,734	5,713
F-test	49.985	49.140	52.273	48.303

Table 3. First-stage Regressions (Continued)

Dependent Variables	(5) Kilocalorie from Fat	(6) IDDS	(7) HDDS	(8) FCS
VARIABLES				
IV: wage growth in provincial capital city * initial village migrant networks	0.924*** (0.135)	0.974*** (0.138)	1.145*** (0.133)	1.145*** (0.133)
age	-0.073*** (0.013)	-0.076*** (0.013)		
age square	0.000*** (0.000)	0.000*** (0.000)		
gender	0.038*** (0.009)	0.041*** (0.008)		
eduyr	-0.001 (0.001)	-0.001 (0.001)		
married	-0.225*** (0.014)	-0.233*** (0.014)		
hhsize	0.243*** (0.008)	0.246*** (0.008)	0.221*** (0.006)	0.221*** (0.006)
farmHH	0.015 (0.013)	0.017 (0.013)	0.018 (0.014)	0.018 (0.014)
child_number	-0.169*** (0.011)	-0.170*** (0.011)	-0.144*** (0.011)	-0.144*** (0.011)
numberofworker	-0.226*** (0.011)	-0.230*** (0.011)	-0.193*** (0.011)	-0.193*** (0.011)
assetpercapita	-0.005 (0.003)	-0.003 (0.003)	-0.004 (0.003)	-0.004 (0.003)
tapwater	-0.008 (0.015)	-0.009 (0.014)	-0.012 (0.015)	-0.012 (0.015)
toilet	-0.010 (0.014)	-0.010 (0.014)	-0.016 (0.015)	-0.016 (0.015)
wave_2004	-0.012 (0.022)	-0.014 (0.023)	-0.022 (0.021)	-0.022 (0.021)
wave_2006	0.027 (0.020)	0.028 (0.020)	0.024 (0.018)	0.024 (0.018)
wave_2009	0.037* (0.022)	0.033 (0.023)	0.023 (0.020)	0.023 (0.020)
wave_2011	0.066*** (0.023)	0.063*** (0.023)	0.060*** (0.022)	0.060*** (0.022)
constant	2.586*** (0.460)	2.650*** (0.471)	-0.320*** (0.024)	-0.320*** (0.024)
Observations	5,701	5,827	5,924	5,924
F-test	47.060	49.844	74.304	74.304

Notes: Standard errors clustered at the village level in parentheses.
Note: Significance levels *** p<0.01, ** p<0.05, * p<0.1.

5. Results

5.1 Migration and Food Intakes

Estimates for the migration effect for food intake levels for both OLS and IV approaches are presented in Table 4[10]. Each row represents the results on the noted dependent variables. The results from the OLS analysis suggest that having a migrant worker in the household leads to greater calorie consumption of the elder. Breaking down by the categories of nutrients, the primary increases are from carbohydrate and fat intake. However, the consumption of protein is not statistically significant.

Table 4. Regression Results: Individual Dietary Intakes

Dependent Variables	(1) Kilocalorie			(2) ln(kilocalorie)		
Estimation methods	OLS	RE	IV	OLS	RE	IV
VARIABLES						
Migrant_hh	116.064***	100.690**	722.083*	0.057***	.049**	0.344
	(42.480)	(41.727)	(422.726)	(0.020)	(0.020)	(0.223)
Individual Characteristics	Yes					
Household Characteristics	Yes					
Year dummies	Yes					
Observations	5,721					
R-squared	0.135	0.184	0.141	0.140	0.195	0.158
Dependent Variables	(3) Kilocalorie from Carbohydrate			(4) Kilocalorie from Protein		
Estimation methods	OLS	RE	IV	OLS	RE	IV
VARIABLES						
Migrant_hh	46.070*	36.164	498.814*	5.183	6.263	-11.238
	(25.798)	(25.287)	(298.283)	(5.296)	(4.815)	(69.751)
Individual Characteristics	Yes					
Household Characteristics	Yes					
Year dummies	Yes					
Observations	5,734			5,713		
R-squared	0.190	0.237	0.175	0.114	0.182	0.177
Dependent Variables	(5) Kilocalorie from Fat					
Estimation methods	OLS	RE	IV			
VARIABLES						
Migrant_hh	42.402**	37.309**	216.933			
	(17.684)	(16.500)	(229.593)			
Individual Characteristics	Yes					
Household Characteristics	Yes					
Year dummies	Yes					
Observations	5,701					
R-squared	0.091	0.127	0.113			

Notes: Standard errors clustered at the village level in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. RE and IV model reported between R-squared.

The results of IV estimates largely mirror those of the OLS model in the direction of impact; however, the magnitude is quite different. For the calories consumed, the impact of migration increased the elders' consumption by more than 34%, and the increase in food intake from carbohydrates contributes nearly 70% to the overall rise in quantity. This result suggests that the OLS estimates were downwardly biased. Nevertheless, as noted above, the IV approach places larger weights on those influenced by the treatment. The calculated causal effects thus represented the upper-bound impacts of migration.

One interesting finding is that households involved in farming increase the elders' calorie intake. While other factors hold equal, there are significant increases in the elder's carbohydrate and protein, but a decrease in fat. This might partly be because they tend to eat more home-grown food, and those types of food could be relatively limited, such as concentrating on staples or vegetables. Finally, the above results indicated that with a migrant member in the household, there seems to be a positive impact on improving the elders' total calorie consumption. However, little is known about the increment nutrition types attributed to food security.

5.2 Migration and Food Diversity

Since migration increased elders' energy intake, it would be of interest to know how it affects their food diversity. IDDS is then used to capture the impact on the variety of food of each elder in Table . The OLS and IV estimates suggest the same trend of decreasing food diversity (except for IDDS), although no significant effects of migration were found in the IV model. Note that IDDS is the total categories of food consumed; thus, the coefficient of each variable less than one implies a minor change in consuming more than one type of food group. To better understand the impact of migration on household food security, I removed the individual characteristics in the regression. Consistent with the finding at the individual level, negative effects of migration on HDDS and FCS were found in the OLS model, while no impacts were shown in the IV model. It should be noted that while IDDS/HDDS are measured at the mean of a three-day record in this research, these indicators merely capture the lower bound of the food diversity status of the observations, compared to the standard time unit of measurement.

Still, the insignificance of coefficients in the IV model implied that it is not yet clear whether migration improves the elders' dietary quality. I thereby portray the results obtained at the individual and household levels in Figure 6. In 2000, HDDS and IDDS of non-migrant elders are 3.650 and 3.388, respectively, and that of migrant elders are 3.560 and 3.206. The values mean that elders consumed less than four categories of food on an average over three days. The status slightly improved over the survey years. In 2011, non-migrant elders' HDDS and IDDS are 4.329 and 3.990, while migrant elders reached 4.220 and 3.819, respectively. Since HDDS is always higher than IDDS in the subsample, it may overestimate the food diversity of the target observation. In other words, while the regressions suggest that migration has no impact on food diversity, we need to be cautious when interpreting the results.

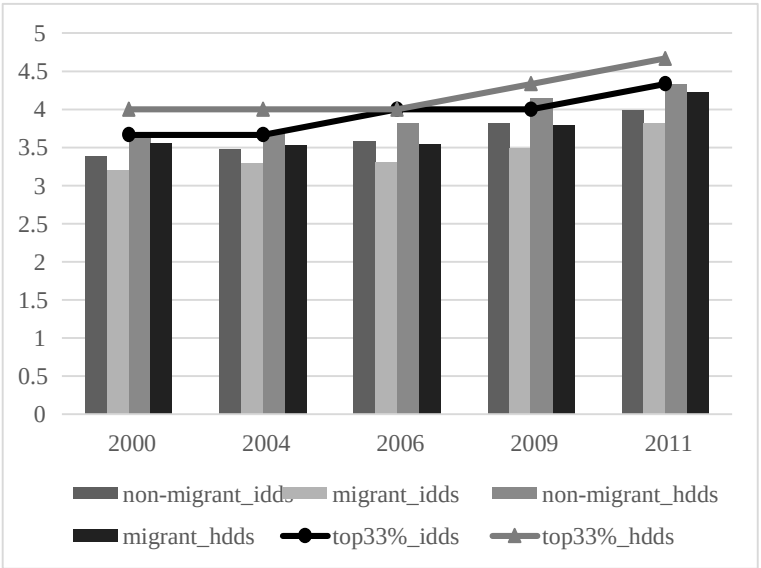
Considering there is no universal cut-off for IDDS, this paper followed the method proposed by The Food and Nutrition Technical Assistance III Project (FANTA) of USAID to establish a target threshold. The threshold is defined as the average diversity score of the 33% highest elders. In 2011, 69.61% of elders in the non-migrant household and 76.29% in the migrant household did not reach the threshold. It accords with my earlier observations, which showed that the deficiency in dietary diversity is more prevalent for elders in migrant households. Finally, comparing with existing literature that stated the elders' average dietary diversity score of 4.40 (out of 6) in Sri Lanka (Rathnayake, Madushani, and Silva 2012), 3.41

(out of 9) in Sharpeville (Oldewage-Theron and Kruger 2008), and 4.15 (out of 9) in the Philippines (Cokieng et al., 2014), the score is comparatively lower in this study.

Table 5. Regression Results: Food Security Indicators

Dependent Variables	(1) IDDS			(2) HDDS		
Estimation methods	OLS	RE	IV	OLS	RE	IV
VARIABLES						
Migrant_hh	-0.163**	-0.139***	0.144	-0.315***	-0.245***	-0.108
	(0.064)	(0.048)	(1.168)	(0.089)	(0.068)	(1.201)
Individual Characteristics	Yes			No		
Household Characteristics	Yes					
Year dummies	Yes					
Observations	5,827			5,924		
R-squared	0.240	0.320	0.313	0.230	0.296	0.303
Dependent Variables	(3) FCS					
Estimation methods	OLS		RE	IV		
VARIABLES						
Migrant_hh	-1.068**		-0.866**	-0.490		
	(0.448)		(0.343)	(6.513)		
Individual Characteristics	No					
Household Characteristics	Yes					
Year dummies	Yes					
Observations	5,924					
R-squared	0.232		0.323	0.329		

Notes: Standard errors clustered at the village level in parentheses.
Significance levels *** p<0.01, ** p<0.05, * p<0.1.
RE and IV model reported between R-squared.

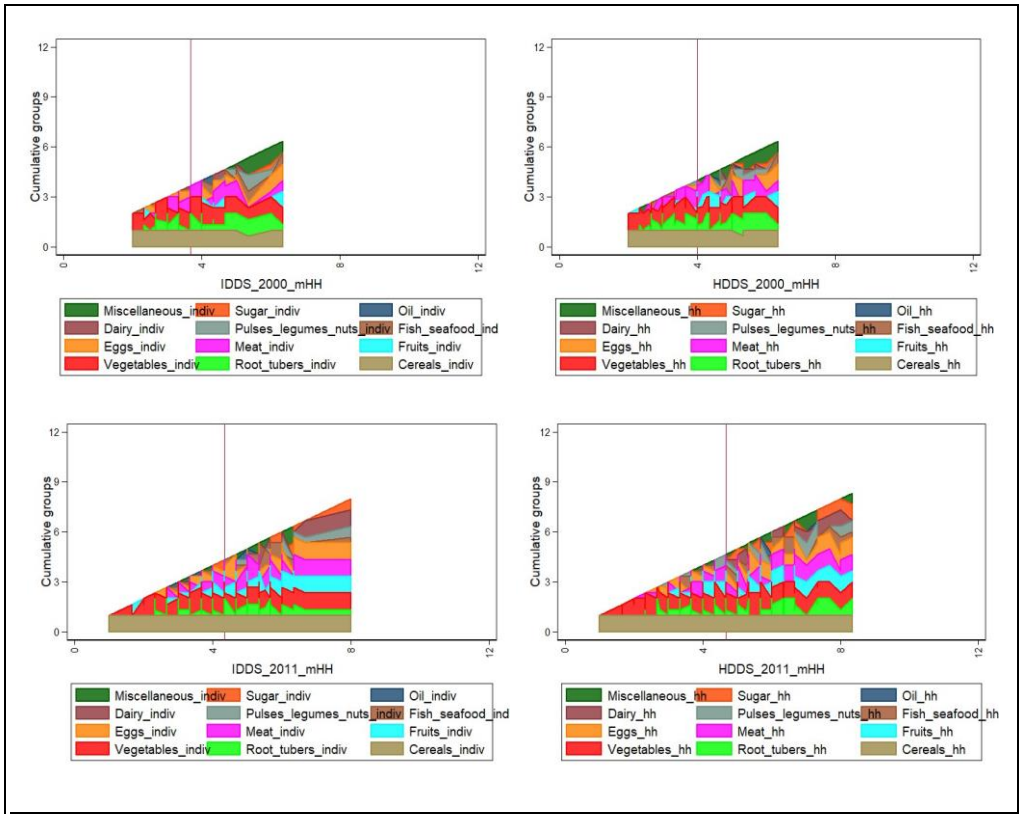


Source: Author calculated with subsample in the research

Figure 6 Elders' Food Diversity Indicators at Individual and Household Level

5.3 Dietary Decompositions

So far, I have demonstrated that elders in migrant households increased their total calorie consumption, but not as much improvement in dietary diversity. To better understand the elders' dietary components, the food composition is separated into 12 groups from IDDS and HDDS. Presented in the left panel of Figure 7, for the lower tail of elders whose IDDS are lower than the threshold (3.667) in 2000, only cereal and vegetables were eaten, and the diversity increased by some roots, tubers, eggs, and meat. The primary differences in consumption from worse to better groups were fruits, fish, seafood, and miscellaneous. In 2011, the elders' food composition was more diversified in both groups below and above the threshold. For example, even the lower-tailed group consumed fruits, eggs, and miscellaneous more than before; more staple food such as roots was included. On the other extreme, the amount of pulses, nuts, and dairy consumed was also more stable for the elders located in the upper tail of the distribution. Even if IDDS did not change much in total, it is clearly shown that the elders in the migrant households improved their food diversity gradually from 2000 to 2011.



Source: Author calculated with subsample in the research

Note: The red line in each chart identifies the threshold measured by the average of top 33% of subsample in each year. For HDDS, the values are 4 and 4.667 in 2000 and 2011; for IDDS, they are 3.667 and 4.333, respectively.

Figure 7 Elders' Food Diversity in Migrant Household

Another way to investigate the changes in food variety is at the household level. The right panel of figure 7 shows that household food variety has increased from 2000 to 2011, especially for those above the threshold. However, it is worthy to identify the difference in the trend from the individual and household levels. While food diversity increased at the household level, it did not improve the elders' food intake at the same rate. For instance, for the top tail in 2011, the households' increments in fish, seafood, pulses, nuts, and miscellaneous did not reflect much on the elders. While the elders and the migrant households as a whole have slightly improved food security, it is also suggested that the rural left-behind elders' nutritional intakes may not have improved as much as that of the household. In other words, the result from the dietary decomposition is consistent with what the regression implied, that the elder's food diversity may yet to reach a satisfactory level.

6. Conclusions

China has experienced mass rural-urban migration since its economic development in the 1980s. As the most populous country in the world, it also encounters a drastic demographic transition into an aging society. Since there lies an enormous social cost on decreasing seniors' poor nutritional status and diet-related diseases, as well as accommodating migrant workers in the city, this paper aims to shed light on the relationship between migration and rural elders' food and nutrition security.

Using the panel data in the CHNS from 2000 to 2011, the paper found that rural elders with at least one migrant worker in the household increased the amount of total calorie consumption, especially the energy from carbohydrates, but not as much improvement into sufficient dietary variety. Specifically, there is no significant evidence of a better-off outcome in terms of food diversity at both individual and household levels.

The findings provide insights into the impacts of migration from another aspect of the Chinese left-behind elders' well-being, which is food and nutrition security. There is, therefore, a definite need for recognizing that elders may face unfavorable consequences in terms of food insecurity when they are left behind. In connection with policy implications, even if the rural seniors received financial supports from their migrant household members, their dietary intakes may not be improved as much, for instance, due to the lack of fundamental nutrition knowledge. While the national nutrition plan (2017-2030) in China primarily aims to improve children and pregnant women's nutrition and health status, more attention shall also be paid to these disadvantaged seniors.

The limitation of this study is the limited information about migration in the current data. Thus, it is unfeasible to trace out more detailed mechanisms through which migration may impact rural food insecurity, such as the remittances provided by the migrant household members, and the destinations where the migrant workers moved. These are left for future research to explore the connections between rural food insecurity and economic development patterns.

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Footnotes

[1] The Chinese government conducted a systematic survey on rural migrant workers and released the National Migrant Workers Monitoring Survey Report annually from 2009. The official statistics of migrant workers before 2008 are not available. To complement this, according to the China Labour Statistical Yearbook, rural employment in urban units (state-owned, urban-collective owned, and other ownership units included) rose from 13.186 million in 2004 to 19.001 million in 2017. Although this only reflects the comparatively narrow type of hired workers, the increasing trend is consistent with the period focused on this research.

[2] According to the National Bureau of Statistics of China, permanent employees refer to those who work in the institution and get paid with wages, social insurance, and housing provident fund. Since migrant workers' wages were not included in the official survey, Lu (2012) calculated the wage ratio by estimating migrant workers' wages and dividing it by permanent employees' wages from the official statistics.

[3] National Food Security Policy Expert Advisory Committee was established on May 31st, 2016, to ensure national food security and improve the decision-making consultation system.

[4] The household migration status was interviewed since 1997 in the CHNS. However, to apply an instrumental variable approach (which will be discussed in the later section), I use the data in 1997 to construct the value of the instrument. Thus, this is not included in the analysis.

[5] IDDS and HDDS apply 12 food groups: Cereals; white tubers and roots; vegetables; fruits; meat; eggs; fish and other seafood; legumes, nuts, and seeds; milk and milk products; oils and fats; sweets; spices, condiments, and beverages. The score range is 0 to 12.

[6] FCS includes 9 food groups: main staples (2); pulses (3); vegetables (1); fruit (1); meat and fish (4); milk (4); sugar (0.5); oil (0.5); condiments (0). We then multiply a given weighted value in parenthesis to obtain the FCS. The maximum value a household can have is 112, implying that the household consumes every food group every day for seven days. Adjusting to the time unit in CHNS, the maximum value here is 48.

[7] Basal metabolic rate (BMR) applied in calculating energy requirement is based on Camps et al. (2015).

[9] While Liaoning Province was not surveyed until 2000 in the CHNS, the initial migrant network of the villages in Liaoning was measured based on the year 2000.

[10] Estimates for the random-effects model were presented for reference only.