Journal of Integrative Agriculture 2019, 18(8): 1780–1792

Available online at www.sciencedirect.com

ScienceDirect

ELSEVIER

RESEARCH ARTICLE

The impact of migration on the food consumption and nutrition of left-behind family members: Evidence from a minority mountainous region of southwestern China

MIN Shi[1], HOU Ling-ling[1], Hermann Waibel[2], HUANG Ji-kun[1], MU Yue-ying[3]

[1] *China Center for Agricultural Policy, School of Advanced Agricultural Sciences, Peking University, Beijing 100871, P.R.China*
[2] *Institute of Development and Agricultural Economics, Leibniz University Hannover, Hannover 30167, Germany*
[3] *College of Economics and Management, China Agricultural University, Beijing 100083, P.R.China*

Abstract

While migration is widely recognized as a valid option for improving farmers' income, the welfare effects of migration on left-behind family members are ambiguous. This study examines the impacts of migration on left-behind family members' food consumption and nutrient intake, particularly in remote rural areas in China. Based on household survey data collected from 611 smallholder rubber farmers in Xishuangbanna Dai Autonomous Prefecture of southwestern China, the empirical results suggest that the migration of family members contributes to improving household net income, whereas it negatively affects left-behind family members' consumption of grain and pork. Migration also leads to a decrease in left-behind family members' nutrient intake. Surprisingly, the economic returns of farmers' migration not only do not foster the transformation of household food consumption from a staple food-dominated dietary structure to one including more meat and dairy products but also reduce left-behind family members' nutrient intake. This study adds to the literature on the impact of farmers' migration. The findings have important implications for better understanding the impacts of migration on farmers' livelihood and human capital development in rural China.

Keywords: migration, food consumption, nutrition, left-behind

1. Introduction

The increasing migration of farmers from rural to urban regions for off-farm work has contributed to improving farmers' incomes in China (Zhu and Luo 2010; Chan 2012). Since 1978, China has been experiencing extensive rural out-migration, with the number of rural-urban migrants increasing from 2 million in 1983 to 253 million in 2010 (Chen *et al.* 2014). Taking into account the multiple effects of migration and change in household size, Taylor *et al.* (2003) found that participating in migration at the household level could increase the household per capita income of left-behind family members by between 16 and 43%. By using household panel data and taking prior village migration networks as an instrument, Du *et al.* (2005) found that having a migrant could increase a household's income per capita by 8.5–13.1%. Migration also significantly boosts income for all ethnic groups; however, the returns to ethnic minority

Received 21 June, 2018 Accepted 7 October, 2018
MIN Shi, E-mail: min.ccap@pku.edu.cn; Correspondence HOU Ling-ling, E-mail: llhou.ccap@pku.edu.cn

doi: 10.1016/S2095-3119(19)62588-8

households tend to be less than those to Han households, thereby increasing the inequality between ethnicities (Howell 2017).

There are rising concerns about the impacts of farmers' migration on left-behind family members, notably children and the elderly. Numerous studies focus on the implications of migration on the education and health of left-behind children in China (Chen 2007; Brauw and Mu 2011; Hu 2012; Lu 2012; Wen and Lin 2012; Zhao *et al.* 2014). For instance, Hu (2013) found that the migration of adults including parents has a negative effect on the educational performance of the children left behind, but that remittances can partially compensate for this loss. Ye and Lu (2011) pointed out that parental migration negatively affects the lives of children, including increased workloads, little study tutoring and supervision, and, above all, the unmet needs of parental affection. Jia *et al.* (2010) found that left-behind children report poorer health-related quality of life than non-left-behind children due to psychosocial dysfunction. Chen and Zhao (2012) also revealed that the migration of parents negatively affected the health status of the left-behind children aged 0–6 years.

Furthermore, the migration of household members increases the time spent on farm work and domestic work by the left-behind elderly, particularly senior women (Chang *et al.* 2011). Indeed, large-scale rural-urban migration has changed the rules and resources of the traditional care system and the family is no longer a "network of safety" or a reliable source of support for the elderly (He and Ye 2014). The elderly living alone without any adult children in the village are most at risk when their children migrate, while those left caring for their grandchildren are also clearly affected (Connelly and Maurer-Fazio 2016).

However, few studies have been conducted on the welfare effects of migration on left-behind family members in China in terms of their food consumption and nutrient intake. Although some studies provide critical insights into this research issue, the results are ambiguous. For instance, Robson *et al.* (2008) found that children with migrant parents consume relatively few nutrients, whereas Zhou *et al.* (2015) showed that for nutrition proxied by the anemia rate, left-behind children perform similarly to children living with both parents. Meanwhile, Mu and Brauw (2015) were unable to estimate the effects of migration on nutrient intake, finding that parental migration has no significant impact on the height of children, but that it improves their weight. Using survey data, Sun *et al.* (2010) found that the nutrient intakes of the left-behind children aged 0–5 years in Donghai county of Jiangsu province were relatively low as compared with the recommended nutrient intakes (RNIs). Similarly, Gong and Yang (2010) found that the nutrition intakes of left-behind children were also lower than the nutrition intakes of other children in rural areas of Hubei Province. However, these two studies were just descriptive statistics. Based on econometric models, Sun and Wang (2016) found the migration of parents had an insignificant effect on the self reported health status of the left-behind children, as the positive effect of the increased income on the left-behind children's health may equivalent to the negative impact of lacking parental care. On the contrary, Tian *et al.* (2017) found the migration of parents had a negative effect on the nutrient intakes of the left-behind children, as there exists a significant and negative effect of lacking parental care on the health status of the left-behind children, while the income elasticity for most nutrients is relatively small.

Similarly, international evidence also suggests that the impacts of migration on food and nutrition security in developing countries are mixed (Azzarri and Zezza 2011; Brauw 2011; Gibson *et al.* 2011; Zezza *et al.* 2011). For example, Karamba *et al.* (2011) examined the link between migration and food consumption patterns in Ghana, suggesting that migration does not substantially affect food expenditure per capita and has a minimal effect on food expenditure patterns. However, Nguyen and Winters (2011) indicated that short-term migration has a positive impact on per capita food expenditure, per capita calorie consumption, and food diversity in Vietnam.

Hence, whether the migration of farmers improves left-behind family members' food consumption and nutrient intake in China remains an open question. Further, more empirical studies of the relationship between migration and food consumption and nutrition are needed, particularly in remote rural areas. Most previous studies of food consumption and nutrition in China focus on representative regions (Bai *et al.* 2010; Zhong *et al.* 2012; Burggraf *et al.* 2015; Chen *et al.* 2017; Ren *et al.* 2017; Yu 2018), and little attention has been paid to remote regions with individual characteristics. However, in the context of building a moderately prosperous society in China, it is essential to pay attention to farmers' food consumption and nutrition in remote rural regions.

In this direction, the present study examines the impacts of farmers' migration on the food consumption and nutrition of left-behind family members in Xishuangbanna Dai Autonomous Prefecture (XSBN) of southern Yunnan Province, Upper Mekong Region. A comprehensive household survey dataset was collected from 611 smallholder rubber farmers in XSBN, a region that borders Laos in the south and Myanmar in the west. Of the prefecture, 95.1% is mountainous with elevations of 475–2 430 m, while the Mekong River (called Lancang Jiang in China) passes through XSBN from northwest to southeast (Min *et al.* 2017c). Almost no food and nutrition-relevant research has been conducted in this remote area. Moreover, rubber farming, a significant income source in rural XSBN, has been experiencing shocks owing to the persistent low price of natural rubber in recent years, while more and more young farmers are migrating to urban regions to chase alternative income sources.

The results of this study suggest that the rural-urban migration of family members for off-farm work contributes to improving the household net income of smallholder rubber farmers in XSBN. However, migration negatively affects left-behind family members' consumption of grain and pork, thereby leading to a decrease in their nutrient intake. The results reveal that the economic returns of farmers' migration not only do not foster the transformation of household food consumption from a staple food-dominated dietary structure to one including more meat and dairy products but also reduce left-behind family members' nutrient intake. These findings help better understand the impacts of migration on farmers' well-being and human capital development in remote areas of rural China.

The rest of this paper is organized as follows. In Section 2, the empirical models related to smallholder rubber farmers' food consumption and nutrient intake are developed. Section 3 briefly introduces the data source. Section 4 reports and discusses the descriptive statistics and estimation results of our models. The last section summarizes and concludes.

2. Model specification

To capture the impacts of migration on left-behind family members' food consumption, nutrient intake, and dietary diversity, we consider two possible mechanisms. Firstly, there is a direct impact of migration on the food consumption of left-behind family members due to the decrease in the number of family members eating at home. Migrants are generally young farmers (Wang *et al.* 2011); they usually are the primary labor for producing food in households but consume more food as well as require more nutrient intake compared with children and the elderly. Therefore, the direct impact of the rural-urban migration of these farmers on the average food consumption and nutrient intake of left-behind family members is ambiguous.

Secondly, an indirect impact of migration on food consumption and nutrient intake occurs by improving the disposable income of households, which can be a significant constraint in this regard (Guo *et al.* 2000; Bai *et al.* 2010; Tian and Yu 2013; Chen *et al.* 2017). To examine this indirect impact, we adopt a mechanism test approach (Li and Zhu 2006; Sekabira and Qaim 2017), which gradually controls for income variables that are significantly affected by migration in the equations of food consumption and nutrient intake to determine whether income factors change the effect of migration.

Referring to previous studies (e.g., Bhandari and Smith 2000; Zhen *et al.* 2010; Tian and Yu 2015; Chen *et al.* 2017), the dependent variables for food consumption and nutrient intake in this study include the average consumption of various food categories (grain, vegetables, pork, poultry, beef, mutton, aquatic products, egg, and milk and dairy products), the intake of energy, protein, fat, and carbohydrate, and dietary diversity. Nutrient intake can be calculated based on surveyed food consumption data and the conversion factors from various food to nutrients suggested by a Chinese dietary reference document. The diversity of food consumption can be used to measure household welfare (Tian and Yu 2015). In particular, we establish a Shannon equitability index of food consumption by taking into account both the number and the weight of the food categories consumed in the household during the survey to measure food diversity.

2.1. Food consumption

In previous food demand studies, demand systems such as the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980) and the Translog (Jorgenson *et al.* 1982) are widely used, due to its consistency with economic theory. For instance, regarding the food demand analysis in China, Fan *et al.* (1994) and Huang and Rozelle (1998) applied and developed the AIDS, while Yen *et al.* (2004) used a Translog demand system. Due to the constraint of data availability in this study, a simultaneous estimation model based on the framework of seemingly unrelated regression is employed to analyze the food consumption of the left-behind family members.

To identify the direct impact of migration on food consumption, we specify the following model:

$$\begin{cases} y_1=\alpha_{01}+\alpha_{11}Migration+\sum_j\alpha_{21j}X_j+\sum_k\alpha_{31k}Z_k+\alpha_{41}G+\varepsilon_1 \\ y_i=\alpha_{0i}+\alpha_{1i}Migration+\sum_j\alpha_{2ij}X_j+\sum_k\alpha_{3ik}Z_k+\alpha_{4i}G+\varepsilon_i \\ y_9=\alpha_{09}+\alpha_{19}Migration+\sum_j\alpha_{29j}X_j+\sum_k\alpha_{39k}Z_k+\alpha_{49}G+\varepsilon_9 \end{cases} \quad (1)$$

Where, y_i is the dependent variable denoting the per capita food consumption of category *i* (*i*=1, ..., 9, respectively represent grain, vegetables, pork, poultry, beef, mutton, aquatic products, egg, and milk and dairy products); *Migration* is a dummy variable denoting if there are migrant family members in a household; X_j are a series of independent variables representing the characteristics of the household head, who generally play an important role in household decision making and their characteristics normally have significant effects on household food consumption. The vector Z_k represents the demographic and socioeconomic variables at the household and farm levels, which are often found to significantly affect food consumption; and *G* is a vector of the geographical variables including the elevation of the household location and township dummy variables. α_{0i}, α_{1i}, α_{2i}, α_{3i}, and α_{4i} are the parameters to be estimated, while ε_i is the error term. While there are no price variables in the food consumption functions, following Yen *et al.* (2008) and Min *et al.* (2015), we assume that the food price at different elevations and within each township is the same during the survey period. Thus, the effect of price on food consumption can be controlled for to some extent by these geographic variables *G*.

2.2. Dietary diversity

To measure dietary diversity, we assume that the number of food categories consumed by the *i*th household is N_i and take into account the evenness of each food category. Hence, the equation of the Shannon index of the *i*th household's food consumption can be expressed as

$$SI_i=-\sum_{n_i=1}^{N_i}[(quantity\_share_{n_i})\ln(quantity\_share_{n_i})] \quad (2)$$

Where, $quantity\_share_{n_i}(n_i\in|1,N_i|)$ denotes the share of the *n*th food category in the food consumption of the *i*th household. Extended from eq. (2), the Shannon equitability index is further defined as the percentage of the actual Shannon index in relation to the maximum possible Shannon index as follows:

$$SEI_i=\left\{\frac{SI_i}{-\sum_{n_i=1}^{N_i}[(\frac{1}{N_i})\ln(\frac{1}{N_i})]}\right\} \quad (3)$$

Then, by simplifying eq. (3), we obtain the Shannon equitability index of the food consumption of the *i*th household:

$$SEI_i=\left[\frac{SI_i}{\ln(N_i)}\right] \quad (4)$$

Where, the value of the Shannon equitability index is between 0 and 1. When the Shannon equitability index is closer to 1, it indicates more dietary diversity and higher welfare. Thus, dietary diversity constructed by the Shannon equitability index is expressed as

$$SEI=\theta_0+\theta_1 Migration+\sum_j\theta_{2j}X_j+\sum_k\theta_{3k}Z_k+\theta_4 G+\varphi \quad (5)$$

Where, the vectors θ and φ denote the parameters to be estimated and error term, respectively.

2.3. Nutrient intake

Similarly to model (1), the model of nutrient intake can be written as

$$\begin{cases} energy=\beta_{01}+\beta_{11}Migration+\sum_j\beta_{21j}X_j+\sum_k\beta_{31k}Z_k+\beta_{41}G+\mu_1 \\ protein=\beta_{02}+\beta_{12}Migration+\sum_j\beta_{22j}X_j+\sum_k\beta_{32k}Z_k+\beta_{42}G+\mu_2 \\ fat=\beta_{03}+\beta_{13}Migration+\sum_j\beta_{23j}X_j+\sum_k\beta_{33k}Z_k+\beta_{43}G+\mu_3 \\ CHO=\beta_{04}+\beta_{14}Migration+\sum_j\beta_{24j}X_j+\sum_k\beta_{34k}Z_k+\beta_{44}G+\mu_4 \end{cases} \quad (6)$$

Where, the dependent variables *energy*, *protein*, *fat*, and *CHO* represent the per capita intake of energy, protein, fat, and carbohydrate. The vectors β and μ are the parameters to be estimated and error term, respectively.

2.4. Identification strategy

Models (1), (5), and (6) are used to estimate the direct impacts of migration on the food consumption, dietary diversity, and nutrient intake of left-behind family members. Because we employ monthly food consumption data, these dependent variables rarely suffer censored issues. Thus, given the forms of each model and settings of each dependent variable, eqs. (1) and (6) are proposed to be estimated by using seemingly unrelated regression (SUR), while eq. (5) can be estimated by ordinary least squares (OLS) linear regression.

As explained in the Introduction, any indirect impacts of migration on left-behind family members' food consumption and nutrition caused by changes in disposable income can be identified by adopting a mechanism test approach. Firstly, disposable income is expressed as a function of migration as follows:

$$Income=\gamma_0+\gamma_1 Migration+\sum_j\gamma_{2j}X_j+\sum_k\gamma_{3k}Z_k+\gamma_4 G+\tau \quad (7)$$

Where, *Income* represents the disposable income of households, while the vectors γ and τ denote the parameters to be estimated and error term, respectively. Because data on disposable income are difficult to collect in field surveys, the disposable income of households is normally proxied by household net income (e.g., Bai *et al.* 2010; Liu *et al.* 2015). However, it generally takes over eight years for rubber farming to obtain a return; accordingly, the household net income of some smallholder rubber farmers does not reflect the disposable income of households. Thus, we employ household wealth as an alternative proxy variable. Eq. (7) is also estimated by OLS linear regression.

Secondly, the variable *Income* is further incorporated into models (1), (5), and (6) as a control variable; the modified models (1), (5), and (6) are thus re-estimated. If the parameter γ_1 in model (7) is statistically significant and the parameters of *Migration* in the modified models (1), (5), and (6) differ from those in the original models (1), (5), and (6), indirect impacts of migration on food consumption and nutrition through household income exist. The signs of the parameter γ_1 in model (7) and parameters of *income* in the modified models (1), (5), and (6) determine the sign of the indirect impact.

3. Data source

This study employed a dataset collected from a socioeconomic survey of smallholder rubber farmers in XSBN in March 2015. The survey followed up a baseline survey conducted in March 2013. In the baseline survey, a stratified random sampling approach, taking into account the rubber planting area per capita and distribution of rubber planting areas across townships, was applied to obtain a representative sample of smallholder rubber farmers in XSBN (Min *et al.* 2017a). The researchers interviewed 612 smallholder rubber farmers from 42 villages in eight townships. For more details of the sampling procedure, see Min *et al.* (2017b). The follow-up survey in March 2015 aimed to trace the smallholder rubber farmers interviewed in the baseline survey. Because one sample household could not be contacted by the registered details, 611 smallholder rubber farmers were successfully traced and interviewed.

The follow-up survey used a comprehensive household questionnaire including detailed information on the characteristics of household members, household, land use, rubber farming, other farm and non-farm activities, expenditure on food and non-food products, and several other modules relevant to rubber. In the module on food expenditure, we asked farmers to estimate the average monthly per capita consumption of nine food categories: grain, vegetables, pork, poultry, beef, mutton, aquatic products, egg, and milk and dairy products. We only collected food consumption data from permanent resident populations in a household and excluded those of migrant family members.

4. Results and discussion

4.1. Descriptive statistics

Table 1 reports the survey results of the average food consumption of smallholder rubber farmers in XSBN in 2014 and compares them with those for China's urban and rural households. On average, the monthly per capita consumption of grain, egg, and milk and dairy products of smallholder rubber farmers was placed between that of urban and rural households in China. Compared with urban and rural households, our sample households consumed the fewest vegetables and mutton, but their consumption of pork, poultry, beef, and aquatic products was the highest. Hence, although the overall food consumption structure of smallholder rubber farmers in XSBN is similar to that at the national level, these smallholders consume more meat than the nation average.

The average nutrient intake of smallholder rubber farmers in XSBN was further estimated based on the survey results of food consumption (Table 1) and conversion factors from various food to nutrients (Appendix A). Table 2 shows the estimated results and comparison with the corresponding reference values of average nutrient intake. Apart from the intake of protein, all other nutrient intake was lower than the corresponding reference values for adults. This is because sample households typically included children and the elderly, with the latter generally needing a lower nutrient intake than young adults.

Fig. 1 shows the kernel density distribution of the Shannon equitability index of smallholder rubber farmers' food consumption to represent the dietary diversity of farmers. The calculated results show that the mean of the Shannon equitability index is about 0.77 with a standard deviation of 0.09 and a small variance (0.01). Visually, the distribution curve is right-skewed, illustrating that the dietary diversity of most smallholders is higher than the medium level.

Moreover, the survey results show that approximately 32% of smallholder rubber farmers (194 households) had at least one migrant family member in 2014. Specifically, as shown in Fig. 2, 417 households (68.3%) had no migrant members, while 128 households (21.0%) had one and 46 households (7.5%) had two. The percentage of households with at least three migrant family members was 3.3% (20 households).

Table 3 presents the differences in the mean food consumption, nutrient intake, and dietary diversity of households with and without migrant family members.

Table 1 Average food consumption of urban households, rural households, and sample households in 2014

Categories	Sample households[1)] (kg/month/person)	Urban households[2)] (kg/month/person)	Rural households[2)] (kg/month/person)
Grain	11.08	9.77	13.97
Vegetables	6.95	8.88	7.41
Pork	3.4	1.73	1.60
Poultry	1.23	0.76	0.56
Beef	0.33	0.18	0.07
Mutton	0.02	0.10	0.06
Aquatic products	1.89	1.20	0.57
Egg	0.77	0.82	0.60
Milk and dairy products	0.68	1.51	0.53

[1)] Data source: authors' survey.
[2)] Data source: NBSC (2015).

Table 2 Estimated average nutrient intake and reference values

Categories	Sample households[1)]	Reference values[2)]	
		Male adults	Female adults
Energy (Kcal/person/day)	1 663.91	2 250–3 000	1 800–2 400
Protein (g/person/day)	73.69	60–65	50–55
Fat (g/person/day)	43.94	50–100	40–80
Carbohydrate (g/person/day)	264.52	281.25–487.5	225–390

[1)] Data source: authors' survey.
[2)] Data source: NBSC (2015).

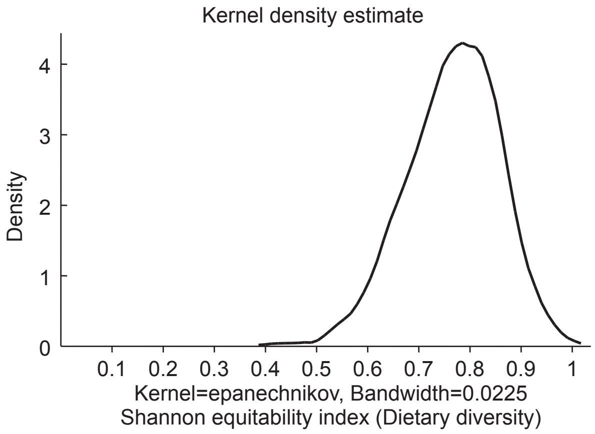

Fig. 1 Kernel density distribution of smallholder rubber farmers' dietary diversity.

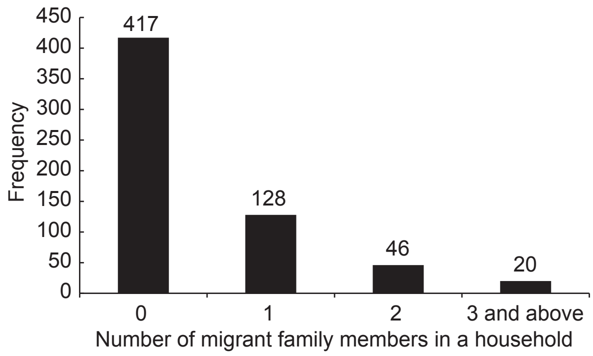

Fig. 2 Frequency distribution of the number of migrant family members.

Left-behind family members in households with migrants consumed less grain, pork, and aquatic products on average than those of family members in households without migrants. Accordingly, the nutrient intake of left-behind family members was also significantly lower than that of family members in households without migrants. Nevertheless, in terms of dietary diversity, there was no significant difference between family members from households with and without migrants. In summary, although the differences in food consumption, nutrient

Table 3 Differences in food consumption, nutrient intake, and dietary diversity by migration

Categories	Migration		Difference
	Yes	No	
Food consumption (kg/month/person)			
Grain	10.51	11.35	–0.84***
Vegetables	6.97	6.94	0.03
Pork	3.23	3.49	–0.26*
Poultry	1.19	1.24	–0.05
Beef	0.29	0.34	–0.05
Mutton	0.03	0.02	0.01
Aquatic products	1.76	1.94	–0.18*
Egg	0.77	0.77	0.00
Milk and dairy products	0.63	0.70	–0.07
Nutrient intake			
Energy (Kcal/person/d)	1 663.91	1 783.40	–119.48***
Protein (g/person/d)	73.69	78.55	–4.86**
Fat (g/person/d)	43.94	46.78	–2.84*
Carbohydrate (g/person/d)	264.52	283.72	–19.20***
Dietary diversity (Shannon equitability index)	0.76	0.77	0.00
Observations	194	417	

*, **, and *** represent the 10, 5, and 1% significant levels, respectively (*t*-test).

intake, and dietary diversity between left-behind family members and others were observed without controlling for other potential influencing factors, these results suggest the need to explore further the impacts of migration on the food consumption, nutrient intake, and dietary diversity of left-behind family members.

Table 4 summarizes the control variables used in the econometric analyses. Household net income per capita was approximately 10.3 thousand CNY, while household wealth proxied by the values of all non-land productive and consumptive assets was 54.8 CNY/person. Only 8% of household heads were women and the average age of household heads was about 48 years. On average, the education level of household heads was relatively low (about four years). Most smallholder rubber farmers were ethnic minorities, while only about 5% were the Han majority. Demographic structure is an important factor affecting household food consumption (Zhong *et al.* 2012; Liu *et al.* 2015). Average household size was five family members, of which 18% were below 16 years and 7% were 65 years or above. Land size per capita was 14.2 mu (1 mu=0.067 ha), with over 70% of land allocated to rubber farming. The percentage of rubber trees in the harvesting phase was close to 40%. According to previous studies (e.g., Bai *et al.* 2010; Min *et al.* 2015; Chen *et al.* 2017), these variables are possible to affect food consumption. Hence, the use of these control variables is conducive to more accurately capture the impact of migration on food consumption, dietary diversity and nutrient intakes of the left-behind family members.

4.2. Estimation results

Tables 5 and 6 report the estimation results of food consumption (model (1)), dietary diversity (model (5)), and nutrient intake (model (6)). The correlation among the error terms ε_i in model (1) is tested by using a χ^2 statistic — Lagrange multiplier statistic (Breusch-Pagan test of independence), suggesting that the error terms of the nine functions are correlated. Similarly, the Breusch-Pagan test of independence in Table 6 confirms the correlation among the four functions of nutrient intake. Hence, the use of SUR to estimate the consumption of the nine food and four nutrient intake categories is superior to a separate estimation for each category. In addition, the F-statistics test in Tables 5 and 6 show the significant joint explanatory power of the used independent variables for food consumption, dietary diversity, and nutrient intake, in addition to the consumption of mutton, perhaps because of the low monthly per capita consumption of mutton. Overall, the statistics validate the specification of our models.

The results in Table 5 show that the direct impact of migration on left-behind family members' food consumption is only significant for grain consumption. The number of migrant family members in a household negatively affects grain consumption. Every additional migrant family member results in a decrease of 0.354 kg/month/person (3.2%) in the

Table 4 Summary statistics of the independent variables

Variable	Definition and description	Mean
Income	Household net income (thousand CNY per person per year)	10.03
Wealth	Values of all non-land productive and consumptive assets (thousand CNY per person)	54.84
Characteristics of the household head		
Gender	Gender of the household head (1=female; 0=male)	0.08
Age	Age of the household head (years)	47.73
Education	Education level of the household head (years)	4.45
Ethnicity	Ethnicity of the household head	
Han	The Han majority (1=yes; 0=otherwise)	0.05
Dai	The Dai minority (1=yes; 0=otherwise)	0.58
Hani	The Hani minority (1=yes; 0=otherwise)	0.11
Yi	The Yi minority (1=yes; 0=otherwise)	0.10
Bulang	The Bulang minority (1=yes; 0=otherwise)	0.09
Other	Other minorities (1=yes; 0=otherwise)	0.07
Characteristics of households and farms		
Household size	Number of family members	5.26
Child	Proportion of children (age<16) in the household	0.18
Elder	Proportion of the elderly (age ≥65 years) in the household	0.07
Area	Land size (mu/person)	14.21
Rubber	Proportion of rubber plantations in the total land area	0.74
Harvest	Percentage of rubber trees in the harvesting phase in total rubber plantations	39.39
Elevation	Elevation of the household location (meters above sea level)	756.84
Township	Seven township dummy variables	Not reported
Observations		611

grain consumption of left-behind family members compared with the average monthly per capita consumption of grain.

While migration does not have a significant impact on dietary diversity, the number of migrant family members negatively affects left-behind family members' nutrient intake, including that of energy, protein, and carbohydrate (Table 6). A one-person increase in migrant family members in a household decreases energy, protein, and carbohydrate intake by 50.427 kcal/person/day (3.0%), 2.173 g/person/day (3.0%) and 7.908 g/person/day (3.0%), respectively.

Table 7 presents the estimation results for model (7). Considering the potential endogeneity of migration in explaining household income and wealth, we adopt a two-stage least squares (2SLS) approach with an instrumental variable (IV). Here, we use the percentage of households with non-farm wage employment in the village as the IV, while the results of the Hausman tests validate the IV. Also, we conduct a falsification test, that is, the IV significantly affects migration but has an insignificant effect on income/wealth for the households without migration. The results of falsification test further validate the proposed IV. Finally, the estimation results for model (7) show the significant and positive effect of migration on household net income and non-significant impact on household wealth. Thus, household net income could be a mediating variable of migration, helping indirectly affect food consumption and nutrition.

Tables 8 and 9 report the estimation results of food consumption, dietary diversity, and nutrient intake by further controlling for the variables of household net income and household wealth. Compared with the results in Table 5, the parameter of migration for grain consumption changes from –0.354 to –0.329; however, the variable of household net income is not significant in Table 8. Interestingly, the parameter of migration for pork consumption becomes significantly negative in Table 8 and household net income positively affects pork consumption. This result confirms that migration has an indirect positive impact on pork consumption through the channel of household income. Specifically, migration can indirectly increase pork

Table 5 Seemingly unrelated regression (SUR) results for the original models of the food consumption of left-behind family members

Variable[1)]	Grain	Vegetables	Pork	Poultry	Beef	Mutton	Aquatic	Egg	Milk
Migration	–0.354**	0.056	–0.122	–0.008	–0.025	0.004	–0.106	0.006	–0.009
	(0.180)	(0.168)	(0.090)	(0.061)	(0.025)	(0.006)	(0.067)	(0.043)	(0.060)
Income	No	No	No	No	No	No	No	No	No
Wealth	No	No	No	No	No	No	No	No	No
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Township	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.140	0.115	0.136	0.092	0.059	0.034	0.147	0.065	0.065
F-statistics	4.32***	3.44***	4.20***	2.69***	1.68**	0.95	4.59***	1.86***	1.85***
Obs.	611	611	611	611	611	611	611	611	611
Breusch-Pagan test of independence: Chi²					442.056***				

1) Other variables include all the variables listed in Table 4 except income, wealth, and township dummy variables.
"Yes" means the variable is controlled in the model, otherwise "No". **, and *** represent the 5 and 1% significant levels, respectively.

Table 6 Seemingly unrelated regression (SUR) results for the original models of the dietary diversity and nutrient intake of left-behind family members

Variable[1)]	OLS	SUR			
	Dietary diversity	Energy	Protein	Fat	Carbohydrate
Migration	–0.004	–50.427**	–2.173*	–1.195	–7.908*
	(0.005)	(22.427)	(1.209)	(0.967)	(4.045)
Income	No	No	No	No	No
Wealth	No	No	No	No	No
Other variables	Yes	Yes	Yes	Yes	Yes
Township	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
R^2	0.106	0.198	0.207	0.179	0.157
F-statistics	3.02***	6.56***	6.94***	5.78***	4.93***
Obs.	611	611	611	611	611
Breusch-Pagan test of independence: Chi²			1 739.694***		

1) Other variables include all the variables listed in Table 4 except income, wealth, and township dummy variables.
"Yes" means the variable is controlled in the model, otherwise "No". * and *** represent the 10 and 1% significant levels, respectively (*t*-test).

consumption by improving household net income, but the direct effect of migration on left-behind family members' pork consumption is negative. The directions of the direct effect of migration and indirect effect of migration through income are opposite, which explains why the parameter of migration for pork consumption becomes significant when we control for the positive effect of household net income.

Consistent with the results in Table 6, the impact of migration on dietary diversity remains not significant even by further controlling for the variables of household net income and household wealth in Table 9. Similar to the negative impact of migration on the grain and pork consumption of left-behind family members, the number of migrant family members also has significant and negative effects on nutrient intake, including energy, protein, fat, and carbohydrate. After controlling for the impact of household income and wealth, migration has stronger negative impacts

Table 7 Estimation results of household income and wealth: 2SLS-IV

Variable[1)]	Income	Wealth
Migration	6.839***	–1.775
	(3.144)	(7.906)
Other variables	Yes	Yes
Township	Yes	Yes
Constant	Yes	Yes
F-statistics	2.01***	6.06***
Obs.	611	611

[1)] Other variables include all the variables listed in Table 4 except income, wealth, and township dummy variables.
"Yes" means the variable is controlled in the model, otherwise "No". *** represents the 1% significant levels, respectively (*t*-test).

Table 8 Seemingly unrelated regression (SUR) results for the modified models of the food consumption of left-behind family members

Variable[1)]	Grain	Vegetables	Pork	Poultry	Beef	Mutton	Aquatic	Egg	Milk
Migration	–0.329*	0.0005	–0.154*	0.0003	–0.031	0.002	–0.108	–0.001	–0.021
	(0.182)	(0.169)	(0.091)	(0.062)	(0.025)	(0.006)	(0.068)	(0.043)	(0.060)
Income	–0.002	0.012**	0.005*	–0.002	0.001	0.0003	–0.0001	–0.0004	–0.0001
	(0.005)	(0.005)	(0.003)	(0.002)	(0.001)	(0.0002)	(0.002)	(0.001)	(0.002)
Wealth	–0.006**	–0.003	0.002	0.001	0.001**	0.0002**	0.001	0.004***	0.005***
	(0.003)	(0.003)	(0.002)	(0.001)	(0.0004)	(0.0001)	(0.001)	(0.001)	(0.001)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Township	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.146	0.123	0.144	0.095	0.075	0.046	0.148	0.099	0.103
F-statistics	4.18***	3.42***	4.11***	2.57***	1.98***	1.19	4.25***	2.7***	2.8***
Obs.	611	611	611	611	611	611	611	611	611
Breusch–Pagan test of independence: Chi^2					408.404***				

[1)] Other variables include all the variables listed in Table 4 except income, wealth, and township dummy variables.
"Yes" means the variable is controlled in the model, otherwise "No". *, **, and *** represent the 10, 5, and 1% significant levels, respectively (*t*-test).

Table 9 Seemingly unrelated regression (SUR) results for the modified models of the dietary diversity and nutrient intake of left-behind family members

Variable[1)]	OLS	SUR			
	Dietary diversity	Energy	Protein	Fat	Carbohydrate
Migration	–0.005	–52.641***	–2.478**	–1.467*	–7.629*
	(0.005)	(22.718)	(1.219)	(0.773)	(4.088)
Income	0.00003	0.365	0.037	0.030	0.009
	(0.0001)	(0.682)	(0.037)	(0.029)	(0.122)
Wealth	0.0003***	0.102	0.042**	0.043***	–0.124**
	(0.0001)	(0.387)	(0.021)	(0.017)	(0.069)
Other variables	Yes	Yes	Yes	Yes	Yes
Township	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
R^2	0.122	0.199	0.214	0.190	0.161
F-statistics	3.24***	6.06***	6.66***	5.73***	4.69***
Obs.	611	611	611	611	611
Breusch–Pagan test of independence: Chi^2			1 739.694***		

[1)] Other variables include all the variables listed in Table 4 except income, wealth, and township dummy variables.
"Yes" means the variable is controlled in the model, otherwise "No". *, **, and *** represent the 10, 5, and 1% significant levels, respectively (*t*-test).

on energy, protein, and fat but a weaker negative impact on carbohydrate compared with the impact of migration on nutrient intake in Table 6.

4.3. Robustness check

To ensure that these results are robust instead of relying on the model specifications, we carry out a robustness check by using alternative models. In the above analysis, we used the number of migrant family members in a household as the main explanatory variable, while here we replace it with a dummy variable for whether there is at least one migrant family member in a household. Appendix B shows the heterogeneity in the mean values of the key independent variables between households with and without migrant family members. However, sample selection bias may exist for the dummy variable of migration due to unobserved heterogeneity (Huang *et al.* 2015). Hence, to assess the impact of the dummy variable of migration on left-behind family members' food consumption and nutrition, we adopt a propensity score matching (PSM) approach with the single nearest-neighbor matching method.

Table 10 reports the simulated average treatment effects on the treated (ATTs) of migration on household income, wealth, food consumption, nutrient intake, and dietary diversity. In line with our main findings, migration has a significant and positive impact on the household net income of smallholder rubber farmers; however, it leads to the decreases in grain and pork consumption and nutrient intake for left-behind family members. When controlling for potential sample selection bias, migration also negatively affects the consumption of milk and dairy products. However, it still has no statistically significant impact on dietary diversity.

Specifically, according to the ATT results, migration leads to left-behind family members in households with migrants consuming less grain by 1.04 kg/month/person (9.0%), pork by 0.32 kg/month/person (9.0%), and milk and dairy by 0.45 kg/month/person (41.7%). Consequently, migration reduces left-behind family members' intake of energy, protein, fat, and carbohydrate by 136.81 Kcal/person/day (7.6%), 4.86 g/person/day (6.2%), 2.62 g/person/day (5.6%), and 25.47 g/person/day (8.8%), respectively.

5. Conclusion

With increasing rural-urban migration in China, the livelihood of left-behind family members including children and the elderly is a concern, particularly in remote rural areas where the improvement in farmers' income and livelihood relates to the nationwide rural revitalization in China. By using data on 611 smallholder rubber farmers in XSBN, this study is the first to explore the impacts of migration on left-behind family members' food consumption, nutrient intake, and dietary diversity. The results suggest that migration reduces the grain and pork consumption and nutrient intake of left-behind family members, although it significantly improves household net income. The robustness of these main

Table 10 Average treatment effects on the treated (ATTs) of migration on household income, wealth, food consumption, and nutrient intake: PSM estimation

Variable	Nearest-neighbor matching using the single closest neighbor		ATT
	Migration	Non-migration	
Income (thousand CNY/year/person)	15.14	6.30	8.84***
Wealth (thousand CNY/person)	58.71	56.81	1.90
Food consumption (kg/month/person)			
Grain	10.51	11.55	–1.04**
Vegetables	6.96	7.29	–0.32
Pork	3.22	3.54	–0.32*
Poultry	1.19	1.08	0.11
Beef	0.29	0.32	–0.03
Mutton	0.03	0.01	0.02
Aquatic products	1.76	1.77	–0.01
Egg	0.77	0.75	–0.02
Milk and dairy products	0.63	1.08	–0.45***
Nutrient intake			
Energy (Kcal/person/day)	1 663.91	1 800.72	–136.81**
Protein (g/person/day)	73.69	78.55	–4.86**
Fat (g/person/day)	43.94	46.57	–2.62*
Carbohydrate (g/person/day)	264.52	289.99	–25.47**
Dietary diversity			
Shannon equitability index	0.76	0.76	0.00

*, **, and *** represent the 10%, 5%, and 1% significance levels, respectively (*t*-test).

findings is also confirmed by using the PSM approach with a counterfactual analysis.

The findings of this study are critical to better understand the welfare effects of migration on left-behind family members. While the migration of farmers from rural to urban regions in China can significantly improve their income (Taylor *et al.* 2003; Du *et al.* 2005; Zhu and Luo 2010; Chen *et al.* 2014), our findings show that the income returns of migrant farmers do not convert into a positive welfare effect for left-behind family members. The income growth of households with migrants does not promote farmers' nutritional transition, switching from a traditional diet intensive in vegetable/fiber products to a more westernized diet intensive in meat and dairy (Yu and Abler 2014). On the contrary, migration leads to a decline in the consumption of grain, pork, and milk and dairy products as well as the nutrient intake of left-behind family members. This result may be because remittances cannot offset the loss of the food previously produced by migrants during on-farm work. Therefore, left-behind family members do not share the welfare benefits of the income growth from rising rural–urban migration. Considering that the food consumption and nutrient intake of farmers relate to human capital development in rural China, it is thus recommended that researchers pay more attention to the well-being of left-behind family members.

Finally, we point out several limitations of this analysis. Firstly, the survey data on food consumption were recalled and estimated by respondents, making the quality lower than those recorded. Another limitation is the substitution within food groups, which might affect the estimated nutrition intakes as the constant food-nutrition conversion is used. Finally, while the current case study of smallholder rubber farmers is unique and provides essential implications for remote rural areas in China, an analysis using more representative nationwide samples may have broader policy implications.

Acknowledgements

This study was conducted under the framework of the Sino-German "SURUMER Project" funded by the Bundesministerium für Wissenschaft, Technologie und Forschung (BMBF; 01LL0919). This work was also supported by the China Postdoctoral Science Foundation (2017M620536) and the National Natural Science Foundation of China (71742002, 71673008, and 71761137002).

Appendices associated with this paper can be available on http://www.ChinaAgriSci.com/V2/En/appendix.htm

References

Azzarri C, Zezza A. 2011. International migration and nutritional outcomes in Tajikistan. *Food Policy*, **36**, 54–70.

Bai J, Wahl T I, Lohmar B T, Huang J. 2010. Food away from home in Beijing: Effects of wealth, time and "free" meals. *China Economic Review*, **21**, 432–441.

Bhandari R, Smith F J. 2000. Education and food consumption patterns in China: Household analysis and policy implications. *Journal of Nutrition Education*, **32**, 214–224.

Brauw A. 2011. Migration and child development during the food price crisis in El Salvador. *Food Policy*, **36**, 28–40.

Brauw A D, Mu R. 2011. Migration and the overweight and underweight status of children in rural China. *Food Policy*, **36**, 88–100.

Burggraf C, Kuhn L, Zhao Q R, Teuber R, Glauben T. 2015. Economic growth and nutrition transition: An empirical analysis comparing demand elasticities for foods in China and Russia. *Journal of Integrative Agriculture*, **14**, 1008–1022.

Chan K W. 2012. Migration and development in China: Trends, geography and current issues. *Migration and Development*, **1**, 187–205.

Chang H, Dong X, MacPhail F. 2011. Labor migration and time use patterns of the left-behind children and elderly in rural China. *World Development*, **39**, 2199–2210.

Chen C J. 2007. Parental labor migration and children's educational progress in rural China. *Review of Economics of the Household*, **9**, 379–396.

Chen Q, Deng T, Bai J, He X. 2017. Understanding the retirement-consumption puzzle through the lens of food consumption-fuzzy regression-discontinuity evidence from urban China. *Food Policy*, **73**, 45–61.

Chen R, Ye C, Cai Y, Xing X, Chen Q. 2014. The impact of rural out-migration on land use transition in China: Past, present and trend. *Land Use Policy*, **40**, 101–110.

Chen Y, Zhao Z. 2012. Impact of the parental rural-urban migration on the health of left-behind children in rural China. *Chinese Journal of Health Policy*, **5**, 48–54. (in Chinese)

Connelly R, Maurer-Fazio M. 2016. Left behind, at-risk, and vulnerable the elderly in rural China. *China Economic Review*, **37**, 140–153.

Deaton A S, Muellbauer J. 1980. An almost ideal demand system. *American Economic Review*, **70**, 321–326.

Du Y, Park A, Wang S. 2005. Migration and rural poverty in China. *Journal of Comparative Economics*, **33**, 688–709.

Fan S, Cramer G, Wailes E. 1994. Food demand in rural China: Evidence from rural household survey. *Agricultural Economics*, **11**, 61–69.

Gibson J, McKenzie D, Stillman S. 2011. What happens to diet and child health when migration splits households? Evidence from a migration lottery program. *Food Policy*, **36**, 7–15.

Gong Z, Yang Q. 2010. Analysis on nutrition status and its influencing factors of left-behind children in rural of Hubei. *Maternal and Child Health Care of China*, **26**, 3775–3778.

(in Chinese)

Guo X G, Mroz T A, Popkin B M, Zhai F Y. 2000. Structural change in the impact of income on food consumption in China, 1989–1993. *Economic Development & Cultural Change*, **48**, 737–760.

He C, Ye J. 2014. Lonely sunsets: Impacts of rural-urban migration on the left-behind elderly in rural China. *International Journal of Population Geography*, **20**, 352–369.

Howell A. 2017. Impacts of migration and remittances on ethnic income inequality in rural China. *World Development*, **94**, 200–211.

Hu F. 2012. Migration, remittances, and children's high school attendance: The case of rural China. *International Journal of Educational Development*, **32**, 401.

Hu F. 2013. Does migration benefit the schooling of children left behind? *Demographic Research*, **29**, 31–70.

Huang J, Rozelle S. 1998. Market development and food demand in rural China. *China Economic Review*, **9**, 25–45.

Huang J, Wang Y, Wang J. 2015. Farmers' adaptation to extreme weather events through farm management and its impacts on the mean and risk of rice yield in China. *American Journal of Agricultural Economics*, **97**, 602–617.

Jia Z, Shi L, Cao Y, Delancey J, Tian W. 2010. Health-related quality of life of "left-behind children": A cross-sectional survey in rural China. *Quality of Life Research*, **19**, 775–780.

Jorgenson D W, Lau L J, Stoker T M. 1982. The Transcendental logarithmic model of aggregate consumer behavior. In: Basman R, Rhodes G, eds., *Advances in Econometrics*. JAI Press, Greenwich.

Karamba W R, Quiñones E J, Winters P. 2011. Migration and food consumption patterns in Ghana. *Food Policy*, **36**, 41–53.

Li H, Zhu Y. 2006. Income, income inequality, and health: Evidence from China. *Journal of Comparative Economics*, **34**, 668–693.

Liu H, Wahl T I, Seale J L, Bai J. 2015. Household composition, income, and food-away-from-home expenditure in urban China. *Food Policy*, **51**, 97–103.

Lu Y. 2012. Education of children left behind in rural China. *Journal of Marriage and Family*, **74**, 328–341.

Min S, Bai J, Seale J L, Wahl T. 2015. Demographics, societal aging, and meat consumption in China. *Journal of Integrative Agriculture*, **14**, 995–1007.

Min S, Huang J, Bai J, Waibel H. 2017a. Adoption of intercropping among smallholder rubber farmers in Xishuangbanna, China. *International Journal of Agricultural Sustainability*, **15**, 223–237.

Min S, Huang J, Waibel H. 2017b. Rubber specialization vs crop diversification: The roles of perceived risks. *China Agricultural Economic Review*, **9**, 188–210.

Min S, Waibel H, Huang J. 2017c. Smallholder participation in the land rental market in a mountainous region of Southern China: Impact of population aging, land tenure security and ethnicity. *Land Use Policy*, **68**, 625–637.

Mu R, Brauw A. 2015. Migration and young child nutrition: Evidence from rural China. *Journal of Population Economics*, **28**, 631–657.

NBSC (National Bureau of Statistics of China). 2015. *China Statistical Yearbook 2015*. China Statistics Press, Beijing, China. (in Chinese)

Nguyen M C, Winters P. 2011. The impact of migration on food consumption patterns: The case of Vietnam. *Food Policy*, **36**, 71–87.

Ren Y, Zhang Y, Loy J. P, Glauben T. 2017. Heterogeneity in food consumption among income classes in rural China. [2018-1-10].https://macau.uni-kiel.de/servlets/MCRFileNodeServlet/dissertation_derivate_00007056/Essays_on_food_consumption,_income_inequality,_and_health-related_issues_in_China.pdf#page=26

Robson M, Luo J, Peng X, Rong Z, Yao K, Hu R, Du Q, Fang J, Zhu M. 2008. The status of care and nutrition of 774 left-behind children in rural areas in China. *Public Health Reports*, **123**, 382–389.

Sekabira H, Qaim M. 2017. Can mobile phones improve gender equality and nutrition? Panel data evidence from farm households in Uganda. *Food Policy*, **73**, 95–103.

Sun B, Ge H, Li Z, Qian Z, Yin C, Dong Y, Ren X, Liu L. 2010. Food and nutrition survey of the left behind children aged 0–5 years in rural China. *Maternal and Child Health Care of China*, **9**, 1237–1240. (in Chinese)

Sun W, Wang Y. 2016. The effect of parental migration on left-behind children's health in China. *China Economic Quarterly*, **15**, 963–988. (in Chinese)

Taylor J E, Rozelle S, De Brauw A. 2003. Migration and incomes in source communities: A new economics of migration perspective from China. *Economic Development and Cultural Change*, **52**, 75–101.

Tian X, Huang Y, Zhong L, Wang H. 2017. Nutritional status of left-behind children in rural China. *China Economic Quarterly*, **17**, 247–276. (in Chinese)

Tian X, Yu X. 2013. The demand for nutrients in China. *Frontiers of Economics in China*, **8**, 186–206.

Tian X, Yu X. 2015. Using semiparametric models to study nutrition improvement and dietary change with different indices: The case of China. *Food Policy*, **53**, 67–81.

Wang X, Huang J, Zhang L, Rozelle S. 2011. The rise of migration and the fall of self-employment in rural China's labor market. *China Economic Review*, **22**, 573–584.

Wen M, Lin D. 2012. Child development in rural China: Children left behind by their migrant parents and children of nonmigrant families. *Child Development*, **83**, 120–136.

Ye J, Lu P. 2011. Differentiated childhoods: Impacts of rural labor migration on left-behind children in China. *The Journal of Peasant Studies*, **38**, 355–377.

Yen S T, Fang C, Su S J. 2004. Household food demand in urban China: A censored system approach. *Journal of Comparative Economics*, **32**, 564–585.

Yen S T, Lin B, Davis C G. 2008. Consumer knowledge and meat consumption at home and away from home. *Food Policy*, **33**, 631–639

Yu X. 2018. Engel curve, farmer welfare and food consumption in 40 years of rural China. *China Agricultural Economic Review*, **10**, 65–77.

Yu X, Abler D. 2014. Where have all the pigs gone? Inconsistencies in pork statistics in China. *China Economic Review*, **30**, 469–484.

Zezza A, Carletto C, Davis B, Winters P. 2011. Assessing the impact of migration on food and nutrition security. *Food Policy*, **36**, 1–6.

Zhao Q, Yu X, Wang X, Glauben T. 2014. The impact of parental migration on children's school performance in rural China. *China Economic Review*, **31**, 43–54.

Zhen L, Cao S, Cheng S, Xie G, Wei Y, Liu X, Li F. 2010. Arable land requirements based on food consumption patterns: Case study in rural Guyuan District, western China. *Ecological Economics*, **69**, 1443–1453.

Zhong F, Xiang J, Zhu J. 2012. Impact of demographic dynamics on food consumption: A case study of energy intake in China. *China Economic Review*, **23**, 1011–1019.

Zhou C, Sylvia S, Zhang L, Luo R, Yi H, Liu C, Rozelle S. 2015. China's left-behind children: Impact of parental migration on health, nutrition, and educational outcomes. *Health Affairs*, **34**, 1964–1971.

Zhu N, Luo X. 2010. The impact of migration on rural poverty and inequality: A case study in China. *Agricultural Economics*, **41**, 191–204.

Executive Editor-in-Chief HUANG Ji-kun
Managing editor WENG Ling-yun