Migration decisions of parents and the nutrition intakes of children left at home in rural China

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Abstract: Using an individual-level dataset drawn from the China Health and Nutrition Survey in 2000, 2004, 2006, and 2009, this paper investigated whether the parental labour migration is associated with deficiencies in the nutrition intakes of children left at home in the rural area. The results show that the parental migration increases the probability of deficiency in the energy and protein intake of children left at home. Although several studies have pointed out that the parental remittances can increase the economic well-being of their children at home, this study points to an undesired cost of the parental migration. Governments should establish effective policies to promote the benefits of migration while minimizing the potential costs. In particular, specific social welfare programs targeting on children in the rural area can be designed to insecure the nutritional health of children left at home in the rural area.

Key words: China Health and Nutrition Survey, health and nutrition, labor supply, parental migration

Since the market-oriented economic reform in 1978, the accelerated development of urbanization has brought about a dramatic increase in the internal migration from rural to urban areas in China. The number of migrants has increased from approximately 30 million in the late 1980s to 145 million in 2009 (National Statistics Bureau of China 2010). Remittances from migrant workers are believed to improve the living conditions and to facilitate productive and non-productive investments within the migrant households in rural areas (e.g., Chimhowu et al. 2004). However, a large population consisting of children, married women, and the elderly are left behind at the rural area because of the rural-urban migration (Chang et al. 2010). It is estimated that almost 58 million children under the age of 18 years (28% of rural children) are left behind to live with only one parent (mostly mothers), grandparents, or other relatives in rural areas in China (All China Women's Federation 2008).

Examining the effect of the parental migration on the nutrition status of children left at home in rural China is of particular interest for the policy-makers. The importance of this issue can be validated by a number of reasons. Grandparents or other family members are in charge of the daily life of children whose parents migrated and worked in urban cities. Childcare differs between parents and other family members, and the nutrition status of children whose parents stay at home may differ compared with the children whose parents have migrated to urban cities. On the other hand, social welfare programs for childcare quality in rural areas are not fully realized compared with those in the cities. Therefore, children left behind in rural China suffer from the decreasing care quality due to the scarcity of the rural formal care services and the exceedingly imperfect social security systems. As a result, the nutrition and health conditions of left-behind children have been great concerns during the process of the Chinese economic reform. Therefore, a comprehensive understanding of the impact of migration on both sides of the migrant workers themselves and the left-behind group is crucial in making informed policy decisions.

Several studies have demonstrated the consequences of the rural labour migration for the Chinese economy and rural households (e.g., Rozelle 1999; Zhao 1999; Zhang et al. 2004; Du et al. 2005). However, these studies primarily focus on the determinants of the migrant workers' employment and how their earnings can improve the living conditions of the remaining household members in the rural area. Not much attention has been given to the effects of the absence of the migrant parents on their children. Although the recent research states that the parental migration is associated with a lower education attainment and school enrolment rate (Hu and Li 2009; Meyerhoefer and Chen 2011), little is known about the impact of the parental labour migration on the nutritional status of children left behind in rural China.

The nutrition status of children left behind at home should be a focus of the policy interest in that malnu-

trition (or nutrition intake deficiency and unsuitable dietary patterns) affects the rate of morbidity and mortality among the young, and also poses a threat to their physical and mental development (e.g., Blau 1986; Senaur and Garcia 1991). In addition, malnutrition weakens the immune responses and aggravates the effects of infection (Pelletier et al. 2003); therefore, children who are malnourished tend to have more health problems, such as severe diarrhoea episodes, and are at a higher risk of pneumonia. A suitable dietary composition and balanced nutrition intake, especially sufficient calorie energy and a high quality protein intake, are essential to guarantee the children's physical and mental development, and also to prevent diseases from occurring. As one of the most important indicators of the quality of life, the nutritional status of children is positively correlated with their education, future labour involvement, and wage determination (Behrman 1990). For these reasons, this study focuses on the nutrition status of children left behind in rural China.

The primary objective of this paper is to investigate the effect of the parental migration on the nutrient intakes of children in rural China. Using data drawn from the China Health and Nutrition Survey in 2000, 2004, 2006 and 2009, this paper compared the welfare of children who live in households in rural China, when one, two, or none of the parents migrated. Moreover, the extent to which the parental migration behaviour affects the well-being of children as measured by nutrient intakes was examined. Emphasis was placed on the deficiencies on the nutrient intake, defined as a situation when a child's nutrition does not conform to the dietary recommendations. The Dietary Reference Intake (DRI) includes recommendations for the energy and other nutrient intakes, and it specifies the level of the average nutrient intakes essential to engage in the required minimal activity related to good health and hygiene (standard minimum requirement) and to carry out productive activities to sustain the supply of energy and other required nutrients to the body.

LITERATURE REVIEW

A large number of studies have documented the benefits of the migrants' remittances to home communities (e.g., Stark and Bloom 1985; Hoddinott 1992, 1994; Azam and Gubert 2006; Amuedo-Dorantes and Pozo 2004), but few have considered the trade-off between the increased material resources from migration and the consequences resulting from the parental absence and migratory influence. Parental migration is likely to affect the time and labour allocation in both productive and reproductive activities, including home production and time spent in childcare (Stark and Bloom 1985; Glick and Sahn 1998). Thus, the parent's labour migration, which reduces the time available for the household activities related to child development, may place young children at a nutritional risk (Swart 2004). These effects may be even more tremendous if the migrating parents are mothers. In the case of imperfect labour or credit markets, where the household is unable to hire labour or the available labour is not a perfect substitute for the labour, the household production and reproduction could suffer substantial consequences. From this point of view, the parental migration behaviours have negative impacts on the child growth (Gibson et al. 2011).

Meanwhile, in the absence of migrant men, women gain a more direct controlling power over the household economic resources, and could decide to allocate them differently, for example, by purchasing more higher quality food. The bulk of the literature in a variety of settings and under different circumstances (e.g., Kennedy and Haddad 1994; Case and Paxson 2001; Maitra 2004; Doss 2006) indicate that the resources controlled by mothers are spent differently (particularly on food and other inputs into child nutrition and health) and undoubtedly, the well-being of children can be improved.

With respect to the rural-urban migration in China, most research has concentrated on the education attainment and school performance of the left-behind children (Chen et al. 2009). A recent study by De Brauw and Mu (2011) examined the effect of Chinese rural-urban migration on the prevalence of underweight and overweight children. They found that migration is related to different nutritional outcomes for the left-behind children aged 2 to 14 years old. Nevertheless, a far less attention has been given to the impact of parental migration on the nutrition intake of children, especially on children who are left behind in rural China.

DATA

Data were drawn from the rural sample of the CHNS, a large-scale survey covering nine provinces in China from 1989 to 2009, conducted jointly by the University of North Carolina at Chapel Hill and the Chinese Academy of Preventive Medicine. It contains variables for the nutrient intakes calculated by food consumption for a three-day period for individuals in the household, the household migratory status, and other socio-economic characteristics at the individual, household, and community levels. Although

Table 1. Nutrition intake status of children 6–17 years old by parental migration status

Intake	Definition	No migrant parents		One migrant parent		Two migrant parents	
		mean	SD	mean	SD	mean	SD
Energy	average energy intake (kcal/d)	1893.24	835.23	1870.72	665.81	1789.79	701.74
Protein	average protein intake (g/d)	56.56	23.8	54.46	22.8	52.18	22.05
Fat	average fat intake (g/d)	60.75	61.46	59.24	34.04	54.51	40.68
D_energy	if energy intake is below the DRI (= 1)	0.78	0.42	0.77	0.42	0.75	0.43
D_protein	if protein intake is below the DRI (= 1)	0.81	0.39	0.85	0.36	0.83	0.38
D_fat	if fat intake is above the DRI (= 1)	0.41	0.49	0.42	0.49	0.32	0.47
Sample		4865		592		330	

Source: China Health and Nutrition Survey (2000, 2004, 2006, 2009)

the CHNS is a panel data set spanning from 1989 to 2009, the present analysis was primarily based on the 2000, 2004, 2006, and 2009 surveys.[1]

In the analytical sample of study, children are defined as individuals aged 6 to 17 years old in rural households; a total of 5787 children were included in the study.[2] Following the definition set by the All China Women's Federation, a migrated parent is defined as a parent who is out of town for work and does not live in the household. Accordingly, *left-behind children* are defined as young children (below 18 years old) who are left in rural areas and live with their grandparents or other family relatives when one or both parents are working away from home. Based on the different migration statuses of the parents, all children were divided into three groups: children with both parents at home, children with one migrated parent, and children with two migrated parents. The sample size of each corresponding subgroup was 4865, 592, and 330, respectively. In the full sample, the left-behind children accounted for 15.93%.

Consistent with the approach used in many public health studies, a cut-off point for each nutrient intake was used to define whether each child is nutritionally deficient. Nutritional intake deficiency was calculated using the dietary reference intake (DRI) for calorie, protein, and fat developed by the Chinese Food and Nutrition Research Institute of China. The DRIs are not individual-specific but are specified for age and gender categories. For the energy and protein intake, the DRIs are defined as the minimum requirements of nutrients for an active and healthy life rather than a simple survival, whereas the upper bound is defined for the fat intake; the excess consumption of fat is harmful to the health. According to this nature of cut-off points, two types of nutrition deficiencies were considered. One is the type of under-nutrition where a child's energy and/or protein intakes are lower than the DRIs, and the other is the type of over-nutrition, when a child's fat intakes exceed the DRIs.[3]

Sample statistics of children's nutrition intakes by different migration statuses of their parents are presented in Table 1. As shown in Table 1, the energy calorie intake deficiency rates were slightly higher among children with no migrant parents than among those whose parents had migrated. The energy calorie deficiency ratio for the children with non-migrated parents was 78%, whereas the energy calorie deficiency ratios for the children with one migrated parent and two migrated parents were 77% and 75%, respectively. In contrast, a higher percentage of children with one migrating parent were exposed to the protein malnutrition compared with those having non-migrated parents. Concerning fat intake, the percentage suffering from the over-consumption of fat was the highest for children with one migrated parent (42%), followed by children with non-migrated parents (41%), and children with two migrated parents (32%).

To assess the effect of the parental migration on child nutrition, a set of variables reflecting the socio-demographic characteristics of children, households, and communities were also examined. First, some

[1]Data in 2000, 2004, 2006, and 2009 of the CHNS survey were only used. This is because information on migration at the household level was available since 1997. In addition, only waves in 2000, 2004, 2006, and 2009 included all provinces of the survey areas in the CHNS.

[2]Because children aged below 6 years old have different nutrient demands, we further excluded those children samples below 6 years old during the survey period.

[3]Detailed information of the DRIs can be found in the Chinese Dietary Reference Intakes (2000), edited by Chinese Nutrition Society, Beijing and published by Chinese Light Industry Publisher.

personal variables, such as the child's gender and age, were selected. Meanwhile, the gender of the child often affected the amount of the intra-household resources he or she received. This is particularly observed in rural China, where the preference of sons still prevails; girls are likely to be in disadvantageous positions that negatively affect their diet (Osmani and Sen 2003). Several household characteristics were considered in the analysis: birth order (a binary variable indicating if the child is the oldest in the household), an indicator variable for whether or not the child is the sole child in the household, and the household size. In general, a child's dietary consumption and nutrient intakes might differ by the birth order, either because of the biological factors or due to the behavioural influences (Horton 1988; Rubalcava and Contreras 2000). Parents may learn from the experience of their older children, and they may be more efficient in raising their latter ones. In other circumstances, differences in the resource allocations may result from the parents' tastes, which in turn may reflect the social and cultural norms. A larger household and more siblings could imply competition for the intra-household resources and might decrease the amount of resources each child receives, as well as increase the probability of overcrowding in the household (Baez 2008). In this work, the household income was included to control the income effect of the parental migration. Household income is hypothesized to have a positive effect on the nutritional status (Behrman and Skoufias 2004). The effect of the dummy variable, which indicates whether an elderly aged 60 years and over lives in the household, on the children's nutritional intakes is ambiguous. It might be taken as a substitute child caregiver when the parents have migrated for employment, and have a positive impact on the children's nutrient intakes.

In addition to the individual data, the CHNS survey also provided an additional dataset which contains the information of the local community that each individual lived in. We specified some variables from this community dataset to capture the economic condition of the local village. The mean price of staple food (e.g., the price of rice, pork, and flour in the free market) were incorporated to explore the effects of agricultural production on the parental migration and the children's nutritional intakes. On the one hand, these price variables reflect the benefits coming from agricultural production, where higher prices mean a higher income earned from agricultural activities and hence make people from rural areas less likely to migrate. On the other hand, these variables are also cost indicators of the household food expenditures; thus, higher prices reflect higher household food expenditures on less food, which will decrease the children's nutrient intake due to a consequent strain on financial resources. Furthermore, the community

Table 2. Summary statistics of the sample

Variable	Definition	No migrant parents		One migrant parents		Two migrant parents	
		mean	SD	mean	SD	mean	SD
Age	child's age (years)	12.22	3.15	11.82	3.20	11.05	3.10
Male	child's gender (male = 1)	0.54	0.49	0.54	0.49	0.52	0.5
Education	child's education (years)	4.57	5.01	4.87	3.96	3.65	4.39
Birth order	if the oldest child	0.75	0.43	0.8	0.39	0.79	0.41
Single child	if single child in the household	0.56	0.49	0.62	0.49	0.62	0.49
Elderly	if there is elderly aged ≥ 60 in the household	0.20	0.40	0.28	0.45	0.52	0.50
HH size	numbers of the household.	4.36	1.21	4.34	1.61	4.91	1.76
Distance	distance from local food market(kilometre)	1.48	2.36	1.46	1.87	1.81	2.38
Rice price	average market rice price (yuan/Jin)	1.65	1.94	1.84	1.7	1.36	2.22
Meat price	average market weighted meat price (yuan/Jin)	9.19	3.71	9.59	3.26	9.82	7.43
Flour price	average market flour price (yuan/Jin)	2.19	4.94	3.31	9.42	2.44	5.61
Income	household's net income(10 000 Yuan)	2.37	2.9	2.05	2.41	1.83	2.33
Village migration	rate of out migration in the village last year	0.28	0.23	0.32	0.23	0.31	0.22
Sample		4865		592		330	

Source: China Health and Nutrition Survey (2000, 2004, 2006, 2009)

variable for the distance between the free markets of meat, poultry, and eggs and the village committee was also added in the analysis to capture the effect of the accessibility to food on the children's nutrition status. Finally, the regional dummy variables were included primarily to control the location fixed effects, including the regional differences in infrastructure and economic conditions. Year indicator variables were also selected to account for the evolution of the Chinese labour market and the trends of children's nutritional outcomes.

Table 2 exhibits the summary statistics for the other variables specified in the analysis. The sample statistics also differed by the migration status of the parents. For instance, the percentages of the elderly living in the household in the case of one migrated parent and two migrated parents were 28% and 52%, respectively, whereas only 20% of the elderly were found when both parents worked at home. In addition, the non-migrant households had moderately higher household incomes compared with the migrant households. For example, in the households of two migrant parents, the average annual household income was 18 300 RMB, whereas the households with one migrant parent and no migrant parents earned 20 500 and 23 700 RMB, respectively.

ECONOMETRIC MODEL

Before introducing the empirical strategy, one economic issue has to be addressed. Parental migration decisions are likely to be endogenous to the nutrition intakes of their children due to some unobserved common characteristics due to the unobserved common factors. To correct the potential endogeneity, the instrumental variable approach was employed (Greene 2010). The instrument used in the parental labour migration was the proportion of the parental migration rates in the village level of the previous year. Migration networks, as important information sources of labour markets, can increase the likelihood of migration by reducing the social, economic, and emotional costs of migration and improving benefits through increasing the chance of finding a job or reducing the job-searching time (Stark and Taylor 1991; Winters et al. 2001; Zha 2003). As a result, the network effect is likely to affect the parental migration decisions directly, but it does not directly affect the household-level choices of food consumption or the health-related outcomes of the children left behind. Several studies have adopted similar identification strategies to investigate the effect of the parental migration on the child health and nutritional status, measured by the anthropometrics or by the infant mortality, and uniformly find positive effects on health (e.g., Karamba et al. 2011; Nguyen and Winter 2011).

Consistent with the standard instrumental approach, the estimation procedure in the present study is a two-stage estimation framework. In the first stage analysis, we estimated a multinomial logit model for the parental migration decision equation. With the consistent estimates of the parental migration decision, we then calculated the predicted probability of the migration activity, and these predicted values were used to replace the observed outcomes of the parental migration decisions, which are included as the important determinants of the children's nutrition equation in the second stage analysis. In the second stage, a trivariate probit model for the children's nutrition deficiency equation system was estimated. The details of the econometric analysis in each stage analysis are introduced below.

First stage: migration decision of the parents

In predicting the status of the migrated parent of the children, a multinomial logistic regression model is specified as follows (Greene 2010):

$$\Pr(I_l = j) = \frac{\exp(X_i \times \gamma_j)}{\sum_{j=0}^{2} \exp(X_i \times \gamma_j)} \quad j = 0, 1, 2 \qquad (1)$$

where I_i represents the parental migration status of i^{th} child, which takes the value of 0 for a child with no migrated parents, 1 for one migrated parent, and 2 for two migrated parents, respectively. X_i is a vector of explanatory variables, and γ_j is a vector of unknown parameters for the migration group j.

Equation (1), therefore, gives the probability that the j^{th} parental migration status of each child, given the array of explanatory variables. The consistent estimates of the multinomial logit model can be obtained using the full information maximum likelihood estimation method (see Greene 2010 for details).

Second stage: modelling children nutrition deficiency

In the second stage, a trivariate probit model is estimated for the children's nutrition deficiency status to allows taking interrelations among different nutrients into account to gain statistical efficiency (Chang et al. 2011). In defining the unobserved latent variables Y_1^*, Y_2^*, and Y_3^*, they are found to represent the propensity of malnutrition of each child for the energy calorie, protein, and fat intakes, respectively.

Therefore, the trivariate probit model can be specified as follows (Chib and Greenberg 1998):

$$Y_{1i}^{*} = \beta_{01} + \beta_{11}\hat{I}_{1i} + \beta_{21}\hat{I}_{2i} + \beta_{31}Z_i + \mu_{1i} \quad (2)$$

$$Y_{2i}^{*} = \beta_{02} + \beta_{12}\hat{I}_{1i} + \beta_{22}\hat{I}_{2i} + \beta_{32}Z_i + \mu_{2i}$$

$$Y_{3i}^{*} = \beta_{03} + \beta_{13}\hat{I}_{1i} + \beta_{23}\hat{I}_{2i} + \beta_{33}Z_i + \mu_{3i}$$

$$\begin{cases} Y_{ki} = 1 & \text{if} \quad Y_{ki}^{*} > 0 \\ Y_{ki} = 0 & \text{if} \quad Y_{ki}^{*} \le 0 \end{cases} \quad (k = 1, 2, 3)$$

where Y_{ki} is observed for each nutrient, a binary indicator that takes the value 1 if the child fails to reach the DRI, and takes the value 0 otherwise. The variables $\hat{I}_{1i}, \hat{I}_{2i}$ are the predicted probabilities given one and two migrated parents; these are calculated based on the estimates of the first stage multinomial logit model. The vector Z_i represents other variables. The vectors u_{ki} are random errors, and they are assumed to follow a multivariate normal distribution $N(0, \Sigma)$ with zero as mean and Σ as the covariance. For model identification purposes, the variance of each nutrient (i.e., the diagonal component of Σ) is normalized to be one (Maddala 1983). Therefore, only the correlation coefficients between each pair of nutrients (ρ_{12}, ρ_{23}, ρ_{13}) are estimated. All econometric analyses were conducted using the STATA 11.0 statistical software.

RESULTS AND DISCUSSIONS

The empirical results are presented in two sets. The first part of the presentation focuses on the determinants associated with the parental migration status of children. Then, the nutrition equations for the children left behind at home are presented.

Determinants of the parental migration status

The decision for parental migration was estimated using the multinomial logit model. The marginal effects are presented in Table 3. The explanatory power of the proposed instrument was tested first before presenting the discussion on the effects of the selected variables. In this study, the village-level migration rate was used as the instrument of the parental migration. The result of the likelihood-ratio (LR) test was 6.02 (p-value = 0.049), implying that the migration rate of the village average was statistically validated at the 10% level of significance. In addition, the instrumental variable (i.e. village level migrant network) had a positive effect on the probability of parental migration, indicating that, other things being equal, a household living in a village of a high migration rate in the last year had a higher likelihood of having a migrant parent than a household living in a village with low migration rates. The finding is in accordance with the importance of the network effect on residents' migration decisions (Taylor 1987; Massey et al. 1993; Zhao 2003).

Table 3. Estimation of the parental migration decisions equation

Variable	One migrant parent		Both migrant parents	
	marginal effect	SE	marginal effect	SE
Age/100	–0.006	0.16	–0.024	0.092
Male	–0.003	0.007	–0.002	0.004
Education	–0.002	0.001	–0.003***	0.001
Birth order	0.010	0.011	0.005	0.006
Single child	–0.007	0.01	0.008	0.006
Elderly	0.028***	0.01	0.067***	0.01
HH size	–0.009***	0.003	0.004**	0.002
Income	–0.009***	0.002	–0.007***	0.001
Distance/100	0.015	0.167	0.212**	0.089
Rice price/100	0.087	0.188	–0.333***	0.104
Flour price/100	0.128***	0.042	–0.029	0.032
Meat price/100	–0.005	0.109	0.086**	0.039
Year 2004	0.127***	0.019	0.03***	0.009
Year 2006	0.135***	0.021	0.035***	0.011
Year 2009	0.171***	0.024	0.043***	0.012
Heilongjiang	–0.045***	0.012	–0.002	0.014
Jiangsu	0.044	0.022	0.021	0.019
Shandong	–0.040	0.013	0.023	0.019
Henan	–0.016	0.014	0.015	0.015
Hubei	0.012	0.018	0.029	0.019
Hunan	0.005	0.017	0.119***	0.037
Guangxi	0.007	0.016	0.013	0.014
Guizhou	0.050**	0.021	0.058**	0.023
Village migration	0.028*	0.015	0.015*	0.009
Log likelihood = –2817.35				
IV Test: LR test value = 6.02; (p-value = 0.049)				

*, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

A multinomial logit model is estimated

Consistent with the finding in the previous studies (e.g., Liu 2008), it is evident that the presence of an elderly aged 60 years and over has a strongly positive and statistically significant effect on the households with both one and two parents that had migrated to the city. Thus, having an elderly living in the household can be viewed as a useful supplement to home production, including childcare. In average, the probability of one and two parents migrating for the household with an elderly increased by 2.8% and 6.7%, respectively, ceteris paribus, compared with households without any residing elder person.

The results show that the parental migration decisions were negatively associated with the household income. Our findings are consistent with the evidence that a parent typically migrates to attain better economic conditions (Massey et al. 1994). Food commodity prices also played an important role in the parental migration decision. The price of rice had a negative and significant effect on households with two migrated parents, whereas the price of pork had a positively significant impact on the parental migration. One possible explanation for this finding is that farmers may benefit more from the primary agricultural production (such as rice production) with the increasing price of rice, and thus, parents that live in the area with a higher price for rice are less likely to migrate. Further, the empirical results also indicated that the rural labour migration rates significantly increased inter-temporally between 2000 and 2009, accompanied by the acceleration of urbanization and industrialization in China.

Effect of migration on the nutrition intakes of children

The empirical results of the effect of the parental migration on the nutrient intakes of children and marginal effects of exogenous variables on the risk of deficenty in the nutrient intakes are shown in Table 4.

In looking at the interrelationships among different nutrient intakes, the test value of the LR test, under the null hypotheses that all of the correlations between each pair of nutrient intakes are zero, was 1238 (p-value < 0.001). Thus, nutrient intakes are dependent. All estimated correlations among each nutrient intake were positively and (or) negatively significant at a level of 1%.

With respect to the effects of the parental migration decisions on the risk of the deficiency in children's nutrient intakes, the results show that two migrant parents have positive coefficients significant at the 5% level in the energy intake and the protein intake equation, respectively, although a one-migrant parent has insignificant coefficients for the energy and protein intakes of children. In addition, the coefficients of one-migrant parent and two-migrant parents are negative and significant at the 1% and 10% level separately in the fat over-intake equation, respectively. According to these results, the probability of deficiency on the energy and protein intakes of children with one absent parent are insignificantly different, after controlling the household income, compared with children with both parents present. Moreover, the energy and protein intakes of children are indeed negatively affected when both parents are absent. The negative information confirms the greater probability that when two parents migrate, the left-behind children face a higher likelihood of malnutrition of energy and protein intake. One plausible explanation is that childcare provided by the members of the extended family, such as grandparents and other relatives, might not be fully motivated, or not fully equipped with know-how. In other words, households with two migrant parents spend less time for home production, including food purchasing, food preparation, and supervision of the children's activities, than other households, and this, therefore, leads to the malnutrition of children left behind. However, the parental migration is shown to be linked to a lower risk of the fat over-nutrition because the left-behind children's dietary consumption structure has been changed due to the parental out-migration, particularly for those children living together with their grandparents. In fact, the dietary structure of the elderly is seen to be significantly different from that of adults, and it seems to be driven by a lower consumption of meats, eggs, pluck, and other fat products, suggesting a lower overall intake in these high-fat foods.

The results of other control variables are also interesting. The coefficients on the *income* variable were negative for the deficiency on energy and protein intake (although insignificant for both nutrient intakes), whereas only the coefficients were negatively significant for the fat over-nutrition at a 1% level. These results show that the migrant workers' remittances affect income, which in turn affect the children's nutritional status. In other words, the risk of the deficiency in energy and protein intake and the fat over-nutrition for children in a household with a higher income appears less likely.

However, the household composition characteristics, including a child's birth order, being a single child, household size, and having an elderly living in the household have different effects on the children's deficiency of nutrient intake. As presented in

Table 4, the performance of the elderly has negative effects on the deficiency in the energy and protein intakes, but it has a positive effect on the risk of the fat over-intake for children, and it shows a strong significance in all three equations at a 1% level. These results imply that an elderly may have a positive effect on the children's nutrient intakes, but on the other hand, childcare may also be adversely affected by the elderly due to the obsolete nutritional knowledge, as well as the resources available in terms of

Table 4. Estimation of children's nutrition intake equation

	Energy intake deficiency			Protein intake deficiency			Fat over-intake		
	coef.	SE	mar. eff.	coef.	SE	mar. eff.	coef.	SE	mar. eff.
One-parent	–1.214	0.812	–0.353	0.249	0.823	0.058	–2.438***	0.752	–0.505
Both-parents	1.116**	0.575	0.325	1.349**	0.622	0.181	–0.867*	0.521	–0.283
Age/100	4.975***	0.798	1.447	0.405	0.819	0.104	–1.533**	0.733	–0.597
Male	–0.092**	0.038	–0.027	–0.357***	0.040	–0.090	–0.050	0.035	–0.019
Education	–0.005	0.006	–0.002	0.01*	0.006	0.003	–0.002	0.005	–0.001
Birth order	0.102*	0.059	0.029	0.066	0.064	0.017	0.087*	0.052	0.034
Single child	–0.059	0.057	–0.017	–0.081	0.059	–0.021	0.059	0.051	0.023
Elderly	–0.189***	0.071	–0.055	–0.195***	0.074	–0.053	0.207***	0.066	0.081
HH size	0.027	0.021	0.008	0.050**	0.022	0.013	–0.143***	0.019	–0.056
Income	–1.411	0.893	–0.411	–0.805	0.948	–0.206	–4.661***	0.842	–1.816
Distance/100	1.578	1.188	0.459	–0.921	1.133	–0.236	–0.009	0.954	–0.004
Rice price/100	0.215	0.281	0.063	–0.768***	0.287	–0.197	1.244***	0.257	0.485
Flour price/100	0.464	0.573	0.135	1.409**	0.632	0.361	–0.138	0.475	–0.054
Meat price/100	–0.019**	0.008	–0.006	–0.019**	0.008	–0.005	0.016**	0.008	0.006
Year 2004	0.268***	0.089	0.078	–0.010	0.092	–0.003	0.192**	0.082	0.075
Year 2006	0.386***	0.093	0.112	0.091	0.095	0.023	0.113	0.085	0.044
Year 2009	0.527***	0.111	0.153	0.123	0.112	0.030	0.27***	0.100	0.106
Heilongjiang	0.198*	0.103	0.058	0.586***	0.111	0.118	–0.022	0.091	–0.009
Jiangsu	–0.302***	0.095	–0.088	–0.586***	0.094	–0.182	0.504***	0.088	0.199
Shandong	–0.097	0.099	–0.028	–0.127	0.100	–0.034	0.224**	0.092	0.089
Henan	0.134	0.089	0.039	0.279***	0.092	0.065	–0.309***	0.080	–0.116
Hubei	–0.249***	0.089	–0.073	–0.009	0.092	–0.002	0.053	0.082	0.021
Hunan	–0.248**	0.104	–0.072	–0.269**	0.105	–0.076	0.392***	0.095	0.155
Guangxi	0.137	0.087	0.039	0.055	0.087	0.014	0.388***	0.076	0.153
Guizhou	0.026	0.101	0.008	0.096	0.104	0.024	0.137	0.093	0.054
Constant	–0.019	0.183	–	0.646***	0.190	–	0.543***	0.169	–
Correlation									
(Protein, Energy)	0.723***	0.014							
(Protein, Fat)	–0.086***	0.022							
(Energy, Fat)	–0.183***	0.021							
Log likelihood = –8576.27 LR test $x^2(3)=1238.36^{\$}$ (p–*value* < 0.001)									

$^{\$}$the null hypothesis: all of the correlation coefficients are equal to zero

***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively

coef is the estimated coefficient; mar. eff. is the marginal effect evaluated at the sample mean

All the valued variables are inflated to 2009 values

time and attention, which increase the risk of the fat over-intake.

Interestingly, the household size had positive and significant effects on the deficiency in children's energy and protein intake, and it had a negative and significant impact on the probability of the children's over-intake of fat at a 1% level. Thus, larger households see more competition for the intra-household resources, decrease the amount of resources each child receives, and increase the probability of overcrowding. However, being a single child generally exhibits no significant difference across the three groups of nutrient intakes. The findings indicate that the birth order is positively associated with the children's nutrient intake deficiency and is significant for the energy intake and fat over-consumption at a 10% level, suggesting that the oldest child in the household is more likely to suffer from the deficiency in nutrient intakes, due to the increased burden on the family resources in terms of the financial resources available to buy food or in terms of the time available for childcare.

The risk of malnutrition differs by gender for all three equations, and has a significant impact for male children. For instance, male children are less likely to be below the DRI for energy and protein, and are less likely to be above the upper bound of fat. One of the possible explanations of this result may be due to the "son preference," which is more significantly present in rural areas. As a result, female children are likely to be in a disadvantageous position for nutrient intakes. The favouring of boys in the intra-household distribution of nutrients is consistent with the findings of the previous studies in China (Senauer et al. 1988; Lee 2011).

The effect of a child's age appears positively significant for the energy intake at a 1% level, and negatively significant for the fat intake at a 5% level, indicating the continual worsening of the calorie energy intake as the age increases, due to the cumulative effects of inadequate food intakes. The prices of rice, flour, and pork meat have significant positive or negative effects on a child's deficiency of nutrition intakes. The positive or negative effect of the price of staple foods on current nutritional status may seem surprising; however, such price effects have been reported in the previous nutrition and health studies and can be explained by strong substitution effects between foods (Pitt and Rosenzweig 1985). Finally, different geographic areas also matter in the children's nutrient intakes. In addition, children's deficiencies in nutrient intakes, including the calorie energy and fat, are increasingly worsened, but the risk of the protein malnutrition has been decreasing since 2000.

CONCLUSION

The world economy has been a witness to the rapid economic growth in China over the past decades. At the same time, economic growth happens unequally in China, which results in an increased income inequality between the rural and urban areas. A higher income and better employment opportunities in the urban areas have attracted significantly rural labourers. As a result, more children are left behind in rural areas. Concerns with the potential impact of the parental migration on the welfare of children left behind have become prominent in the policy discussions. This paper contributes to this interesting issue by assessing the effects of the parental migration decisions on the nutrition status of children left behind in rural areas of China.

Using data drawn from the CHNS, this study divided all children into three groups to explore the relationships between the parental labour migration and the nutrient intake deficiencies of the children left behind in rural areas. Employing an instrumental variable approach, this paper found heterogeneous effects of the parental migration on the children's nutrition. The likelihood of inadequate energy and protein intakes is significantly and positively associated with the parental migration, whereas the parental migration has a negative impact on the risk of the fat over-nutrition for the left-behind children. In terms of child welfare, the parental labour migration results in the disruption of family life and the separation between parents and children; household production, including food purchasing, food preparation, and supervision of the children's activities, is adversely affected. Therefore, the parental migration has undesirable effects on the children's nutrient intakes.

Establishing a relationship between the migration and nutrition security has important policy implications. Considering the evidence that malnutrition places children at a greater risk of poor physical and mental development, the children's welfare should be taken into account when promoting policies aimed at enhancing the developmental impact of migration. Effective policies and programs to alleviate malnutrition should be established to protect the welfare of the children of migrants, to promote the benefits of migration, and to minimize the potential costs. First, in the short term, the improvement and extension of the school meal programs for the left-behind children in rural areas should be effective means to dampen some of the negative effects of the parental out-migration on the nutrition intakes of children. Second, policies can be designed to offset whatever nutritional risks are associated with the parental migration rather

than to discourage such work when these risks are present. One possible direction for policy is to ensure that adequate childcare alternatives are available for parents who migrate from rural areas to urban areas for work. Lastly, migrant workers and their children should be entitled to all kinds of public services in the urban areas to be provided by the local government, such as education and health care resources, after the unification reforms of rural and urban social security systems are done in the long run.

Although several interesting findings are revealed in this study, a few caveats may pertain. For instance, due to the limitation of the dataset, we do not have detailed information regarding the timing of parents immigrated to the urban area. If this information becomes available, it will be interesting to further examine the duration of the parental migration decisions may affect children's nutrition in different ways. Furthermore, that will be interesting to examine whether the types of work of the parents in the urban area may result in different outcomes of their children left at home. It is likely that parents who worked for part-time jobs may have more time to visit their children left at home. In contrast, less attention and care would be paid for parents who work for full time jobs in the cities. These interesting questions can be further investigated when the necessary information becomes available.

REFERENCES

All China Women's Federation (2008): A study report of the situation of the left-behind children in rural China. Available at http://www.women.org.cn/allnews/02/1985.html (in Chinese).

Amuedo-Dorantes C., Pozo S. (2004): Workers' remittances and the real exchange rate: the paradox of gifts. World Development, *32*: 1407–1414.

Azam J., Gubert F. (2006): Migrants' remittances and the household in Africa: a review of evidence. Journal of African Economies, *15*: 426–462.

Baez J. (2008): Does More Mean Better? Sibling Sex Composition andthe Link between Family Size and Children's Quality. IZA Discussion Paper No. 3472. Institute for the Study of Labor (IZA), Bonn.

Behrman J., Skoufias E. (2004): Correlates and determinants of child anthropometrics in Latin America: background and overview of the symposium. Economics and Human Biology, *2*: 251–335.

Behrman J. (1990): The Action of Human Resources and Poverty on one Another: What we have yet to Learn. Living Standards Measurement Working Paper No. 74. The World Bank, Washington, DC.

Blau D. (1986): Fertility, child nutrition, and child mortality in Nicaragua: an economic analysis of interrelationships. The Journal of Developing Areas, *20*: 185–202.

Case A., Paxson C. (2001): Mothers and others: who invests in children's health? Journal of Health Economics, *20*: 301–328.

Chang H., Rodolfo M. Jr., Chan K. (2011): Gendered analyses of nutrient deficiencies among the elderly. Journal of Family and Economic Issues, *32*: 268–279.

Chang H., Dong X., MacPhail F. (2010): Labor Migration and Time Use Patterns of the Left-behind Children and Elderly in Rural China. Department of Economics Working Paper No. 5. University of Winnipeg.

Chen X., Huang Q., Rozelle S., Shi Y., Zhang L. (2009): Effect of migration on children's educational performance in rural China. Comparative Economic Studies, *51*: 323–343.

Chib S., Greenberg E. (1998): Analysis of multivariate probit models. Biometrika, *85*: 347–361.

Chimhowu A., Piesse J., Pinder C. (2004): The Impact of Remittances. Enterprise Development Impact Assessment Information Service (EDIAIS), Issue 29.

De Brauw A., Mu R. (2011): Migration and the overweight and underweight status of children in rural China. Food Policy, *36*: 188–100.

Doss C. (2006): The effects of intrahousehold property ownership on expenditure patterns in Ghana. Journal of African Economies, *1*: 149–180.

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

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.

Glick P., Sahn D. (1998): Maternal labor supply and child nutrition in West Africa. Oxford Bulletin of Economics and Statistics, *60*: 325–355.

Greene W. (2010): Econometric Analysis. 7th ed. Prentice Hall, Upper Saddle River.

Hoddinott J. (1992): Rotten kids or manipulative parents: are children old age security in Western Kenya? Economic Development and Cultural Change, *40*: 545–565.

Hoddinott J. (1994): A model of migration and remittances applied to Western Kenya. Oxford Economic Paper, *46*: 459–476.

Horton S. (1988): Birth order and child nutritional status: evidence from the Philippines. Economic Development and Cultural Change, *36*: 341–354.

Hu F., Li S. (2009): The effects of parental out-migration on the educational attainment of their left-behind children in rural China. Management World, *2*: 67–74 (in Chinese).

Karamba W., Quinones E., Winters P. (2011): Migration and food consumption patterns in Ghana. Food Policy, *36*: 41–53.

Kennedy E., Haddad L. (1994): Are preschoolers from female-headed households less malnourished? Journal of Development Studies, *30*: 680–695.

Liu J. (2008): Non-farm work, maternal care and child health: evidence from rural China. Economic Research, *9*: 136–149 (in Chinese).

Maddala G. (1983): Limited-dependent and Qualitative Variables in Econometrics. Cambridge University Press, Cambridge.

Maitra P. (2004): Parental bargaining, health inputs and child mortality in India. Journal of Health Economics, *23*: 259–291.

Massey D., Arango J., Hugo G., Kouaouci A., Pellegrino A., Taylor J. (1993): Theories of international migration: a review and appraisal. Population and Development Review, *19*: 431–466.

Massey D., Arango J., Hugo G., Kouaouci A., Pellegrino A., Taylor J. (1994): An evaluation of international migration theory: The North American case. Population and Development Review, *20*: 699–751.

Meyerhoefer C., Chen C. (2011): The effect of parental labor migration on children's educational progress in rural china. Review of Economics of the Household, *3*: 379–396.

National Statistics Bureau of China (2010): Report of migrants monitoring survey in 2009. Available at http://www.stats.gov.cn/tjfx/fxbg/t20100319_402628281.htm

Nguyen M., Winters P. (2011): The impact of migration on nutrition: the case of Vietnam. Food Policy, *36*: 71–87.

Osmani S., Sen A. (2003): The hidden penalties of gender inequality: fetal origins of ill-health. Economics and Human Biology, *1*: 105–121.

Pelletier D., Frongillom E. (2003): Changes in child survival are strongly associated with changes in malnutrition in developing countries. Journal of Nutrition, *113*: 107–119.

Pitt M.M., Rosenzweig M.R. (1985): Health and nutrient consumption across and within farm households. The Review of Economics and Statistics, *67*: 212–223.

Rozelle S., Guo L., Shen M., Hughar A., Giles J. (1999): Leaving China's farms: survey results of new paths and remaining hurdles to rural migration. China Quarterly, *158*: 367–393.

Rubalcava L.,Contreras D. (2000): Does gender and birth order matter when parents specialize in child's nutrition? Evidence from Chile. Journal of Applied Economics, *3*: 353–386.

Senauer B., Garcia M. (1991): Determinants of the nutrition and health status of preschool children: an analysis with longitudinal data. Economic Development and Cultural Change, *39*: 371–389.

Senauer B., Garcia M., Jacinto E. (1988): Determinants of the intrahousehold allocation of food in the rural Philippines. American Journal of Agricultural Economics, *70*: 170–180.

Stark O., Bloom D. (1985): The new economics of labor migration. American Economic Review, *75*: 173–178.

Stark O., Taylor J. (1991): Migration incentives, migration types: the role of relative deprivation. The Economic Journal, *101*: 1163–1178.

Swart E. (2004): The effects of internal migration and related factors on nutrient intake and anthropometric status of children aged 1–9 years in South Africa, 1999. [Doctoral Dissertation.] University of the Western Cape, Bellville.

Taylor J. (1987): Undocumented Mexico-U.S. migration and the returns to households in rural Mexico. American Journal of Agicultura1 Economics, *69*: 626-637.

Winters P., de Janvry A., Sadoulet E. (2001): Family and community networks in Mexico-US migration. The Journal of Human Resources, *36*: 159–184.

Zhang L., de Brauw A., Rozelle S. (2004): China's rural labor market and its gender implications. China Economic Review, *15*: 230–247.

Zhao Y. (1999): Leaving the countryside: rural-to-urban migration in China. American Economic Review, *89*: 281–286.

Zhao Y. (2003): The role of migrant networks in labor migration: the case of China. Contemporary Economic Policy, *21*: 500–511.

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