Mother's Migration and Children's Nutritional Status: Evidence from Rural China*

Abstract:

A dramatic change of rural Chinese women in the last 30 years is that a large scale of rural women migrating to urban areas to earn their lives. It is a great progress for rural Chinese women, for they can get their economic and social independence from the old rural family.However, as mothers, women's migration to urban areas will affect their children's nutritional status. Migration to urban areas will increase their income, thus in favor of their children's nutritional status; on the other hand, these left-behind children with mother migrating will face the problem of caring defect, which will make negative effects on children's nutritional status. The total effect of mothers' migration depends on the relative scale of income effect and substitute effect.

The paper studies the effects of mothers' migration from rural to urban areas on children's nutritional status under 5 years old based on the data of Chinese Food and Nutrition Surveillance System. To control the possible endogeneity, propensity score matching (PSM) method is employed. It is shown that nutritional status of children with mothers migrating to urban areas is lower than these with mother employed in hometown significantly because of mother's caring defect. On the other hand, there is no significant difference in nutrition status between children with mother employed in agricultural sector and non-agricultural sector in hometown, though their incomes are different significantly. The result implies that marginal effect of income on children's nutritional status is decreasing; however, it becomes more important of mother's caring for children's nutritional status.

Key words: rural-urban migration, mother's caring, children's nutrition status, propensity score matching

JEL: I12, J16, J22

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I. Introduction

A dramatic change of rural Chinese women in the last 30 years is that a large scale of rural women migrating to urban areas to earn their lives. The ratio of women migrants was only about 21.8% to the total migrants in 1980s, which has increased to 30.4% in 1990s (Zhai and Duan, 2006), and reached to 36% in 2006 (NBS, 2008). It is a great progress for rural Chinese women, for they can get their economic and social independence from the old rural family.Migration to urban areas has increased their income, however, there are also other effects of rural women's migration, one of which, as their maternal responsibility, is the impact on children's nutritional status.

The importance of children's nutritional status is accepted worldwide, and is one intrinsic parts of the MDGs(UN and IFPRI, 2000; UNICEF 2006). It is showed that malnutrition at infant stage affects children's growth, physically as well mentally, which hinders their capacity formation, and which makes loss to economic development(Barnett, 1995; Strauss and Thomas, 1998).

Children's nutritional status in China has been improved obviously in the last 30 years; however, gap between rural and urban children is also remarkable. Survey by Chinese CDC (Centers for Disease Control) shows that the rate of underweight of rural children under 5 years old is 6.1%, higher than urban children, which is only 1.4%, and the rate of stunting of rural children under 5 years old is 16.3%, much higher than urban children, which is 3.1% in 2005 (Chen, et al., 2010).

Chinese government has taken measures to improve nutritional status of rural children, the biggest one of which is the "Nutrition Improvement Plan for Rural Compulsory Education Students". However, most of these measures concern the intake of nutrition, and caring is always neglected. In fact, the importance of caring to children's nutritional status is demonstrated by many studies (Leslie, 1988). The

change of rural women's employment pattern, that more and more rural women migrate to urban areas for jobs, has made their children as left-behinds in rural areas, which causes nutritional problems for children.

There are two effects of mother's migration on left-behind children's nutritional status theoretically: one is income effect, that high income taken by migration to urban areas would bring about high quality food hence improving children's nutritional status (Blumberg, 1988); the second is substitute effect, that mother's migration would reduce caring time for their children hence harmful to children's nutritional status (Engle and Menon, 1999; Ruel, et al., 1999). The general effect of mother's migration on left-behind children's nutritional status need empirical evidence.

Leslie(1988) reviews more than 50 empirical studies before 1980s on the effect of women's employment on children's nutritional status, and summarizes that there is little evidence to show negative effect of mother's employment on children's nutritional status. However, empirical studies afterwards show no consensus on how mother's employment affecting children's nutritional status. Study in Guatemala (Engle, 1991) shows that mother's employment makes no significant effect on children's health after controlling other variables such as mothers' education. Blau, et al.(1996) also gives the similar result based on the data in Philippine. Glick and Sahn(1998) shows that there is negative effect of mother's labor supply on their children's nutritional status in west Africa; andPierre-Louis, et al.(2007) also gives significant negative effect of mother's economic activities on children's health. However, Lamontagne, et al.(1998) shows positive effective of mothers' employment on children's nutritional status in Nicaragua.

Women's migration also affects children's nutritional status. The existing studies shows no consensus about effect of internal migration on children's nutritional status, too. For example, Mansuri(2006)finds that there is significant positive effect of migration on left-behind children's Height for Age (HAZ) in Pakistan; Nobels (2007) finds that migration to other countries has negative effect on their left-behind children's HAZ in Mexico.

There are some studies on the effect of migration on children's nutritional status in

China. Brauw and Mu(2011)studies the effect of rural-urban migration on left-behind children's health based on CHNS data (China Health and Nutrition Survey) and the results show that migration to urban areas has no significant effect on left-behind children's Body Measure Index (BMI) 2 to 6 years old, but has significant negative effect on 7 to 12 years old left-behind children's weight. Chen (2009) studies the effect of migration of rural women on left-behind children's nutritional status based on CHNS data, and the results show that there is no significant effect of mother's migration on under 5 years old children's HAZ, but there is negative effect on 6 to 18 years children's health. Another study based on CHNS data also shows negative effect of parents' migration on their left-behind children's morbidity (Li and Zang, 2010). The Fourth National Survey on Health Services shows that the two-week prevalence rate of children with parents migrating is higher significantly than that of children with parents working locally (Song and Zhang, 2009).

Studies on the effect of rural women's migration on left-behind children's nutritional status in China, most of which using CHNS data, lack of more widely evidence, and some of the studies neglect the problem of endogeneity in estimation, which causes biases (Glick, 2002). However, it needs further evidence of the impact of mother's migration on left-behind children in rural China. Based on existing studies, this paper attempts to estimate the effect of mother's migration to urban areas on nutritional status of their left-behind children using the 2008 Chinese Food and Nutrition Surveillance System data (CFNSS), and in order to control the possible endogeneity, the paper employs Propensity Score Matching method (PSM).

II. Framework and methodology

The framework analyzing impact of mothers' migration on children's nutritional status is based on Becker's (Becker, 1965) time allocation theory, in which the mother maximizes utility function through making choice between migration and caring children within home subject to time constraint and income constraint. The total effect contains pair of opposite effects: income effect, i. e. migration can increase household's income which in turn increase food quality and nutrition intake, and

substitute effect, i. e. mothers' migration decrease the time caring children at home, which make negative effect on children's nutritional status. The outcome equation of children's nutritional status can be obtained by the household production equation as the following:

$$H = h(M_E, M_I; \boldsymbol{X}) \quad (1)$$

in which M_E is mothers' employment status, containing local agricultural employment, local non-agricultural employment and migrating to urban areas，which will be described in detail in next part. M_I is mothers' income, and $\boldsymbol{X}$ is other controlling variables. The empirical equation used in estimation can be derived from (1):

$$H_i = \beta_0 + \beta_1 M_{Ei} + \beta_2 M_{Ii} + \boldsymbol{\beta_3 X_i} + \varepsilon_i \quad (2)$$

OLS method is usually used to estimate (2); however, OLS cannot tackle the biases caused by endogeneity, which is always a problem in studies on this topic (Glick, 2002; Glick and Sahn, 1998). Endogeneity in the estimation of impact of mothers'migration on children's nutritional status is derived from two sources: one is that unobserved factors affect mothers' choice of migration and children's nutritional status at the same time, which causing selection bias; the other is simultaneous bias, i. e. mothers' migration affect children's nutritional status, while children's nutritional status affect mothers' migration decision simultaneously. This paper attempts to use Propensity Score Matching (PSM) method controlling possible endogeneity to estimate the effect of mothers' migration on left-behind children's nutritional status in rural China.

The idea of matching is to find a unit not treated that is "similar" to a treated unit, so that to estimate the intervention's impact as the difference between a treated unit and the matched comparison case. The rationality of matching is that in absence of an experimental design in most social science studies, assignment to treatment is frequently nonrandom, and thus, units receiving treatment and those excluded from treatment may differ not only in their treatment status, but also in other characteristics that affect both participation and the outcome of interest, which will bias the

estimated results. If there is only one observed characteristics that can be used as the "similar" characteristics to divided the treated group and controlling group, such as age, or gender, or education, and this characteristics can clarify the two groups thoroughly, then simple matching is enough. But, what happens mostly is that there are covariates as "similar" characteristics to divide treated group and controlling group, which is called the problem of dimensionality in matching. In order to tackle this problem, propensity score matching is developed to summarize these observed covariates as the propensity score, and to match treated unit with controlling unit according to this propensity score (Rosenbaum and Rubin ,1983).

Actually, as to evaluate the impact of a programme, the Average Treatment Effect on the Treated (ATT) needed to be estimated:

$$\tau_{ATT} = E(\tau|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \quad (3)$$

in which $Y(1)$ is the outcome of treated group, $Y(0)$ is the outcome of controlling group, and $D = \begin{cases} 1, \text{ treated group} \\ 0, \text{ controlling group} \end{cases}$. The first item at the right hand of (3) is the observed outcome; however, the second item is a counterfactual outcome that cannot be observed. A simple method is to use $E[Y(0)|D = 0]$ to replace $E[Y(0)|D = 1]$. If the programme or experiment was designed and implemented randomly, then unbiased results could also be obtained. Nonetheless, most of survey data in economics and social sciences are nonrandom, and there is some correlation between participation into programme and the outcome of the programme, which causing estimate biases (Heckman, et al., 1998). If $E[Y(0)|D = 1]$ was replaced by $E[Y(0)|D = 0]$, it could be showed that:

$$\begin{aligned} \Delta &= E[Y(1)|D = 1] - E[Y(0)|D = 0] \\ &= \tau_{ATT} + E[Y(0)|D = 1] - E[Y(0)|D = 0] \\ &= \tau_{ATT} + SB \end{aligned} \quad (4)$$

However, if observed characteristics of treated group is as the same or "similar" to that of controlling group, which implies random designing treated group and controlling group, then selectivity bias could be eliminated. The PSM method, hence, to design treated group and controlling group by propensity scores to correct possible

selectivity bias.

Two conditions need to be satisfied to use PSM:

Condition I: Confoundedness

$$\mathrm{Y}(0), \mathrm{Y}(1) \coprod \mathrm{D}|\mathrm{X} \tag{5}$$

which is also called Conditional Independence Assumption (CIA), implying that whether one unit participate in the programme is independent to the outcome of the programme after controlling the observed covariates.

Condition II: Common Support

$$0 < P(D = 1|X) < 1 \quad (6)$$

which is also called Overlap Condition, insuring that there will be overlap between treated group and controlling group after matching.

However, these two conditions is hard to be satisfied in practice. If the aim is only to estimate ATT, then the two conditions can be relaxed (Heckman, et al., 1998): weak unconfoundedness condition as $\mathrm{Y}(0) \coprod \mathrm{D}|\mathrm{X}$, and weak common support condition as $P(D = 1|X) < 1$. Under the two weak conditions, the empirical equation estimating ATT using PSM is as following (Caliendo and Kopeinig, 2008):

$$\tau_{\mathrm{ATT}}^{\mathrm{PSM}} = \mathrm{E}_{\mathrm{P(X)|D=1}}\{\mathrm{E}[\mathrm{Y}(1)|\mathrm{D} = 1, \mathrm{P(X)}] - \mathrm{E}[\mathrm{Y}(0)|\mathrm{D} = 0, \mathrm{P(X)}]\} \tag{7}$$

In this paper, we will conduct the following steps to estimate the effect of mother's employment patterns on left-behind children's nutritional status using PSM:

First, the Logit model of mothers' employment patterns will be estimated:

$$\Pr(\mathrm{D_i} = 1|\boldsymbol{X_i}) = \exp(\boldsymbol{\beta X_i})/1 + \exp(\boldsymbol{\beta X_i}) \tag{8}$$

$X_i$are the covariates affecting mothers' employment patterns, and $\boldsymbol{X_i}$ need satisfy the following conditions: first, $\boldsymbol{X_i}$ containing only these variables affecting mothers' employment patterns and left-behind children's nutritional status at the same time; second, these variables that impacted by mothers' employment pattern must be excluded (Hill, 2008; Smith and Todd, 2005).

Second is to predict the Propensity Scores of mothers' employment patterns, $\widehat{\mathrm{P}}(\mathrm{X_i})$, based on the results from the first step.

Third is to match units between treated group and controlling group according to

the Propensity Scores. The Kernel matching will be used in the paper. In Kernel matching, which is nonparametric matching, each outcome of units in treated group will be compared to the Kernel weighted mean outcome of units in controlling group, and the highest weight will be given to these units with the nearest distance. The advantage of this matching method is that almost all outcomes of units in controlling group are used, which implying more information; disadvantage of this method is that there are bad matching for some units.

The fourth step is to conduct the balancing test and common support test, and if the testes are passed, then the ATT will be estimated.

III. Data and description of variables

There are three indexes (Z-scores) to measure children's nutritional status, first is Height for Age (HAZ), second is Weight for Age (WAZ), the third is Weight for Height (WHZ). The formula of Z-score is:

$$Z = (W - RM)/SD \tag{9}$$

in which W is the height or weight of the sample; RM is the median of reference standard height or weight, and SD is standard deviation of reference standard height or weight. Here, the reference standard is from WHO. HAZ<-2 means stunting, which measures long term and chronic malnutrition; WAZ<-2 refers to underweight, which measures short term and brachychronic malnutrition; and WHZ<-2 means wasting, measuring general situation of malnutrition (Nandy, et al., 2005). In this paper, HAZ and WAZ are used to measure children's nutritional status.

The data used in the paper comes from the "2008 Chinese Food and Nutrition Surveillance System (CFNSS)" conducted by Chinese CDC (Centre for Disease Control) of Ministry of Health. CFNSS, established in 1989, has been conducted 6 rounds, 1990, 1995, 1998, 2000, 2005 and 2008. The 2008 round was only conducted in rural areas. The design, establishment, and survey can be found in Chen, et al.(2006) and Chen, et al. (2010). The sample size is 10726 of rural children under 5 years old,

and the sample is distributed in 20 provinces[1].

The stunting rate (HAZ<-2) and underweight rate (WAZ<-2) of rural children under 5 years old in 2008 are 13.17% and 5.08%, respectively. The stunting rate and underweight rate show increasing before 24 months, and then decreasing (Figure 1).

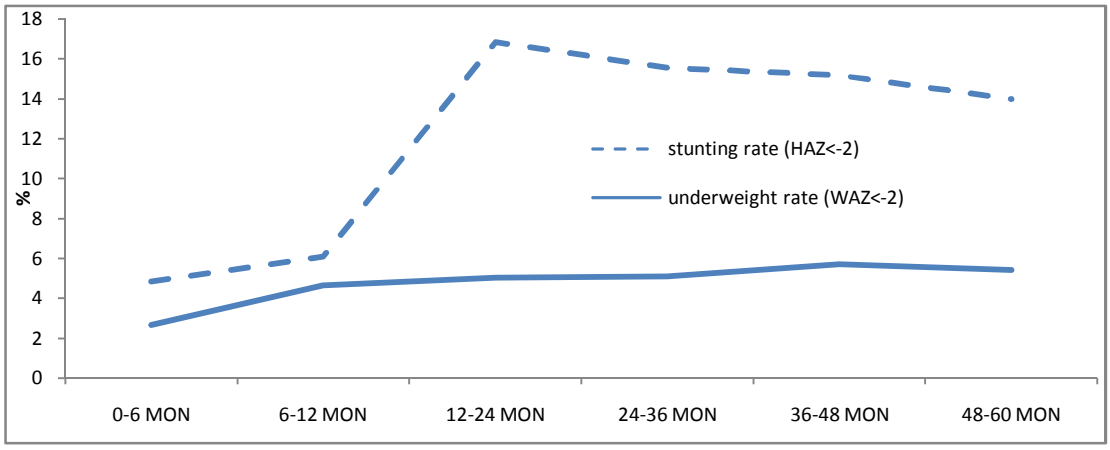

Figure 1. Stunting rate and underweight rate by months of rural children under 5 years old

In China, the rural-urban migrants are not recognized as urban citizens, since they have no urban *Hu Kou*, although they work and live in urban areas. They are also recognized as rural residents. According to this background, employment of rural residents in China can be divided into three categories: first is the traditional agricultural employment, and second is non-agricultural employment at hometown, or local non-agricultural employment; the third is employment in urban areas, i. e. migrating to urban areas. Meanwhile, rural women's employment also takes these three patterns. These three employment patterns impact women's time allocation differently: mothers undertaking local agricultural employment have more time caring their children while they earn less; mothers undertaking local non-agricultural employment also have time to care their children while they earn more; mothers migrating to urban areas left their children in rural areas have little time to care their children while they have higher income. The patterns of time allocation, caused by the patterns of employment, impact children's nutritional status through income effect and

[1]Tian Jin, Shan Xi, Nei Meng Gu, Liao Ning, Hei Long Jiang, Jiang Su, An Hui, Jiang Xi, Shan Dong, He Nan, Hu Bei, Hu Nan, Guang Dong, Guang Xi, Si Chuan, Gui Zhou, Yun Nan, Shan'xi, Qing Hai, and Ning Xia.

substitute effect.

Here, households in the data are divided into four categories according to mothers' employment patterns: local agricultural employment, local non-agricultural employment, migration, and others[2]. The data shows that the proportion of households with mothers migrating to urban areas is 22.86%, and the proportion of households with mothers undertaking local non-agricultural employment is 14.77%; while, the proportion of households with mothers undertaking local agricultural employment is more than half (50.45%) (Table 2).

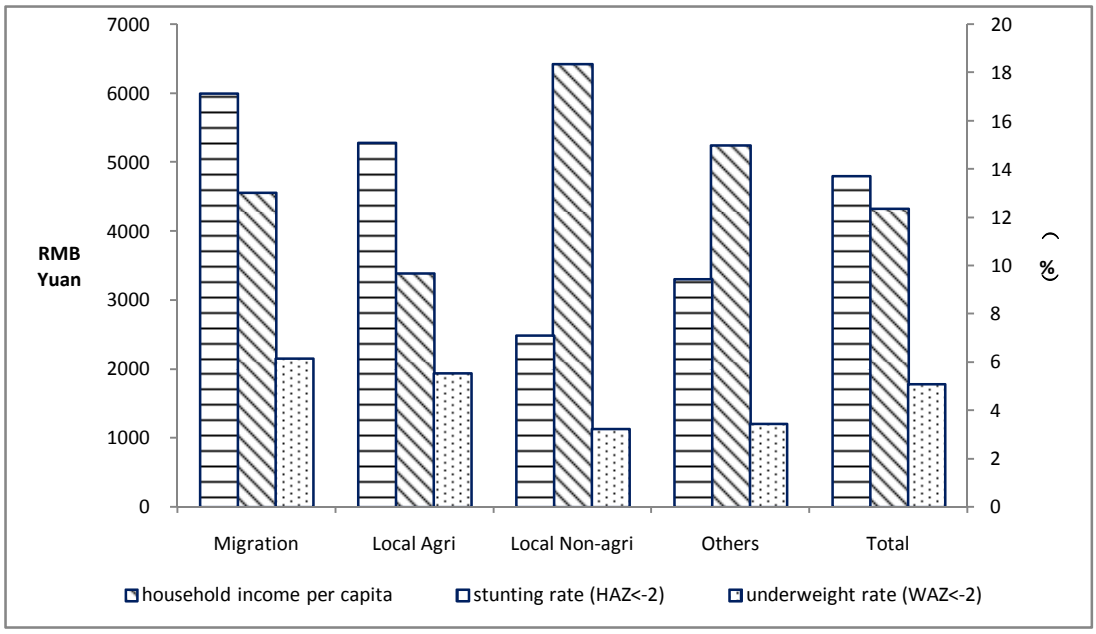

Figure 2. Household income, stunting, and underweight by different employment patterns

Households with mothers undertaking local non-agricultural employment have highest income per capita, the annual income is 6364 RMB Yuan, and households with mothers undertaking local agricultural employment have the lowest income per capita, the annual income is only 3396 RMB Yuan. While, the per capita annual income of households with mothers migrating to urban areas are 4559 RMB Yuan. However, children with mothers migrating to urban areas have the worst nutritional status, i. e. the highest stunting rate and underweight rate, although per capita income of these households is much higher than households with mothers undertaking local agricultural employment. Furthermore, the nutritional status of children with mother undertaking local non-agricultural employment is the best (Figure 2; Table 1).

[2]The "Others" will not analyzed further.

Mothers' education is also an important factor impacting children's nutritional status. In this paper, mothers' education is divided into five categories: first is illiterate and semiliterate, second is elementary, third is junior middle, fourth is senior middle, and the last is collage and above. Rural women's educational attainment is concentrated at junior middle, accounting for 60.16% of the total; then is senior middle, accounting for 8.68%. Illiterate and semiliterate accounts for 4.6%, and collage and above accounts for 1.6%. The descriptive statistic shows that there is positive relationship between mothers' educational attainment and their children's nutritional status, that higher level of education of mothers, higher level of their children's nutritional status (Table 1).

In order to estimates the effect of mothers' employment patterns, i. e. local employment including local agricultural and local non-agricultural employment, and migrating to urban areas, on their children's nutritional status, the covariates include the following three groups, besides personal characteristics such as the children's age, gender, mothers' employment patterns, and mothers' education.

The first group contains variables about household income and household structure. The first one is the household per capita income that impacting children's nutritional status by income effect (Case, et al., 2002). The second is the number of family members, impacting children's nutritional status from two ways: one is that more family member can provide more care for children that improving children's nutritional status; the other is that more family member may reduce the expenditure on children's nutrition intake. Meanwhile, family size is also a factor affecting mothers' employment choice, that women in large size family may have higher propensity to migrate or undertake non-agricultural employment. The third variable of this group is whether there are old person with chronic disease, physical disability, or above 70 years old, who need caring by other family members that may reduce caring for children.

The second group is about living environment, including two variables: the type of floor of living houses, and the type of drinking water. Traditionally, most of Chinese rural house floor is compacted soil, which is damp easily, and breeding kinds

of bacteria; however, in the last several decades, brick floor, and cement floor have become more and more in rural China. Here the types of floor are categorized into two: one is traditional compacted soil floor, and the other is brick and cement floor. The quality and types of drinking water also have impact on children's health (Jalan and Ravallion, 2003). The types of drinking water in this paper are divided into five categories: the first type is running water or tap water, second is well water, third is surface water, fourth is pipe water, and the fifth is others.

The third group of variables is about community and region that children live in. Economic and social development, public infrastructure, public services such as public medical services, are also factors impacting children's nutritional status (Thomas and Strauss, 1992; Thomas, et al., 1996). Communities and regions with higher quality public infrastructure and plenty of medical resources affect children's health, since households and children have more chances to get public resources. This group contains three variables: the distance to the nearest health-center or clinic, the distance to the nearest county town, and west, middle and east coastal regions. The distance to the nearest health-center or clinic, measured by the minutes to that health-center or clinic by foot, implying the extent of the cost to reach to the medical resources; and the distance to the nearest county town, measured by the minutes to the county town by bus, meaning the cost to get kinds of public services. West, middle and east coastal regions control the possible regional heterogeneity. Table 2 gives the descriptive statistic of these variables.

Table 1. Mothers' employment patterns, education and children's nutritional status

Children's nutritional status		HAZ	WAZ	Stunting Rate	Underweight Rate
		Mean		%	
Mothers' employment pattern	*Migration*	-0.840	-0.447	17.15	6.16
	Local Agri	-0.617	-0.186	15.11	5.54
	Local Non-agri	-0.258	-0.007	7.11	3.24
	Others	-0.278	0.011	9.45	3.46

	Total	-0.575	-0.196	13.72	5.09
	Illiterate/Semiliterate	-1.220	-0.658	27.96	10.2
Mothers'	*Elementary*	-0.905	-0.476	20.08	7.56
education level	*Junior Middle*	-0.442	-0.086	10.74	3.93
	Senior Middle	-0.312	0.027	9.63	3.46
	Collage and above	-0.066	0.130	6.47	3.53
	Total	-0.576	-0.197	13.7	5.08

Table 2. Descriptive statistic of variables

Variables		Variables	
Children's age (in month)	31.06	Mothers' education (%)	
Mothers' age (in year)	29.3	*Illiterate/ semiliterate*	4.6
Income per capita (RMB Yuan)	4331.19	*Elementary*	24.96
Number of family member (person)	4.95	*Junior middle*	60.16
Time to health center(minute)	14.31	*Senior middle*	8.68
Time to county town (minute)	41.53	*Collage and above*	1.6
Boy (%)	53.74	Drinking water(%)	
With old person (%)	13.45	*Tap water*	39.16
Compacted soil floor (%)	12.18	*Well water*	48.73
Mothers' employment patterns(%)		*Surface water*	0.37
Migration	22.86	*Pipe water*	11.44
Local agricultural	50.45	*Others*	0.3
Local non-agricultural	14.77	Region(%)	
others	11.91	*East*	19.27
		Middle	39.47
		West	41.25

IV. Results

In this paper, we focus on the comparison of children's nutritional status, indicated by HAZ and WAZ, according mothers' employment patterns, which are divided into three categories[3], first is agricultural employment locally, the second category is non-agricultural employment locally, and these two categories are local employment; the third category is migration to urban areas, or non-agricultural employment in urban areas. The comparison will be conducted among four pairs of children's nutritional status according to mothers' employment patterns: first is migration vs. local employment, and local employment is controlling group; second is migration vs. local agricultural employment, and local agricultural employment is controlling group; third is migration vs. local non-agricultural employment, and local non-agricultural employment is controlling group; fourth is local non-agricultural employment vs. local agricultural employment, and local agricultural employment is controlling group.

PSM method is employed to estimate the effect of mothers' employment patterns on children's nutritional status. The covariates used in Logit model of mothers' employment choice include children's age (in month), gender, mothers' age (in year), square of mothers' age, mothers' education level, number of family members, whether there is old person with chronic disease, physical disability, or above 70 years old, types of house floor, types of drinking water, distance to the nearest health center or clinic (minutes by foot), distance to the nearest county town (minutes by bus), regions (west, middle, and east). Accordingly, variables included here must satisfy two conditions(Hill, 2008; Smith and Todd, 2005): affecting children's nutritional status and mothers' employment choice at the same time, and these variables that are affected by mothers' employment must be excluded. So household income is not included in the Logit model, since it is affected by mothers' employment directly. The result of Logit model is shown in Table 3.

Table 4 and Figure 3 gives the balancing test and common support test of PSM. The differences between outcomes of treated group and controlling group decrease and

[3]The "Others" employment is neglected in the estimation.

diminish after matching by propensity scores. Test of common support shows that there is overlap between treated group and controlling group. Table 5 gives the result of PSM.

Table 3. Result of Logit model for mothers' employment choice

	Migration/Local employment	Migration/ Local agri	Migration/ Local non-agri	Local non-agri/ Local agri
Boy	-0.011	-0.013	-0.092	-0.014
	0.057	0.059	0.091	0.076
Children age (in month)	0.023***	0.027***	0.007**	0.021***
	0.002	0.002	0.003	0.002
Mothers' age (in year)	0.213***	0.224***	0.117	0.125
	0.067	0.068	0.104	0.081
Square of mothers' age	-0.005***	-0.005***	-0.003	-0.003**
	0.001	0.001	0.002	0.001
Number of family members	0.326***	0.315***	0.390***	0.003
	0.019	0.019	0.033	0.028
With old person	-0.022	-0.005	-0.102	0.003
	0.081	0.085	0.136	0.122
Compacted soil floor	-0.365***	-0.278***	-0.916***	0.771***
	0.085	0.086	0.185	0.173
Distance to health center	0.011***	0.009***	0.032***	-0.022***
	0.002	0.002	0.004	0.004
Distance to county town	-0.001	-0.002**	0.007***	-0.007***
	0.001	0.001	0.002	0.002
Mothers' education (Illiterate/semiliterate as base outcome)				
Elementary	0.698***	0.694***	-0.123	0.760**
	0.152	0.153	0.409	0.364
Junior middle	0.414***	0.526***	-1.313***	1.588***
	0.15	0.151	0.397	0.354

Senior middle	0.450**	0.987***	-2.005***	2.930***
	0.178	0.187	0.411	0.366
Collage and above	0.436	2.324***	-2.585***	4.827***
	0.275	0.391	0.467	0.468
Types of drinking water (Tap water as base outcome)				
Well water	0.533***	0.335***	1.029***	-0.736***
	0.066	0.068	0.098	0.082
Surface water	0.881*	0.642	.	.
	0.459	0.46	.	.
Pipe water	0.404***	0.334***	0.527***	0.188
	0.1	0.104	0.157	0.147
Others	-0.745	-0.946	.	.
	0.838	0.837	.	.
Regions (East region as base outcome)				
Middle region	0.292***	-0.273***	1.411***	-1.813***
	0.089	0.097	0.123	0.097
West region	0.251***	-0.339***	1.388***	-1.857***
	0.09	0.099	0.123	0.102
Cons	-6.230***	-5.571***	-2.970*	-3.054**
	0.994	1.018	1.611	1.301
Pseudo R2	0.1094	0.1139	0.2991	0.2678
N	7624	6351	3189	5672

Note: *p<0.1, **p<0.05, ***p<0.01。

Table 4. Balancing test of PSM matching

Variables		Mean		T-test	
		Migration	Local employment	t-value	p-value
Boy	Unmatched	0.534	0.540	-0.44	0.659
	Matched	0.534	0.523	0.71	0.475
Children age (in month)	Unmatched	34.333	30.698	8.39	0.000
	Matched	34.333	34.249	0.16	0.872
Mothers' age (in year)	Unmatched	28.106	29.884	-13.04	0.000
	Matched	28.106	28.049	0.41	0.684
Square of mothers' age	Unmatched	808.830	922.530	-13.27	0.000
	Matched	808.830	805.700	0.38	0.706
Number of family members	Unmatched	5.605	4.718	21.98	0.000
	Matched	5.605	5.577	0.48	0.631
With old person	Unmatched	0.157	0.125	3.62	0.000
	Matched	0.157	0.158	-0.10	0.924
Compacted soil floor	Unmatched	0.840	0.892	-6.07	0.000
	Matched	0.840	0.843	-0.28	0.777
Distance to health center	Unmatched	16.485	13.833	7.15	0.000
	Matched	16.485	16.049	0.88	0.378
Distance to county town	Unmatched	42.993	42.287	1.09	0.276
	Matched	42.993	43.309	-0.39	0.693
Mothers' education	Unmatched	2.719	2.781	-3.18	0.001
	Matched	2.719	2.709	0.45	0.654
Drinking water	Unmatched	2.027	1.807	9.31	0.000
	Matched	2.027	2.041	-0.48	0.629
Region	Unmatched	2.308	2.172	7.04	0.000
	Matched	2.308	2.323	-0.70	0.481

Note: Here only the test of pair of migration and local employment is given. Other pairs also pass the test.

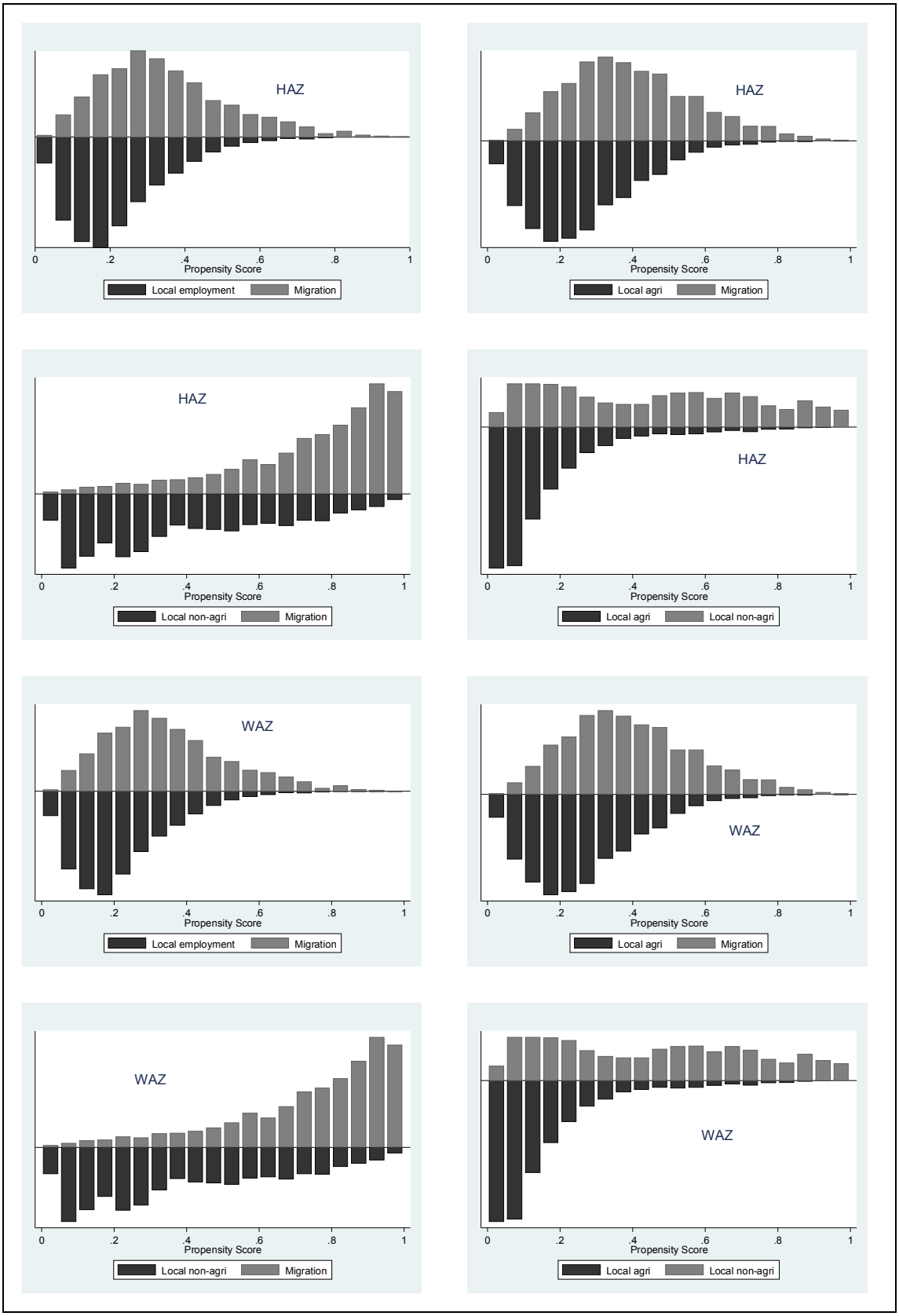

Figure 3. Common support test

Table 5. Result of PSM

		Migration	Local employment	Diff.	S.E	T-value
	Unmatched	-0.738	-0.450	-0.288***	0.037	-7.79
	Matched ATT	-0.738	-0.615	-0.123***	0.040	-3.05
		Migration	Local agri	Diff.	S.E	T-value
	Unmatched	-0.738	-0.532	-0.207***	0.039	-5.34
	MatchedATT	-0.738	-0.654	-0.085***	0.043	-1.97
HAZ		Migration	Local non-agri	Diff.	S.E	T-value
	Unmatched	-0.737	-0.169	-0.569***	0.048	-11.93
	MatchedATT	-0.737	-0.507	-0.230***	0.084	-2.74
		Local non-agri	Local agri	Diff.	S.E	T-value
	Unmatched	-0.169	-0.530	0.361***	0.045	8.03
	MatchedATT	-0.169	-0.219	0.050	0.083	0.61
		Migration	Local employment	Diff.	S.E	T-value
	Unmatched	-0.370	-0.069	-0.301***	0.030	-10.13
	MatchedATT	-0.370	-0.219	-0.151***	0.032	-4.72
		Migration	Local agri	Diff.	S.E	T-value
	Unmatched	-0.370	-0.108	-0.262***	0.031	-8.45
	MatchedATT	-0.370	-0.220	-0.150***	0.034	-4.40
WAZ		Migration	Local non-agri	Diff.	S.E	T-value
	Unmatched	-0.370	0.066	-0.436***	0.038	-11.35
	MatchedATT	-0.370	-0.171	-0.200***	0.070	-2.85
		Local non-agri	Local agri	Diff.	S.E	T-value
	Unmatched	0.066	-0.107	0.173***	0.037	4.72
	MatchedATT	0.066	0.132	-0.065	0.067	-0.97

Note: The kernel matching method is used here. The S. E. in the table is calculated by the following formula: $1/N * \mathrm{Var}(Y|D=1) + \sum w_i^2/N^2 * \mathrm{Var}(Y|D=0)$, in which N is the sample size after matching, D=1 refers to treated group after matching, and D=0 refers to controlling group after matching, w_i is the weight of i in controlling group after matching. The bootstrap method is also used to calculate the S. E., and there is no changes of the significance. T-test is used here to test the outcome of different pairs. *p<0.1, **p<0.05, ***p<0.01.

The PSM reduce the differences of HAZ and WAZ between treated group and controlling group. For instance, the difference of HAZ between children with mothers migrating to urban areas and children with mothers undertaking employment locally is -0.288 points before matching, and decreases to -0.123 points after matching.

The result of PSM shows that HAZ and WAZ of left-behind children whose mothers migrating to urban areas are lower significantly than the children whose mothers employed locally. After matching by propensity scores, the HAZ of left-behind children is lower 0.123 points (16.62%) than HAZ of children whose mother undertaking employment locally; WAZ of left-behind children is lower 0.151 points (40.79%) than children whose mother undertaking employment locally. The total effect of mothers' migration to urban areas on their children's nutritional status is negative, which implying the substitute effect exceeds the income effect of mothers' migration. Although migration can obtain much higher income (per capita income of households with mother migrating to urban areas is 4559.4 RMB Yuan, higher than that of households with mother employed locally, which is 4083.7 RMB Yuan), their left-behind children's nutritional status is worse than children with mother working locally.

As stated above, per capita income of households with mothers undertaking local non-agricultural employment is highest, and then is households with migrating mothers, the lowest per capita income is at households with mothers undertaking agricultural employment locally. However, nutritional status of left-behind children with migrating mothers is worse not only than children with mothers undertaking local non-agricultural employment, but also lower significantly than children whose mother undertaking local agricultural employment. The ATT after matching shows that HAZ of children whose mother migrating to urban areas is lower 0.230 points than children whose mother undertaking local non-agricultural employment, and lower 0.085 points than children whose mother undertaking local agricultural employment. The ATT result of WAZ shows that same trend. Given different income level, although households with mother migrating to urban areas have much higher per capita income, left-behind children's nutritional status is worse than children with

mothers undertaking local agricultural employment, implying that the negative effect of caring defect, especially mothers' caring defect, overpasses the income effect.

Another evidence demonstrating that substitute effect overpasses income effect of mothers' migration on children's nutritional status is that there is no significant differences of HAZ and WAZ between children with mothers undertaking local agricultural employment and children with mothers undertaking local non-agricultural employment after matching, although there is a large gap of household per capita income between these two households. Before matching, HAZ and WAZ of children whose mothers undertaking local non-agricultural employment are higher significantly than that of children whose mothers undertaking local agricultural employment; whereas, after matching the differences become very small (HAZ decreases from 0.361 to 0.050, and WAZ decreases from 0.173 to -0.065) and insignificant, which also implying good performance of PSM to reduce endogeneity bias. This evidence also shows that children's nutritional status will be no significant gap provided their mothers can take care of them, regardless different income level. Otherwise, if mothers migrating and left their children behind, their children's nutritional status would be worse, implying negative effect of mothers' migration.

The result also implies that the marginal effect of increasing households' income on children's nutritional status has diminished with economic growth in rural China in past several decades, and the importance of mothers' caring has exceeded the importance of income increasing on children's nutritional status. Nutrition intake, of course, is important to improving rural children's nutritional status, however, caring defect now should be emphasized.

V. Conclusion and policy implication

A dramatic change of rural Chinese women in the last 30 years is that a large scale of rural women migrating to urban areas to earn their lives. It is a great progress for rural Chinese women, for they can get their economic and social independence from the old rural family. Meanwhile, migrating to urban areas can also take much higher income to their households. However, most of mothers migrating to urban areas left their

children in rural hometown, since they are not recognized as urban citizens according to the *Hu Kou* system in China. Left-behind children's nutritional status is impacted by their mothers' migration through two paths: income effect and substitute effect, the former is positive to children's nutritional status, and the later is negative to children's nutritional status. This paper estimates the effect of mothers' migration on children's nutritional status based on the data of 2008 CFNSS using PSM method controlling possible endogeneity.

It is showed that nutritional status of children whose mother migrating to urban areas is worse significantly than that of children whose mother employed locally, though households with mother migrating to urban areas have much higher per capita income. This result implies that the income effect of migration on children's nutritional status is exceeded by substitute effect that caused mainly by caring defect. Meanwhile, there is no significant difference of nutritional status between children whose mother undertaking local agricultural employment and children whose mother undertaking local non-agricultural employment, although there is income gap between these two households.

It should be recognized that increasing of women's income brought about by their migration has promoted their children's nutritional status in the last several decades, which can be demonstrated by the increasing of rural children's nutritional status (Chen, et al., 2010); but the result of the paper implies that the marginal effect of income increase has become decreased, otherwise, the importance of caring has become more and more important for children's nutritional status.

Chinese government has issued a series of policies and measures to improve rural children's nutritional status in recent years, the main one of which is the "Nutrition Improvement Plan for Rural Compulsory Education Students" issued by the State Council in 2011. There are also other programmes improving rural children's nutritional status, such as "Children Early Development Programme", "Extending Plan for Children Nutrition Package", "Nutritional Breakfast Plan", etc., conducted by local governments. However, the framework of these programmes is focused on nutrition intake, and mothers' caring is always neglected. But as this paper shows,

caring defect has become more important than nutrition intake for rural children's nutritional status.

It is expected that more rural women would migrate to urban areas in the future years as Chinese government has put forward to promote the urbanization process as national development strategy, which resulting more left-behind children in rural areas provided the current rural-urban dualistic system. This trend adds difficulty to improve rural left-behind children's nutritional status further. Measures should be taken into agenda to resolve this problem, so to improve rural children's nutritional status.

A feasible measure that can be taken in short-term is to subsidy mothers migrating to urban areas in poor rural areas by government so they can interrupt their jobs in urban areas and back home to take care of their children under 1 year old, or 6 months old. There is fiscal possibility to conduct this subsidy, while the social benefit to improving children's health will be large.

The second measure is to enlarge the coverage of maternity insurance for rural-urban migrants in urban areas, thus to guarantee women migrants' jobs and essential income when they give birth and take care of their infants. However, according to the Law of Social Insurance issued in 2010, all workers employed formally should be covered by maternity insurance. But most of regions have not cover rural urban migrants.

Thirdly, services facilities for children caring, such as kindergarten, child-care centers, nurseries, should be established in enterprises employing migrants, so mothers can take care of their infants conveniently. These services facilities could be built by private organizations, non-profit organizations, or by governments directly.

From a long-term respect, the rural-urban dualistic system should be broken down and rural-urban migrants should be recognized as urban citizens so to promote their integration to city mainstream, which in turn reduces the size of rural left-behind children.

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