Left-Behind Villages, Left-behind Children: Migration and Cognitive Achievement of Rural Children in China

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Abstract

Although the potential effects of migration on cognitive development of children in origin communities reflect both household- and community-level processes, few studies have examined how community-level migration affects child cognitive development. Applying multilevel methods to a nationally representative data of 2248 children from 427 villages in China, we examine whether village migration intensity influence child cognitive ability, and if so, what accounts for them. Findings suggest lower cognitive achievement in communities experiencing high migration intensity. Children living in high migration intensity are expected to have a 1.33 and 1.54 unit lower verbal and math scores, which is equivalent of 0.62 and 0.87 year of formal education respectively. A possible explanation for this effect is the change in demographic composition that communities are depleted with better educated adults.

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Introduction

Large-scale migration has been an integral part of China's unprecedented industrialization and urbanization processes since the economic reform of the late 1970s. Currently, China has the largest internal migrant population in the world, account for over one third of global internal migrants (IOM, 2016). By 2016, internal migrant reached 277 million, or 20% of Chinese population, and the number is expected to grow continuously in the future (NHFPC, 2017). Meanwhile, the proportion of residential population in rural areas decreased from 80% in late 1970s to 44% in 2016 (World Bank, 2015). Barriers in accessing urban public services, high costs of urban living, poor housing conditions, long working hours and lack of social support network in destination cities (Lee & Park, 2010; Mu & Brauw, *2015*) prevent many migrants from bringing along their children to destinations. As a result, over 61 million children are estimated being left behind in rural areas, represent over one third of all rural children (Duan et al., 2013).

These numbers reflect a major change in the family and community environment in which children are cared for. Parental migration brings about changes in family structure and dynamics (Lu, 2012), entails a trade-off between economic beneifts and parenting inputs, such as parental supervision and emotional support. At community-level, selective migration may affect child achievement by changing community demographic composition, shifting sociocultural norms and aspirations, community institutional resources and social capital. Whereas the body of literature examining the effect of family processes of parental migration on child achievement is rapid accumulating, little effort has been devoted to examining whether and to what extent child achievement is influenced by labor migration at community level, and, if so, what accounts for them.

The present study seeks to bridge this gap using data from the China Family Panel Studies, currently the largest social survey initiated in 2010 (Xie & Hu, 2014). We examine several empirical questions: 1) is village level migration associated with child cognitive ability, net of child and family characteristics? 2) If there is an independent community migration effect, what factors mediate the effect? 3) Is there a cross-level synergistic effect of village level migration on parental migration and child cognitive development?

Background

Family and neighborhood environment and child cognitive development

Childhood cognitive ability is a powerful predictor of adult well-being across multiple domains, whether educational attainment, labor market success, or health outcomes (Gottfredson & Deary, 2004; Herrnstein & Murray, 1994; Jencks, 1979; Marks, 2013; Schnittker, 2005). Cognitive ability is shaped by a cumulative process of interaction among inherited endowments, family and school inputs (Todd & Wolpin, 2003), especially during the early years in the life course (Heckman, 2006). Research on both industrialized and developing countries has

highlighted various family factors that may be associated with child cognitive development, including family resources for children (e.g. food, health care that may determine child health and nutritional status), cognitive stimulation, and parenting skills (Paxson & Schady, 2007).

Another strand of literature also highlights the importance of neighborhood as a social context in altering and structuring child cognitive development (Leventhal & Brooks-Gunn, 2000; Rogoff, 1990; Sampson, Sharkey, & Raudenbush, 2008; Vygotsky, 1980). Neighborhood, in which a child grows up, can exert remarkable influence on the child's cognitive development (Flavell, 1992). The sociocultural understanding of child cognitive development emphasized by theorists like Rogoff (1990) and Vygotsky (1980) contends that children "acquire knowledge and skills by participating in societally structured activities together with their parents, other adults, and children".

Recent reviews by Sastry (2012) and Sharkey and Faber (2014) of the literature for neighborhood effect discussed a variety of channels through which the characteristics of neighborhood may influence child cognitive achievement. First, the availability and quality of local institutions (e.g. schools, social services) could directly and indirectly influence children's acquisition of skills; and the availability and quality of local institutions may be influenced by the characteristics and connectedness of local residents. Second, children's cognitive development may be affected by neighborhood social interactions. For example, exposure to educated adults and positive role models could motivate children to excel academically. In neighborhood with dense and overlapping social ties, children may receive help and support from adults outside of their families, and they may also benefit from a wider range of public verbal interactions. Third, the neighborhood normative environment, particularly the value placed on education achievement and tolerance toward deviant behaviors, may also be influential to child achievement.

Parental migration, split family, and child achievement

Previous studies have highlighted countervailing mechanisms through which parental migration and changes in family structure and dynamics influence child cognitive development. On the one hand, increased family resources enable investment in human capital through better nutrition, more spending on education and reduced child labor; on the other hand prolonged absence of parents can reduce parenting inputs and incur psychological distress (Antman, 2013; Dustmann & Glitz, 2011; Gibson, McKenzie, & Stillman, 2011). In addition, parental or child educational aspiration may be influenced by migration, either positively or negatively, depending on migrants' perception of economic return to education at destination (McKenzie & Rapoport, 2006). Thus, heterogeneous effects may be expected, contingent upon how these contradictory effects plays out in particular sociocultural context (De Haas, 2010; Lu, 2014). This prediction is supported by varied and inconsistent empirical findings from a variety of national context (De Brauw & Giles, 2008; McKenzie & Rapoport, 2006), and is illustrated by cross-country comparisons (Lu, 2015).

Selective migration and sending community

While there is abundant evidence that migration may influence child cognitive development through changes in family environment, relatively little is known about the community-level processes. The selective nature of migration, when combined with its high volume, has the potential to dramatically alter the demographic composition, social structure, and social organization of sending (and receiving) communities (Weeks, 2011). The impact of the changes brought about by migration to the sending communities has been a topic of live debate. A synthesize of theoretical and empirical literature by De Hass (2010) on migration and development provides an overview of various (contradictory) schools of thoughts. Drawing from the historical experience of rural-to-urban migration within Europe and the United States and emigration from Europe to North America, neo-classical migration theory views migration as a form of optimal allocation of production factors to the benefit of both sending and receiving communities.

Contradictory to this view, cumulative causation theory and neo-Marxist theory raise a variety of concerns about associated socioeconomic problems or what Reichert (1981) called "migrant syndrome". At the core is "brain/brawn drain" – with the large-scale departure of educated, young, able-bodied men and women from rural areas, many sending communities are left with older adults and children whose parents are absent. In addition, studies have documented sociocultural effects of migration (De Haas, 2010). For example, ethnographic studies have linked migration with consumerist, non-productive and remittance-dependent attitudes, the disruption of traditional kinship systems and care structure, and the breakdown of traditional institutions regulating village life and agriculture and the loss of social solidarity (De Haas, 1998; Hayes, 1991; King & Vullnetari, 2006). "The exposure of rural youth to the relative wealth and success of migrants, combined with changing 'urban' tastes and material aspirations…" could lead to a "culture of migration" (De Haas, 2010). The potential to gain economic mobility through migration may reduce the motivation to invest in education if the perceived availability of low-skill employment is abundant (Kandel & Kao, 2001).

The Chinese Context

The large-scale departure of rural labor force in China has brought forth unprecedented changes in rural communities. Migration has been removing the relatively young, better educated and more productive out of rural labor force, resulting in gradual rural depopulation and altered demographic composition with a disproportionate number of elderly, children and females in rural communities (Davin, 1998). The implication of such large scale out-migration of educated and capable members of rural communities to the wellbeing of remaining rural residents is not well understood, although scholarly concern has been raised, and some ethnographic studies have provided some insights to the transition of rural China (e.g. Biao, 2007; Pan & Ye, 2017).

In early 1990s, the concept of "village hollowing" emerged in literature to describe this rural demographic and micro-geographic transition[1] (Long et al., 2012; Sun, Liu, & Xu, 2011). The sociocultural changes have also been documented. Out-migration of community members, often to different areas, weakens social bonding, and cohesion of rural communities (Tan, 2011). With a large migrant population, the social organizations in many labor sending communities have been dissolving; traditional agricultural customs and social norms that stress reciprocal support have been replaced by more individualistic market ethics (Peng, 2014). With a large migrant population, labor sending communities have little human resources for public social cultural events (Tan, 2011). Per capita cost of providing public services is high, community hygiene and sanitation is deteriorating as a result (Peng, 2014). Out-migration of educated and capable members of rural communities weaken the capacity of the community as a whole to mobilize resources for education and provide for those left-behind (Biao, 2007).

The present study

The first aim of the study presented here was to see whether there is an independent village level migration effect on child cognitive ability, net of child and family characteristics. As discussed above, selective nature of migration could remove community of its young and better educated, weaken social organization, and reduce public verbal. The net effect of village migration may be detrimental to the cognitive development of rural children.

The second aim of the study was to examine the factors that might interpret the negative effects of village migration. We tested three hypotheses related to the mechanisms of educational composition of remaining residents, density of social interactions and collective attitude concerning the importance of education. Finally, we examined whether there is a cross-level synergistic effect of village level migration on parental migration and child cognitive development. We test the hypothesis that village migration compounds the challenges of parental absence and produce a stronger negative effect on child cognitive development.

[1] Geographically, village hollowing refers to the fact that rural residents abandon traditional housing in village centers for new housing on village fringes

Data and Methods

The data used in this analysis are derived from the 2010 baseline survey of the China Family Panel Studies (CFPS). Using a stratified multistage procedure with probability proportional to size (PPS), the CFPS drew a national representative sample from 25 provinces which altogether cover 95% of China's total population. From the 25 provinces, 649 rural villages and urban neighborhoods were chosen randomly from 162 counties. Within each community, 25 households were randomly drawn. The final sample contains a total of 57,115 individuals from 14,960 households. All members age 10 or above from chosen households were interviewed while information on younger children were provided by primary caregiver.

We restrict our analyses to a subsample of 2,666 rural children (children with an agricultural household registration) age 10 to 15. Other than rural-urban labor migration, many other reasons could lead to parental absence, such as divorce, military separation, imprisonment and death. These experiences are perceived rather differently by other family members, and may lead to varied outcomes (Botezat & Pfeiffer, 2014). We, thus, exclude a total of 292 children whose parents are deceased, divorced, or separated due to military services or pursue education. In addition, 107 migrant children[2] were also exclude, because the developmental contexts may not be equivalent to those stayed in rural communities. Furthermore, 73 children with missed information on cognitive test were excluded, result in an analytic sample of 2,301 rural children.

The proportions of cases with missing covariates were low (from 0.1% to 1.1%). Employing list-wise deletion of cases with missing data on any covariate, we ended up with excluding 53 cases (2.3%). This brings our analytic sample down to 2,248 children from 427 villages.

Measures

Cognitive development is measured by two standardized tests administered to children age 10 to 15 in the CFPS, measuring children's achievement in vocabulary and mathematics. Drawn from the textbooks used in primary and secondary schools, the vocabulary test consists of 34 Chinese characters while the mathematic test includes 24 mathematical problems that are sorted in ascending order of difficulty. The final score for each test is the rank order of the most difficult question that the respondent can answer correctly. To improve the efficiency, respondents who completed primary school or higher were assigned to higher entry points, and the rank order of the question preceding the entry point were assigned as the test score if the respondent failed to answer any of the questions. For those who failed the test, the assigned scores represent a censored upper bound on cognitive ability, and thus including these cases in analyses may lead to estimates biased toward zero because variation in the censored score masks the true effects (Paxson & Schady, 2007). Fortunately, the fraction of children not attained the

[2] A child is considered migrant if the *hukou* address indicate that he/she is from another township within or outside the county he/she is currently living.

minimum scores is very small in our analytic sample (less than 1 percent) [3]. Scores on standardized assessments represent "gold standard" measures, since alternatives such as children self-reported or guardian-reported grades are often subject to systematic nonresponse, recall bias, and noncomparability across different schools or classes (Sastry, 2012).

At community level, the main variable of interest was migration intensity, which was defined as the proportion of individuals aged 15 to 65 currently engaged in labor migration. The survey included a detailed household roster with basic demographic information for each household member as well as whether he/she was current at home, and if not, the reasons for their absence (e.g. pursuing education, incarcerated, labor migration). Based on the information, we aggregated the number of individuals engaged in labor migration among the randomly selected households in each village to create village migration intensity. On average, 24.5 households and 78 individuals in each village were included in the calculation. One source of potential bias stemmed from permanent out-migration (migration with transferred *hukou*), to the extent that we were not able to include people permanently migrated in the past, we ran the risks of underestimate the ratio because of the excluded cases contribute strongly to the numerator and proportionately less to the denominator (Massey, Goldring, & Durand, 1994). Such a bias is unlikely to be substantial, however, since hukou conversion in China remained difficult for most migrate labors (Ye, 2018).

Parental migration experience was differentiated by the number and gender of parent engaged labor migration (i.e. nonmigrant family, father-only migration, mother-only migration, and both-parent migration). We measure parental migration in the year before the survey to correct for the possibility of cognitive performance as a (de)motivation for migration.

Informed by previous research (Liu & Xie, 2015; Xu & Xie, 2015), and considering theoretical significance, we control for a number of variables, at individual and community levels. At the individual level, we control for children's demographic characteristics, including age, gender and ethnicity. Children's cognitive ability is highly inheritable (Flavell, 1992; Herrnstein & Murray, 1994). Parental education and cognitive ability are closely related to children's cognitive achievement. In the analyses, we controlled for parental education attainment (0=primary school or no education, 1=junior high school education, 2=high school education or above). Family structure characteristics, including family size and age composition of family members, indicate the level of family labor supply, and competition over those resources such as the potential need for senior care, and are important factors that influence family migration and the well-being left-behind children. Considering that the effect of labor migration may change household income or family assets dramatically, to avoid over-controlling for the intervening variable (Xu & Xie, 2015), initial family SES, indicated by whether the child ever attended kindergarten and whether the child was born in hospital, was controlled for (Xu &

[3] Additional sensitivity analyses replicated the finding by excluding the censored cases.

Xie, 2015). We dichotomize the initial family SES into two categories: born at home and never attended a kindergarten (1) vs. born in a hospital or ever attended a kindergarten (0).

At the community level, we control for a set of covariates to reflecting community geographic characteristics and remoteness, including village terrain, minority concentration, distance to nearest high school and travel time to business center of nearest town. The variables included in the analyses were listed in table 1.

Analytical approach

We adopted a hierarchical linear modeling strategy to account for the clustered data within communities. Hierarchical linear modeling (HLM, Raudenbush & Bryk, 2002) has the advantages of explicitly modeling the clustered nature of the date, improving the accuracy of standard error estimation and inferential decision; moreover, it allow investigation of sources of variations within and across clusters (Carle, 2009). We specified a multilevel model that incorporates two levels of analysis (individual and community).

We present several HLM models and examine the predictive power obtained by separately entering indicators of migration intensity, we also specify several multilevel interactions that examine the impact of village level migration on the association between parental migration and child cognitive outcomes. The level 1 equation of HLM took the following form:

$$Y_{ij} = \pi_{0j} + \pi_{1j} Pmig_{ij} + \sum \beta_q X_{ij} + e_{ij} \qquad (1)$$

where (Y_{ij}) is the cognitive test score of child i in village j. The dependent variable is considered a linear function of parental migration status ($PMig_{ij}$), and a set of child and family (X_{ij}) characteristics. The intercept π_{0j} was the mean cognitive score of children residing in village j, and it was allowed to vary across villages. The village level (level 2) equation estimated effects of community variables:

$$\pi_{0j} = \beta_{00} + \beta_{01} Vmig_j + \sum \beta_{0q} X_j + r_{0j} \qquad (2)$$

The level 1 intercepts (π_{0j}) were predicted by village migration intensity ($Vmig_j$) and a set of village level characteristics (X_j). β_{00} and β_{0q} were level 2 intercept and coefficients for each community variable; r_{0j} was level 2 random effect. We allow the coefficients of parental migration in equation (1) to vary randomly across communities to test heterogeneity, thus the coefficient from equation (1) was used as dependent variable in the level 2 equation:

$$\pi_{1j} = \beta_{10} + \beta_{11} Vmig_j + r_{1j} \qquad (3)$$

Where π_{1j} was the effect of parental migration on child cognitive outcomes and was predicted by village migration intensity; r_{1j} was level 2 random effect for the slope. The

specification tests the hypothesis that association between parental migration and child outcomes is contingent on village migration intensity.

Albeit capable of providing useful information on the association between migration at family and village level and child cognitive achievement, the results must be interpreted with caution. Strong assumptions are required to draw causal inferences from cross-section analyses as is discussed by Todd and Wolpin (2003) and Paxson and Schady (2007).

First, it is important to recognize the role of selectivity in explaining associations between parental migration and child outcomes[4]. The selectivity has been found in both initiating and returning processes. Migrants are generally perceived as a "positively selected" group, whereby, migrants are typically younger, more educated, more resourceful to pursue opportunities and to overcome obstacles of migration, and in better physical and mental health than randomly selected individual from their origin communities (Abraido-Lanza et al., 1999; Chiswick, Lee, & Miller, 2008; Jass & Massey, 2004). However, studies on international migration (Massey et al., 1994), and internal migration in China (M. Sun & Fan, 2011) suggest that as migration streams mature, the selectivity of migration declines; "over time migration streams became increasingly diverse and increasingly representative of the home community" (M. Sun & Fan, 2011). To the extent that positive selection is present, self-selection may lead to overestimate the positive effects (or underestimate the negative effects) of migration on the well-being of the left-behind children, because the shared latent factors (e.g. genetic predisposition, ambition, determination) may both select parents into migration and shape child developmental outcomes (Kuhn, Everett, & Silvey, 2011). Nevertheless, we could mitigate the selection bias by holding village migration intensity constant.

Moreover, it is possible that parental migration is affected by children's cognitive ability. The amount of resources parents invest in child development may be contingent on their perception of the child's ability, whether "compensatory" – parents invest more time and resources when children lack of progress in cognitive development or "complementary" – gifted and bright children may receive more resources or parental attention (Becker & Tomes, 1976; Paxson & Schady, 2007). Although we measure parental migration in the year *prior* to the survey, it is not possible to rule out the possibility that the associations between parental migration and child cognitive development is influenced by parents' perception and responses to their children's cognitive ability.

At community level, the problem of selection bias has long been a challenge to studies of urban neighborhood and children's cognitive development in the US literature (Sastry, 2012;

[4] One way to address the problem of selection would require longitudinal data. Although the CPFS follow the sampled children overtime, the cognitive tests were not in the same across panels. The cognitive tests in 2012 and 2016 waves were entirely different from that of 2010 and 2014. Although the content of the cognitive tests in 2010 and 2014 were largely the same, but the way of administration changed. Moreover, started from 2014, the household roster no longer differentiates labor migration as a separate reason when a family member is absent, rendering overtime comparison inconsistent.

Sharkey & Faber, 2014). Spurious relationship between neighborhood context and children's cognitive ability may result if unobserved or unmeasured family characteristics (e.g. parental self-efficacy, attitude toward child education) influence both the family's neighborhood choice and child cognitive development simultaneously. This is, however, unlikely a significant source of bias in the Chinese context of rural villages because of the peculiar institutional barrier of household registration system. Changing rural hukou registration status from rural to urban or even from one rural village to another has been extremely difficult since the inaction of household registration system in 1950s; the household registration location of residence is often out of individual's control for most of rural Chinese people, and thus can be considered exogenous to family characteristics (Meng & Yamauchi, 2017).

Nevertheless, the level of village migration may be partially determined by village natural endowments (Chan, 2012; Davin, 1999; Tuñón, 2006), while these factors may also shape the physical (and social) environment that exert significant influence on child development (Viner et al., 2012). To address this concern, a set of community characteristics was controlled for, including village terrain, minority concentration, distance to nearest high school and travel time to business center of nearest town. Therefore, although selectivity should not be a serious concern on the village-level, readers should interpret parental migration effects at household level with caution.

Results

Table 1 presents the descriptive statistics for the variables used for the analyses. The average verbal and math scores are 10.8 and 20.9 respectively. Figure 1 presents the distribution of these cognitive test scores. It shows that while math score almost follows a normal distribution, verbal score is skewed to the left. The interpretation of these scores in absolute term is not straightforward since no reference has been developed.

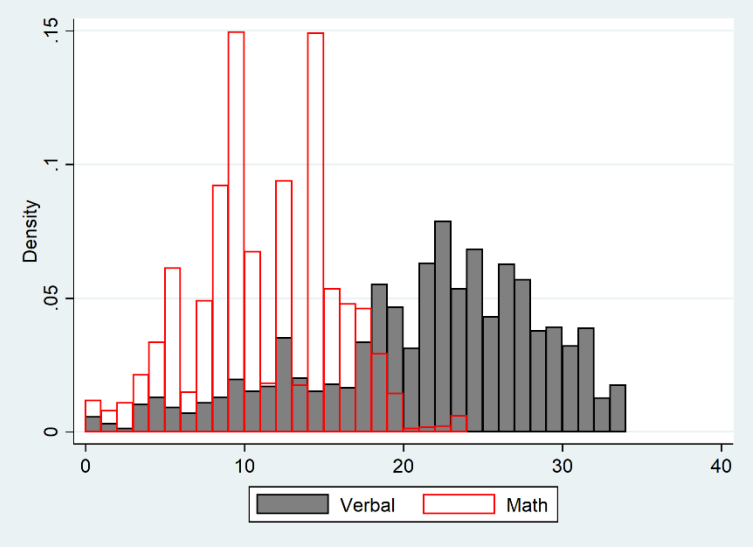

Figure 1. Distribution of verbal and math test score

Nearly 28% children are identified as left-behind children. Consistent to the traditional patriarchal gender relations, when only one parent involved in migration, migration of fathers is much more common than that of mothers. In fact, only 3 percent of the sampled children currently living with resident father while mother migrated, while 19 percent are living with their mothers when fathers are absent. Considerable fraction of these children is left behind by both parents.

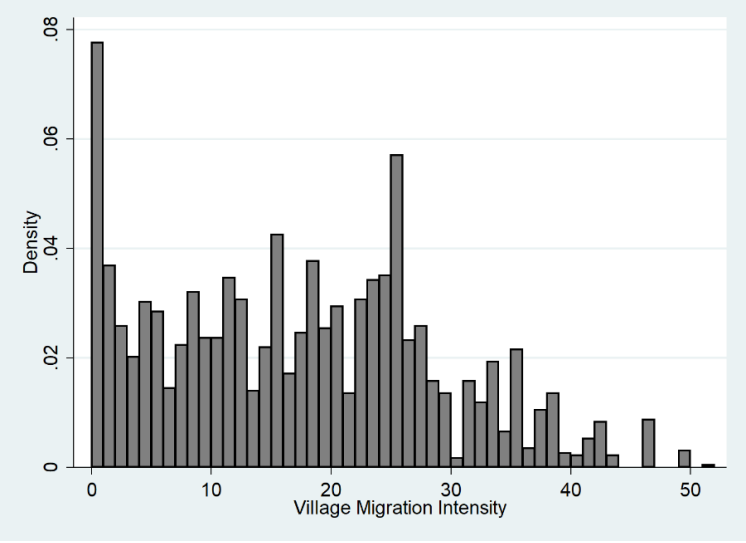

Figure 2. Distribution of village migration intensity

Figure 2 presents the distribution of village migration intensity. It shows that the village migration intensity ranges from 0 to 51 %. Over 90 % of the children live in a village which has some migrants. The average village migration intensity is 17 %, indicating that over half of the children living in a village where over 17% of adult population are currently away.

The average neighborhood education level of sampled adults (with migrants excluded) is 5.09 years. Average village social capital, as measured by the average number of social activities that sampled households do with neighbors, is approximately 22. Neighborhood level proportion of adult consider education to be critical for a child future success is generally high; on average,

Table 1. Percentages and means of the characteristics of analytic sample, rural children aged 10-15, CFPS 2014 (N = 1397)

Variable	Description	Mean	SD
Dependent variables			
Verbal score	Verbal test scores (0 - 34)	10.8	4.4
Math score	Math test scores (0 - 24)	20.9	7.3
Individual-level explanatory variables			
Parental migration status	0 = Both parents present	0.79	
	1 = Father only migrant	0.14	
	2 = Mother only migrant	0.20	
	3 = Both parent migrant	0.51	
Village migration intensity	Proportion of adults out-migrated	17.22	11.54
Community mechanisms			
Village resident adult education	Neighborhood level average number of schooling of sampled adults age 16 and above	5.09	1.92
Village social capital	Neighborhood level average of the number of the following activities that sampled families do with neighbors: 1) having dinner or other types of entertainment, 2) sending food or gift, 3) offering help, 4) visiting, 5) chatting	21.86	11.23
Village collective socialization	Neighborhood level proportion of adult consider education to be critical for a child future success	0.77	0.14
Covariates			
Individual characteristics			
Age	In month	150.70	21.05
Gender	1 = Male	0.51	
Ethnicity	1 = Han	0.87	
Early family SES	1 = Born at home and never attend kindergarten	0.36	
Father's education	0 = Illiterate/primary	0.46	
	1 = Middle school	0.44	
	2 = High school or above	0.10	
Family size	The number of family members	5.05	1.55
Family member aged 14 or below	Proportion of family member aged 14 or below	0.32	0.16
Family member aged 65 or above	Proportion of family member aged 65 or above	0.06	0.13
Home learning environment	Home environment reflecting parental interest in children's education and the parents initiating communication with children (2-10)	6.75	1.23
Parental involvement	Composite score measuring parents' involvement in their children's education (0-24)	12.88	4.74
Village characteristics			
Village terrain	0 = Plain	0.39	
	1 = Hill	0.32	
	2 = Mountain	0.18	
	3 = Other	0.11	
Minority concentration	1 = Village in an ethnic minority area	0.14	
Distance to nearest high school	Neighborhood level mean distance (km) from sampled households to nearest high school	19.85	19.17
Distance to nearest business center	Neighborhood level mean travel time (minutes) from sampled households to business center of nearest city	34.19	27.58

77% of sampled adults agree or strongly agree that education is critical for a child success. This proportion ranges from 21% to 100%.

Turing now to covariates. Children in the sample are 151 months (12.5 year) old. Slightly over half of them are males, and 87% are han. Approximately 36% are born at home and never attended kindergarten. The proportions of their parents completed middle school and high school or above are 44 % and 10 % respectively. The average household size is approximately 5 in our sample. The interviewer rated home learning environment, reflecting parental interest in children's education and the parents initiating communication with children, is on average 6.7. Most of these children live in area that can be classified as plain (39 %), followed by hill (32 %) and mountain (11 %). About 14 % of the children are from an ethnic minority area.

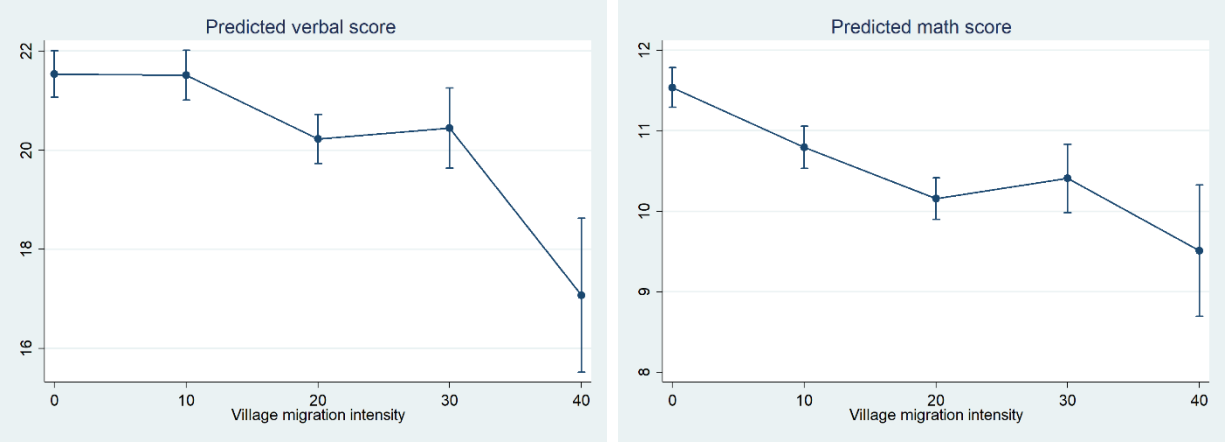

Figure 3. Verbal and math scores in 427 Chinese villages, by village migration intensity

Table 2 presents the unconditional HLM models predicting children's cognitive scores. Controlling only for children's age and gender, village migration intensity is negatively associated with child cognitive outcomes, and the associations are highly significant. Every 1 percentage increase in village migration intensity is associated with 0.07 unit decrease in verbal and 0.05 unit decrease in math scores. The intraclass correlation coefficients for verbal and math score are 0.21 and 0.14 respectively, indicating that 21 % and 14 % variation in verbal and math are attributable to between village variation. Figure 3 depicts the association between verbal and math score at five levels of village migration intensity. The graph shows a roughly linear association.

HLM models predicting verbal score are presented in Table 3. The six columns display six explanatory models to compare the additive effects of our community measures and overall predictive power. Model 6 specify the full model in which children's verbal score is predicted by a full set of individual, household and village characteristics. The last two rows of the table show the changes of village variance and the percentage of variance explained by additional explanatory variables relative to model 1.

Across the models, higher verbal score, as expected, is associated with older age, female gender, better early family SES, greater parental education, smaller family size, better home

learning environment and parental involvement. Few differences appear in the effect of parental migration. Somewhat unexpectedly, relative to children living with both parents, the coefficients for mother-only and both-parent are not significant, with father-only positively associated with verbal score ($p<0.05$). Jointly, parental migration is only marginally significant at $p<0.1$ level. The result suggests that once other individual characteristics and family inputs are held constant, parental migration may not be a significant predictor of child cognitive score.

Table 2. Unconditional HLM models predicting children's cognitive achievement, CFPS 2010

	Verbal	**Math**
Age	0.158**	0.137**
Male	-1.160**	0.072
Village migration intensity	-0.069***	-0.051***
ICC	0.206	0.137
Number of children	2,248	2,248
Number of villages	427	427

Notes: + p < .10. *p < .05. **p < .01 ***p < .001

Model 1 presents the baseline specification with basic controls of child individual characteristics and family environment along with parental migration status. With individual characteristics and family environment controlled, village migration intensity is significantly associated with children's verbal score ($p<0.05$). Every 1 percentage increase in village migration intensity is associated with 0.03 unit decrease in verbal scores. Model 2 add to the specification of community controls. At individual level, few coefficients changed, except the effect size of han ethnicity is cut in half and no longer significant, which suggests that the association may be explained by community characteristics, especially minority concentration and remoteness. Controlling for village characteristics, the coefficient of village migration intensity attenuated slightly, but remained significant ($p<0.05$), indicating that the effect of village migration intensity cannot be explained by the added variables. Relative to model 1, the added village characteristics explain 3.4 % variation on village level.

By introducing a village level average educational attainment among non-migrant residents to model 2, model 3 test the hypothesis that the effect of village migration intensity is mediated through the lack of well-educated role model. Relative to model 2, the effect of village migration is almost cut in half, and no longer significant. The result provide evidence that the effect of village migration intensity is operated through depletion of educated members from the community. Likewise, model 4 and model 5 test the mediation effects of village collective attitude toward education, and village social organization. None of these two variables appears significant net of all other controls, and the coefficient of village migration intensity remained almost the same. The association between village migration intensity is accounted for by the variables proposed. Finally, model 6 present a full model predicting children's verbal score.

Table 4. Multilevel models predicting children's verbal score, rural children aged 10-15, CFPS 2010 (N=2,248)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
A. Individual level effects						
Age	0.160***	0.159***	0.158***	0.159***	0.159***	0.158***
Male	-1.220***	-1.190***	-1.183***	-1.197***	-1.195***	-1.194***
Ethnicity – Han	2.078***	0.986	0.962	1.061+	0.992	1.028+
Initial family SES	-1.214**	-0.900**	-0.771*	-0.906**	-0.934**	-0.366
Parental education (ref.: Illiterate/primary)						
Middle school	0.964***	0.893**	0.764**	0.885**	0.896**	0.760*
High school or above	1.773***	1.672***	1.504***	1.667***	1.671***	1.498***
Household size	-0.362***	-0.349***	-0.330***	-0.347***	-0.348***	-0.328***
Family member aged 14 or below	0.696	0.638	0.646	0.636	0.625	0.632
Family member aged 65 or above	1.418	1.374	1.353	1.412	1.378	1.386
Home learning environment	0.666***	0.671***	0.669***	0.671***	0.664***	0.662***
Parental involvement	0.063*	0.057+	0.053+	0.058*	0.055+	0.052+
Parental migration (ref.: both parent present)						
Father only migration	0.725*	0.769*	0.797*	0.775*	0.773*	0.806*
Mother only migration	-0.469	-0.492	-0.445	-0.488	-0.529	-0.479
Both parent migration	0.785	0.818	0.810	0.817	0.807	0.797
B. Village level effects						
Village terrain (ref.: plain)						
Hill		0.091	0.194	0.108	0.0936	0.210
Mountain		-0.873	-0.702	-0.858	-0.864	-0.681
Other		0.193	0.383	0.251	0.206	0.441
Minority concentration		-1.172+	-1.084	-1.158+	-1.224+	-1.125+
Distance to nearest high school		-0.001	0.002	-0.000	-0.001	0.002
Distance to nearest business center		-0.014+	-0.010	-0.014+	-0.014+	-0.011
Village migration intensity	-0.030*	-0.026*	-0.014	-0.028*	-0.025+	-0.014
Village resident adult education			0.277**			0.278*
Village educational aspiration				-0.019		-0.795
Village social capital					-1.024	-0.019
Intercept	-7.876***	-6.104***	-7.929***	-5.388***	-5.595***	-6.869***
Village variance	4.29***	4.14***	4.01***	4.07***	4.12***	3.91***
Percentage of variance explained		3.4%	6.5%	4.0%	5.1%	8.7%

Notes: + p < .10. *p < .05. **p < .01 ***p < .001

Relative to model 3, introducing two additional community mechanisms does not further reduce the magnitude of village migration intensity coefficient, although the percentage of variance explained by the model increased somewhat.

Identically structured models predicting children's math scores are presented in Table 4. Similar to the results of verbal scores, across the models, higher math score, as expected, is associated with older age, better early family SES, greater parental education, smaller family size and better home learning environment. Parental involvement and ethnicity are not significant predictors. The direction, magnitude and significance level of parental migration are comparable across models. Relative to children living with both parents, the coefficients for mother-only and father-only are not significant. However, both-parent migration is positively associated with verbal score ($p<0.05$). Jointly, parental migration is significant at $p<0.05$ level.

Compared to the baseline model, adding the community controls in model 2 decreases the coefficient of village migration intensity slightly. Controlling for village characteristics, the coefficient of village migration intensity attenuated slightly, but remained significant ($p<0.01$), indicating that the effect of village migration intensity cannot be explained by the added variables. Relative to model 1, the added village characteristics explain 3.8 % variation on village level. Again, by introducing village level mechanisms, model 3 to 5 test the hypothesis that the effect of village migration intensity is mediated through the proposed channels. Similar to the results observed for verbal test, no evidence supporting the mechanisms of village collective attitude toward education and village social organization is observed. There is one important distinction, however - while 23% of the village migration intensity effect is interpreted by depletion of educated members from the community, it does not fully account for the effect of village migration intensity, as the main effect remained highly significant. Finally, compared the full model (model 6) to model 3, introducing two additional community mechanisms does not further reduce the magnitude of village migration intensity coefficient, nor does the percentage of variance explained by the model increased appreciably. Evaluating multiple mechanisms simultaneously, the only significant variable appears to be depletion of educated members from the community.

Finally, tests for heterogeneity of effect of parental migration by village migration intensity showed no significant results; no cross-level interaction is detected.

Table 4. Multilevel models predicting children's math score, rural children aged 10-15, CFPS 2010 (N = 2248)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
A. Individual level effects						
Age	0.136***	0.135***	0.135***	0.135***	0.135***	0.135***
Male	-0.010	0.004	0.009	0.003	0.004	0.008
Ethnicity – Han	0.444+	-0.149	-0.173	-0.143	-0.149	-0.173
Initial family SES	-0.701***	-0.572**	-0.486**	-0.573**	-0.575**	-0.489**
Parental education (ref.: Illiterate/primary)						
Middle school	0.456**	0.424**	0.334*	0.423**	0.424**	0.334*
High school or above	0.586*	0.529*	0.412+	0.528*	0.529*	0.411+
Household size	-0.189***	-0.186***	-0.172***	-0.185***	-0.185***	-0.172***
Family member aged 14 or below	-0.377	-0.387	-0.378	-0.387	-0.388	-0.379
Family member aged 65 or above	0.490	0.446	0.421	0.449	0.446	0.421
Home learning environment	0.338***	0.340***	0.339***	0.340***	0.339***	0.338***
Parental involvement	0.006	0.002	-0.001	0.002	0.002	0.002
Parental migration (ref.: both parent present)						
Father only migration	0.0461	0.076	0.094	0.077	0.077	0.094
Mother only migration	0.530	0.520	0.551	0.521	0.518	0.547
Both parent migration	0.826**	0.858**	0.851**	0.858**	0.857**	0.850**
B. Village level effects						
Village terrain (ref.: plain)						
Hill		-0.096	-0.035	-0.095	-0.096	0.082
Mountain		0.0423	0.149	0.0434	0.0429	0.268
Other		-0.086	0.028	-0.082	-0.086	0.067
Minority concentration		-0.681*	-0.631+	-0.680*	-0.685*	-0.671*
Distance to nearest high school		-0.002	-0.000	-0.002	-0.002	0.002
Distance to nearest business center		-0.007+	-0.004	-0.007+	-0.007+	-0.002
Village migration intensity	-0.033***	-0.030***	-0.023***	-0.031***	-0.030***	-0.023***
Village resident adult education			0.173**			0.174**
Village educational aspiration				-0.083		0.000
Village social capital					-0.001	-0.002
Intercept	-10.85***	-9.902***	-11.02***	-9.845***	-9.868***	-10.98***
Village variance	0.93***	0.90***	0.84***	0.90***	0.90***	0.84***
Percentage of variance explained		3.8%	9.5%	3.6%	3.8%	9.6%

Notes: + p < .10. *p < .05. **p < .01 ***p < .001

Discussion

We investigated, among the first, the effects of village migration on children's cognitive achievement, using data from CFPS on 2,248 children from 427 villages. Findings from these analyses underscore that village level migration does have a statistically significant effect on child cognitive development in rural China, net of all the controls at child, household and community levels. The effect cannot be explained by village remoteness. The effect size is relatively small - every 10 percentage points increase at migration intensity reduces child verbal and math score by 0.26 and 0.30 points. Looking at the extreme, however, the children living in the highest migration intensity (0.513) are expected to have a 1.33 and 1.54 units lower verbal and math scores, which is equivalent of 0.62 and 0.87 year of formal education respectively[5]. Additional analyses (results upon request) shows that the effect of village migration may not be linear for verbal score – the predicted verbal scores decline only after migration intensity reach 20%, indicating a potential threshold effect.

We found that the negative effect of village migration on child verbal score can largely interpreted by the average education level of residential adults. However, average education level of residential adults can only partially account for the effect of village migration on math score (about 23%). However, the social organization and collective attitude concerning the importance of education do not appear to mediate the village migration effect. Auxiliary analyses (appendix 1) show that higher village migration intensity is significantly associated with lower proportion of adult consider education to be a critical factor for the success of a child, the effect size is however relatively small. On the other hand, the predicted average number of social interactions is in the opposite direction of our prediction.

We found no evidence for a cross-level interaction between village level migration and parental migration despite the theoretical considerations that the effect of parental migration may appear different at the high and low ends of village migration intensity. When village migration intensity is high, deprived village environment may compound the challenges of parental absence and produce a stronger negative effect. On the other hand, when village migration intensity is low, the selectivity may be strong (Massey et al., 1994); children left behind thus may exhibit better outcome just because they share certain latent factors, whether genetic predisposition, ambition, determination. Future analyses of these issues would be welcome.

As we have discussed in the method session, the cross-sectional nature of the analyses restricts the ability of the study to make causal inferences, especially for migration at household level. Interpretation of the associations is thus subject to some uncertainty. To the extent that the findings are causal, they suggest that neighborhood environment is an important developmental context for child cognitive development in rural China, and targeted interventions may be

[5] Predicting the cognitive scores using the same full models (model2, results not shown), the coefficients of grade were 2.14 and 1.78 respectively.

warranted to improve cognitive development among young children from villages with a high migration intensity level.

Appendix 1 multilevel models of village migration intensity on education input

	Community average education	Social norm on education	Collective efficacy
Village migration intensity	-0.038***	-0.184***	0.084***
Number of villages	427	427	427
Number of observations	2248	2248	2248

Notes: All regressions in this table control for the full set of children's characteristics, parental characteristics, household composition, and village level controls.
+ p < .10. *p < .05. **p < .01 ***p < .001

References

Abraido-Lanza, A. F., Dohrenwend, B. P., Ng-Mak, D. S., & Turner, J. B. (1999). The Latino mortality paradox: a test of the“ salmon bias” and healthy migrant hypotheses. *American Journal of Public Health*, *89*(10), 1543–1548.

Antman, F. M. (2013). 16 The impact of migration on family left behind. *International Handbook on the Economics of Migration*, 293.

Becker, G. S., & Tomes, N. (1976). Child endowments and the quantity and quality of children. *Journal of Political Economy*, *84*(4, Part 2), S143–S162.

Biao, X. (2007). How far are the left-behind left behind? A preliminary study in rural China. *Population, Space and Place*, *13*(3), 179–191.

Botezat, A., & Pfeiffer, F. (2014). The Impact of Parents Migration on the Well-Being of Children Left Behind–Initial Evidence from Romania. *ZEW-Centre for European Economic Research Discussion Paper*, (14-029). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2432946

Carle, A. C. (2009). Fitting multilevel models in complex survey data with design weights: Recommendations. *BMC Medical Research Methodology*, *9*(1), 1.

Chan, K. W. (2012). Migration and development in China: Trends, geography and current issues. *Migration and Development*, *1*(2), 187–205.

Chiswick, B. R., Lee, Y. L., & Miller, P. W. (2008). Immigrant selection systems and immigrant health. *Contemporary Economic Policy*, *26*(4), 555–578.

Davin, D. (1998). *Internal migration in contemporary China*. Springer.

Davin, D. (1999). Internal migration in contemporary China. Retrieved from http://www.popline.org/node/629641

De Brauw, A., & Giles, J. (2008). Migrant opportunity and the educational attainment of youth in rural China. *World Bank Policy Research Working Paper Series, Vol*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1096849

De Haas, H. (1998). Socio-economic transformations and oasis agriculture in southern Morocco. In *Pp. 65-78 in Looking at Maps in the Dark, edited by Leo de Haan and Piers Blaikie*. Citeseer.

De Haas, H. (2010). Migration and development: A theoretical perspective. *International Migration Review*, *44*(1), 227–264.

Duan, C., Lu, L., Guo, J., & Wang, Z. (2013). The Condition of China’s Rural Left-behind Children: An Analysis Based on the Sixth Census, *35*. https://doi.org/10.3969/j.issn.1004-129X.2013.03.004

Dustmann, C., & Glitz, A. (2011). Migration and education. In *Handbook of the Economics of Education* (Vol. 4, pp. 327–439). Elsevier.

Flavell, J. H. (1992). Cognitive development: Past, present, and future. *Developmental Psychology*, *28*(6), 998.

Gibson, J., McKenzie, D., & Stillman, S. (2011). The impacts of international migration on remaining household members: omnibus results from a migration lottery program. *Review of Economics and Statistics*, *93*(4), 1297–1318.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why? *Current Directions in Psychological Science*, *13*(1), 1–4.

Hayes, G. (1991). Migration, metascience, and development policy in Island Polynesia. *The Contemporary Pacific*, 1–58.

Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science*, *312*(5782), 1900–1902.

Herrnstein, R., & Murray, C. (1994). The bell curve. *Intelligence and Class Structure in American Life, New York.*

IOM. (2016). *2015 Global Migration Trends Factsheet*. Retrieved from http://publications.iom.int/system/files/global_migration_trends_2015_factsheet.pdf

Jass, G., & Massey, D. S. (2004). *Immigrant health: selectivity and acculturation*. IFS Working Papers, Institute for Fiscal Studies (IFS).

Jencks, C. (1979). Who gets ahead? The determinants of economic success in America.

Kandel, W., & Kao, G. (2001). The impact of temporary labor migration on Mexican children's educational aspirations and performance. *International Migration Review*, 1205–1231.

King, R., & Vullnetari, J. (2006). Orphan pensioners and migrating grandparents: the impact of mass migration on older people in rural Albania. *Ageing & Society*, *26*(5), 783–816.

Kuhn, R., Everett, B., & Silvey, R. (2011). The effects of children's migration on elderly kin's health: A counterfactual approach. *Demography*, *48*(1), 183–209.

Lee, L., & Park, A. (2010). Parental migration and child development in China. Retrieved from http://repository.upenn.edu/gansu_papers/24/

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin*, *126*(2), 309.

Liu, A., & Xie, Y. (2015). Influences of monetary and non-monetary family resources on children's development in verbal ability in China. *Research in Social Stratification and Mobility*, *40*, 59–70.

Long, H., Li, Y., Liu, Y., Woods, M., & Zou, J. (2012). Accelerated restructuring in rural China fueled by "increasing vs. decreasing balance"land-use policy for dealing with hollowed villages. *Land Use Policy*, *29*(1), 11–22.

Lu, Y. (2012). Education of children left behind in rural China. *Journal of Marriage and Family*, *74*(2), 328–341.

Lu, Y. (2014). Parental Migration and Education of Left-Behind Children: A Comparison of Two Settings. *Journal of Marriage and Family*, *76*(5), 1082–1098.

Lu, Y. (2015). Internal migration, international migration, and physical growth of left-behind children: a study of two settings. *Health & Place*, *36*, 118–126.

Marks, G. N. (2013). *Education, social background and cognitive ability: The decline of the social*. Routledge.

Massey, D. S., Goldring, L., & Durand, J. (1994). Continuities in transnational migration: An analysis of nineteen Mexican communities. *American Journal of Sociology*, *99*(6), 1492–1533.

McKenzie, D., & Rapoport, H. (2006). Can migration reduce educational attainment? Evidence from Mexico. *Evidence from Mexico (June 1, 2006). World Bank Policy Research Working Paper*, (3952). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=923259

Meng, X., & Yamauchi, C. (2017). Children of Migrants: The Cumulative Impact of Parental Migration on Children's Education and Health Outcomes in China. *Demography*, *54*(5), 1677–1714.

Mu, R., & Brauw, A. de. (2015). Migration and young child nutrition: evidence from rural China. *Journal of Population Economics*, *28*(3), 631–657. https://doi.org/10.1007/s00148-015-0550-3

Pan, L., & Ye, J. (2017). "Children of Great Development": Difficulties in the Education and Development of Rural Left-Behind Children. *Chinese Education & Society*, *50*(4), 336–349.

Paxson, C., & Schady, N. (2007). Cognitive development among young children in Ecuador the roles of wealth, health, and parenting. *Journal of Human Resources*, *42*(1), 49–84.

Peng, J. (2014). Rural hollowing and rural community development (in Chinese). *China Civil Affairs*, (10), 34–35.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.

Reichert, J. S. (1981). The migrant syndrome: Seasonal US wage labor and rural development in central Mexico. *Human Organization*, 56–66.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* Oxford University Press.

Sampson, R. J., Sharkey, P., & Raudenbush, S. W. (2008). Durable effects of concentrated disadvantage on verbal ability among African-American children. *Proceedings of the National Academy of Sciences*, *105*(3), 845–852.

Sastry, N. (2012). Neighborhood effects on children's achievement: A review of recent research. In *The Oxford handbook of poverty and child development*.

Schnittker, J. (2005). Cognitive abilities and self-rated health: Is there a relationship? Is it growing? Does it explain disparities? *Social Science Research*, *34*(4), 821–842.

Sharkey, P., & Faber, J. W. (2014). Where, when, why, and for whom do residential contexts matter? Moving away from the dichotomous understanding of neighborhood effects. *Annual Review of Sociology*, *40*, 559–579.

Sun, H., Liu, Y., & Xu, K. (2011). Hollow villages and rural restructuring in major rural regions of China: a case study of Yucheng City, Shandong Province. *Chinese Geographical Science*, *21*(3), 354–363.

Sun, M., & Fan, C. C. (2011). China's permanent and temporary migrants: differentials and changes, 1990–2000. *The Professional Geographer*, *63*(1), 92–112.

Tan, S. (2011). A literature review on Chinese left-behind Children (in Chinese). *Social Science in China*, *1*(1), 140–141.

The National Health and Family Planning Commission. (2016). The 2016 Report on China's Migrant Population Development. Retrieved from http://www.nhfpc.gov.cn/xcs/s3574/201610/58881fa502e5481082eb9b34331e3eb2.shtml

Todd, P. E., & Wolpin, K. I. (2003). On the specification and estimation of the production function for cognitive achievement. *The Economic Journal*, *113*(485).

Tuñón, M. (2006). Internal labour migration in China: Features and responses.

Viner, R. M., Ozer, E. M., Denny, S., Marmot, M., Resnick, M., Fatusi, A., & Currie, C. (2012). Adolescence and the social determinants of health. *The Lancet*, *379*(9826), 1641–1652.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard university press.

Weeks, J. (2011). *Population: An introduction to concepts and issues*. Nelson Education.

World Bank. (2015). Urban population (% of total) | Data | Table. Retrieved December 10, 2015, from http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

Xie, Y., & Hu, J. (2014). An Introduction to the China Family Panel Studies (CFPS). *Chinese Sociological Review*, *47*(1), 3–29.

Xu, H., & Xie, Y. (2015). The Causal Effects of Rural-to-Urban Migration on Children's Well-being in China. *European Sociological Review*, jcv009.

Ye, J. (2018). Stayers in China's "hollowed-out" villages: A counter narrative on massive rural–urban migration. *Population, Space and Place*, *24*(4), e2128.