Project-induced migration and depression: A panel analysis

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ABSTRACT

The study examines the mental health consequences of involuntary migration resulting from the world's largest dam project in China. Past claims of a causal link between migration and mental health are inconclusive because they have been based mainly on retrospective data and, therefore, are plagued by a plethora of methodological problems. This study addresses these problems by analyzing the pre- and post-migration changes in depression measured by the CES-D scale with data collected using face-to-face interviews from a sample ($n = 1530$ for the initial survey and 1070 for the follow-up) consisting of both migrants and non-migrants. Changes in CES-D were analyzed using 'the difference model', an analytical strategy which is agreed by methodological experts as "the method of choice" in establishing causal relationship in quasi-experimental research. Our results provide strong support to the claim that forced migration elevates depression not only directly, but also indirectly by weakening the psychosocial resources that safeguard migrants' mental well-being.

Although there are convincing arguments suggesting a causal association between migration and depression (Bhugra, 2004; Kuo, 1976; Portes & Rumbaut, 1996; Ryan, Dooley, & Benson, 2008), empirical proof of the causality is nonetheless problematic because migration is often selective (Borjas, 1987; Clampet-Lundquist & Massey, 2008; Lu, 2008; Rubalcava, Teruel, Thomas, & Goldman, 2008). Because migrants often differ from non-migrants in traits that are related to mental health, observed differences between migrants and non-migrants in mental health can result from their pre-existing differences rather than the presumed effects of migration (Winship & Morgan, 1999). Thus, unless we can rule out pre-existing differences between migrants and non-migrants as a cause, any claim of a causal association between migration and depression is untenable (Beiser, 2005; Lu, 2008; Rubalcava et al., 2008). However, researchers rarely have the luxury to foretell migration in advance, let alone to collect pre-migration information prospectively (but see some recent studies based on the Mexican Family Life Survey such as Rubalcava et al., 2008, the Indonesia Family Life Survey, e.g., Lu, 2008, and the Mexican Migration Project, e.g., Massey & Zenteno, 2000, for exceptions). As a result, empirical studies of the mental and physical health effects of migration continue to rely heavily on post-migration observations of migrants, using non-migrants at the place of destination as a comparison group (Kedia, 2009; Lindert, Ehrenstein, Priebe, Mielck, & Brähler, 2009; Porter & Haslam, 2005; Uscher-Pines, 2009).

Selective migration is not the only factor that threatens claims of causal relationship between migration and its presumed consequence. Another challenge researchers often face in this type of research is reification of a spurious association between migration and an "outcome" measure as a causal one. This happens when researchers attempt to avert selective migration problems by using migrants as their own control (Firebaugh, 2008). In other words, pre- and post-migration differences in the variables of interest for migrants, rather than differences between migrants and non-migrants in these variables, are taken as the consequence of migration (Winship & Morgan, 1999). While the problem of selectivity is avoided with this design, it does not rule out the possibility that the pre- and post-migration difference in an outcome variable for migrants could have resulted from contemporaneous social changes that would have happened even without migration (Campbell & Stanley, 1966). For example, the revolutionary shift from a planned economy to a market economy in China is likely to raise the level of stress among Chinese citizens (Solinger, 1999).

Aside from problems of selectivity and spuriousness, previous studies of migration consequences share a weakness with all retrospective studies. Because researchers seldom have the luxury to foresee migration, migration studies are often done after the fact (Jasso, Massey, Rosenzweig, & Smith, 2000). Thus, to detect if migration has the presumed effect, researchers compare post-migration measures of the outcome variables of interest with the pre-migration measures taken retrospectively. While measurement

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errors for post-migration measures can arguably be assumed to be minimal and unbiased, it is less reliable to make the same assumption about the pre-migration measures due to non-random variations in individual ability to recall. In addition, the accuracy of recall is often contaminated by a human tendency to make *ex post-facto* rationalization of the past based on present circumstances (Schacter, 2001). Thus, our detected "consequences" of migration may no more than an artifact of memory bias rather than an accurate reflection of the pre- and post-migration differences.

The quasi-experimental design we used effectively addresses all these methodological concerns. First, it minimizes selectivity by selecting migrants and non-migrants from the same geographic region with similar socioeconomic profiles. Second, adding non-migrants as a control group neutralizes the effects of contemporaneous social changes as a confounder because both groups were exposed to the same social changes. Finally, measurement errors resulting from retrospective measures are curtailed by taking the pre-migration measures prospectively. We examined the hypotheses that the forced relocation would negatively affect the mental well-being of migrants not only directly, but also indirectly by weakening their psychosocial resources and that migrants with more protective resources would be less adversely affected.

The study represents an important extension of a recent publication (Hwang, Xi, Cao, Feng, & Qiao, 2007) which examined anticipatory stress of forced migration using pre-migration data. Although that study supports the claim that involuntary migration elevates depression, the fact that it was done before migration inevitably weakens its conclusiveness. Because migration can affect depression not only through pre-migration factors but also factors related to the migration process and post-migration adjustments (Porter & Haslam, 2005; Ryan et al., 2008), an adequate testing of the hypothesis needs to control for factors pertaining to migration processes and post-migration adjustments.

Background

Although development projects such as dam and highway construction may be justified in the name of economic benefits, they often entail unintended negative consequences (Cernea & Guggenheim, 1993; Hwang et al., 2007; Kedia 2009). The construction of such projects necessitates the clearing of land at or near the construction site and the relocation of people who are in the way; the long-term costs to the environment and the affected people can be grave. The case in point is China's Three Gorges Dam Project (hereafter called the Dam Project) on the Yangtze River. It is a multi-purposed project intended to control recurring floods, to generate hydroelectric power, and to facilitate development in China's massive interior by improving inland navigation (Li, 1998; Tao, 1994). However, the completion of the project will submerge a populated region in central China, thus necessitating the displacement of about 1.3 million people from the homes they have lived in for generations (Zhu, 1996).

An important questions is whether forced relocation affects the mental well-being of the displaced (Hwang et al., 2007). The Dam Project provides an ideal condition to test the hypothesis while avoiding the methodological challenges discussed earlier. The construction of the dam and the reservoir required non-selective relocation of all those who are in the way. In addition, because the project was a scheduled event, it permitted us to conduct pre- and post-migration surveys rather than having to rely on retrospective measures to assess migration consequences. Finally, because the relocation was planned, it allowed us to neutralize the effects of social change by including non-migrants from the same areas who were subject to the same social changes as a control group.

Although the longitudinal Family Life Surveys conducted in Mexico and Indonesia enabled researchers to minimize these methodological problems to a certain degree (Lu, 2008; Rubalcava et al., 2008), such studies are very costly and inefficient because they require very large sample sizes in order to capture enough numbers of migrants for meaningful comparisons. Problems of cost and efficiency can be minimized by targeting areas with a long tradition of migration (Massey & Zenteno, 2000), but doing so is likely to introduce a new bias as those who are left behind become increasingly homogeneous over time as the more selective people leave. In contrast, the planned nature of the massive population resettlement in China presented us a rare opportunity to address an important research question under conditions that approximate a natural experiment.

Theoretical framework

This study is guided by Pearlin's (1989) *stress process model* and its applications to study migration-induced stress (Berry, 1997; Ek, Koiranen, Raatikka, Järvelin, & Taanila, 2008; Gadalla, 2009; Ryan et al., 2008). The stress process model consists of three conceptual domains: stressors, protective resources, and stress outcomes (Pearlin, 1989). The major tenet of the model is to explain how exposures to stressors translate into depression. Because the link between the two is often indirect and contingent upon other factors, psychosocial mediators are invoked to explicate the indirect and conditional association (Ek et al., 2008; Ensel & Lin, 1991; Gadalla, 2009). While the stress process model encompasses mental distress resulting from a wide range of stressors, a growing body of literature focuses on a single stressor, namely migration, and identifies a set of risk factors and mediators specifically related to migration-induced distress (Lindert et al., 2009; Porter & Haslam, 2005; Uscher-Pines, 2009). A recent article by Ryan et al. (2008) has done a wonderful job in formalizing a theoretical framework based on the stress process model with an emphasis on loss of resources as a primary stressor. Although it is intended to explain post-migration adaptation and mental well-being among refugees, it can easily be adapted to examine project-induced displacement.

Project-induced migration as a stressor

Migration is seen as a stressor because it uproots people from their homes and transplants them to an often unfamiliar environment that requires challenging social, economic, and psychological adjustments (Ben-Sira, 1997; Hwang et al., 2007; Ryan et al., 2008). Project-induced migration adds additional stress to the process because it is often imposed upon migrants by a powerful actor (Albrecht, 1995). Furthermore, because project-induced migration is always planned, anticipatory stress begins before the relocation actually takes place. Finally, while other types of forced migrants such as refugees of wars and natural disasters are often repatriated once circumstances return to normal, project-induced migration is an irreversible process.

Project-induced migration often has negative economic and social consequences. Economically, the displaced often become homeless, landless, and jobless (Cernea & Guggenheim, 1993; Heggelund, 2004; Xi & Feng, 2001). The Dam Project is expected to submerge 25.9 thousand hectares of mostly fertile farmland, and it is estimated that 40% of the affected farmers will be ousted from farms and forced into occupations for which they are not prepared (Yangtze Valley Water Resources Protection Bureau, 1999). Government efforts to lure factory jobs to the region have proven largely unsuccessful; many displaced farmers have, therefore, become jobless and must survive on meager government handouts (Cody, 2006).

In terms of social ramifications, the forced relocation will not only uproot the migrants from their home of many generations (Zhu, 1996), it will also tear apart their close-knitted social networks, mainly because land shortage and logistic considerations have necessitated breaking affected villages into smaller units and sending villagers of the same clan to diverse destinations (Hwang et al., 2007).

In sum, the project-induced migration is expected to elevate depression among the displaced because of the hardships and losses directly related to relocation and the challenges of post-migration readjustment. Further, prolonged anticipation of the forced relocation also triggers other secondary stressors (Hwang et al., 2007; Xi, Hwang, Feng, Qiao, & Cao, 2007).

The mediating and moderating roles of protective resources

Not all displaced will be affected equally, however, because of differential distribution of protective psychological and social resources (Turner & Lloyd, 1999). Psychological resources refer to resilient personality traits that are helpful in offsetting stress. Mastery, or perceived control over one's own life circumstances (Pearlin & Schooler, 1978), for example, has been effective in fighting off stress (Gadalla, 2009). Social resources refer to benefits that are endowed upon a person due to his/her position in a social network and broader social system. For example, social support is often seen as a useful social resource that protects individuals from a variety of stressors (Lin, Dean, & Ensel, 1986; Son, Lin, & George, 2008).

Psychosocial resources have been seen as both *mediators* and *moderators* of stress (e.g., Ensel & Lin, 1991; Pearlin, 1989). When they are viewed as mediators, the focus is to suggest a mechanism explaining why a stressor leads to distress in an indirect manner. One mechanism often cited is that exposure to stressors erodes psychosocial resources which safeguard mental well-being (Ensel & Lin, 1991).

When psychosocial resources are used as moderators, on the other hand, the emphasis is to explain why exposure to the same stressor does not always lead to the same level of distress for the exposed. For example, while we believed that the forced relocation would harm the mental health of the displaced, we also anticipated that those in higher positions and blessed with greater social support would be more immune to such harm.

Coping and physical health also play important roles in protecting people's mental health. One strategy to cope with the stress of forced relocation, for example, is to view the Dam Project in a positive light so that all personal sacrifices become more worthwhile. Given the much documented association between physical health and mental health (Ryff & Marshall, 1999), we argue that people with better physical health are less easily distressed.

In sum, we expected that the forced relocation experience and its secondary effects would heighten levels of depression among migrants relative to their non-migrating counterparts. We also anticipated the forced relocation would affect migrants indirectly by weakening their psychosocial resources and physical health, which safeguard mental health. Finally, psychosocial resources, positive coping, and physical health were expected to moderate the harmful effect of forced relocation because of their protective function.

Data and methods

This study was approved by the Institutional Review Board at the University of Alabama at Birmingham and an ad hoc ethics committee at Nanjing University in China, where a co-investigator was employed. The study population was 1.3 million Chinese who would be displaced by the construction of the Three Gorges Dam on the mid-section of the Yangtze River. Although our primary interest was migrants, we included non-migrants as a control group. The analyses were based on two waves of interviews spaced 3 years apart. The pre-migration survey, conducted in 2002–2003, included 975 designated movers and 555 non-migrants. Designated movers were those who lived below 175 meter above sea level, areas that would be flooded once the dam project was completed. Those who lived above the line were spared relocation. Our sampling took place in two stages. First, we randomly selected three rural and two urban communities from two strata of communities in the Wanxian Relocation and Development Region, a region where 80% of designated movers resided (Weng, 1999). Secondly, we selected households from the selected communities by conducting censuses in three small communities and systematic sampling in the two larger ones. Face-to-face interviews were conducted with a household member aged 16 years or older. The survey had a response rate of 99%, a high rate typical of face-to-face interviews in China (Feng, 2007). While a response rate as high as this is quite unusual for U.S. researchers, it is the norm in China (Feng, 2007). Examples include several datasets deposited at the ICPSR by scholars such as Logan and Bian, and Zeng and Vaupel.

Our sample was made up of 51% urban and 49% rural residents. Urban residents were over-sampled to reduce costs because rural residents were more dispersed. To adjust for over-sampling, we conducted weighted regression analyses by assuming that the urban/rural composition of the population observed in China's 2000 census still applied in 2003. The weighted analyses results were similar to the un-weighted ones. Fifty-five percent of our respondents were female. The sample had an average age of 45 and an average educational attainment of 7.48 years. The apparent "overrepresentation" of women, older, and less educated respondents was not a result of research design but reflects the high out-migration rate of the region even before the Dam Project began (Roberts, 1997; Solinger, 1999).

A follow-up survey was conducted in early 2006, 1070 subjects were successfully traced (with the help of up to two contact persons named by the respondents in the initial survey and local officials overseeing the relocation), with a success rate of 70%. Among those who were successfully traced, 350 were non-migrants, 286 were designated migrants who had not moved, and 420 were designated migrants who had moved. Fourteen residents who had moved before the first survey but returned to their residence temporarily were captured in our pre-migration survey. They were excluded from the analyses because they should not have been included in the first phase. Thus, our analysis included 1056 subjects of whom 350 were non-migrants, 286 were designated migrants who had not moved at the second survey, and 420 designated migrants who had moved. To address possible biases that might result from the attrition, we conducted a sensitivity analysis by regressing a dummy variable which indicated whether a respondent captured in wave 1 was missed in wave 2, on six socio-demographic variables measured at time 1 using a linear probability model. The results (see Table 1) indicated that only two of these factors (i.e., migration status and urban/rural residence) had a significant effect. We address the implications of attrition in the result section.

Measurement

Our dependent variable was *change in depression* from time 1 to time 2. Depression was measured by the 20-item CES-D scale (Radloff, 1977), which was used in both pre-migration ($\alpha = 0.87$) and post-migration surveys ($\alpha = 0.89$). Although cross-cultural application of the CES-D has aroused concerns in the past,

Table 1
Selection equation for missed cases[a] ($n = 1530$).

Variable	Coeff.	t-Value
Intercept	0.22*	2.80
Migration status (migrant = 1)	0.07*	2.78
Gender (female = 1)	0.02	0.99
Residence (rural = 1)	−0.11*	−4.30
Age	0.00	1.29
Education	0.00	0.15
House income (in ten thousand)	0.01	1.88

*Indicates a coefficient is significant at the $p < 0.05$ level using one-tailed t-test.
[a] 0 = success in follow-up, 1 = missing in follow-up.

empirical evidence shows that the scale is appropriate for many non-white samples including Chinese (Beiser, 2005; Lin, 1989).

Our key independent variables were two alternative measures of forced migration. The first was *migration status*, which was used to examine if there was a significant difference in the depression change score between migrants and non-movers. Because some of the people designated for relocation had not yet moved due to revisions of relocation schedule when the follow-up survey was conducted, we used a three-category nominal variable to differentiate (1) designated migrants who had moved, (2) designated migrants who had not moved, and (3) non-migrants. Two dummy variables were used to contrast the two groups of migrants with non-migrants (the reference group).

Our second independent variable was a direct measure of *migration-induced stress* based on respondent's self assessment. Our direct measure asked the migrants to identify any negative changes they had actually experienced from the forced relocation from a list which included income loss, worsening of housing conditions, incidences of domestic conflicts, and difficulties getting along with new neighbors. The count variable had an empirical range of 0–4. Because our direct measure of migration-induced stress was applicable only to designated movers who had actually moved in the follow-up survey, our analysis was restricted to a smaller sample when this variable was used as a predictor.

The experiencing of *undesirable life events* can be seen as a secondary stressor, a source of depression that is often confounded with other stressors (Pearlin, 1989). We used a 15-item inventory to record the experiencing of any negative life events during a 12 month period prior to the interview. The measure was adapted from a widely used instrument (Holmes & Rahe, 1967). The sum of the 15 items yielded a count measure. The variable used in our analysis was *change in number of undesirable life events* from time 1 to time 2.

We focused on four types of protective resources: psychological resources, social resources, positive coping, and physical health. Psychological resources are indicated by the mastery scale (Pearlin & Schooler, 1978). The first- and second-wave α's for the scale were 0.74 and 0.78, respectively.

Social resources were captured by three measures: household income, community resources, and social support. Household income was measured by the log-transformed annual household income received during the year preceding the interview. Community resources were measured by asking respondents how convenient it was for them to (a) see doctors, (b) go to school, (c) visit relatives, (d) shop, and (e) have recreation in their current place of residence using a five-point scale for each. Responses to the five questions were summed to form a scale with scores ranging from −10 to 10, with a higher score indicating more community resources. The scale had a Cronbach's α of 0.84 for the first wave and 0.88 for the second wave. Social support was measured by asking respondents whether or not they had talked to or contacted any of the following individuals with whom they did not share a residence: (1) parents; (2) adult children; (3) siblings; (4) other relatives; (5) good friends; (6) neighbors; (7)

colleagues; (8) local cadres; and (9) other significant others during the past 30 days. The sum of the 9 items yielded a count measure.

We used a positive comparison scale to capture the effects of coping. Respondents were asked: "Compared to those whom you know, would you say that you are (a) much worse, (b) somewhat worse, (c) about the same, (d) somewhat better, or (e) much better in terms of (1) income; (2) occupation; (3) social prestige; and (4) social connections (*guanxi*)?" Responses to the four questions were summed to form a scale with scores ranging from 4 to 20. The scale had a Cronbach's alpha of 0.79 and 0.81 for the first and second wave.

Finally, we included self-rated physical health as a protective resource in the analysis. It ranged from very poor (1) to very good (5) with a higher score indicates better health. All our independent variables, except for migration stressor, were measured in change scores.

Analytical strategy: the difference model

The panel surveys provided pre- and post-migration measures of both depression and its predictors. The panel data were analyzed using the *difference model* (see Eq. (1) below), one of the most common forms of *fixed effect models* (Allison, 1994; Firebaugh 2008; Halaby, 2004). The model allowed us to examine the extent to which changes in depression can be explained by changes in predictors while implicitly controlling for all time-invariant independent variables.

$$Y_{i2} - Y_{i1} = \alpha + \delta X_i + \gamma(W_{i2} - W_{i1}) + \varepsilon_i \qquad (1)$$

The equation makes clear that the difference in Y between time 1 and time 2 are explained by X, or migration status; and by the changes in values of time-variant factors W from time 1 to time 2. The δ in the equation, which measures the difference between migrants and non-migrants in pre- and post-migration difference in average depression, can be estimated by the *difference-in-differences* (DID) estimator (Allison, 1994; Halaby, 2004):

$$DID = (\overline{Y}_{M2} - \overline{Y}_{M1}) - (\overline{Y}_{N2} - \overline{Y}_{N1}) \qquad (2)$$

or alternatively:

$$DID = (\overline{Y}_{M2} - \overline{Y}_{N2}) - (\overline{Y}_{M1} - \overline{Y}_{N1}) \qquad (3)$$

In other words, migration effect was measured by the extent to which the average difference between migrants (M) and non-migrants (N) in time 2 measure of depression exceeded their time 1 difference.

The difference model has several advantages over other alternatives for panel analysis (Firebaugh, 2008). The most important one is that time-invariant exogenous variables, many of which are unobserved, can be omitted from the model without incurring omitted variable biases (Winship & Morgan, 1999). Furthermore, the difference model has been known to researchers as an effective tool for controlling "period effects" (Halaby 2004). The DID estimator is nearly always preferable in non-experimental studies as a means for estimating the effects of events because it provides automatic control for all constant, unobserved differences between individuals, regardless of whether or not those differences are associated with the likelihood of event occurrence (Allison, 1994).

Results

Table 2 provides descriptive statistics which examine the changes in dependent and independent variables from time 1 to

Table 2
Differences scores and difference-in-differences scores for migrants and non-migrants ($n = 1056$).

		Differences scores			DID scores[a]
		$\bar{Y}_1$	$\bar{Y}_2$	$\bar{Y}_1 - \bar{Y}_2$	
CES-D	Migrant	21.95	26.25	4.31*	3.49*
	Non-migrant	20.82	21.64	0.82*	
Negative events	Migrant	0.36	0.54	0.18*	0.28*
	Non-migrant	0.34	0.24	−0.10*	
Mastery	Migrant	21.40	19.98	−1.42*	−0.42
	Non-migrant	22.58	21.59	−1.00*	
Household income	Migrant	11,575.19	11,765.74	190.55	−2728.70*
	Non-migrant	10,511.84	13,431.09	2919.25*	
Community resources	Migrant	5.15	3.85	−1.30*	−1.54*
	Non-migrant	6.07	6.32	0.25	
Social support	Migrant	3.55	3.69	0.14	−0.26*
	Non-migrant	3.80	4.20	0.39*	
Positive comparison	Migrant	10.65	10.28	−0.36*	−0.46*
	Non-migrant	11.02	11.11	0.10	
Subjective health	Migrant	3.48	3.19	−0.29*	−0.18*
	Non-migrant	3.53	3.42	−0.11*	

*indicates the difference is significant at the $p < 0.05$ level using two-tailed t-test.
[a] DID Scores are difference-in-differences scores estimated by $(\bar{Y}_{M2} - \bar{Y}_{M1}) - (\bar{Y}_{N2} - \bar{Y}_{N1})$.

Table 3
Regression analysis of involuntary migration as a stressor ($n = 1056$).

Variable	Model 1		Model 2		Model 2a	
	Coeff.	Beta	Coeff.	Beta	Coeff.	Beta
Attrition Correction Factor					−3.62	−0.02
Stressor						
Migration Status						
Migrant	3.17*	0.13	1.82*	0.08	1.97*	0.08
Designated Migrant (not moved)	0.10	0.00	0.22	0.01	0.41	0.02
Change in Negative Events	1.67*	0.13	1.22*	0.10	1.19*	0.09
Psychological resources						
Change in Mastery			−0.75*	−0.38	−0.75*	−0.38
Social resources						
Change in household income[a]			−0.87*	−0.08	−0.89*	−0.08
Chang in community resources			−0.15*	−0.08	−0.15*	−0.08
Change in Social Support			−0.36*	−0.06	−0.37*	−0.06
Change in positive comparison			−0.28*	−0.07	−0.27*	−0.07
Change in health			−1.94*	−0.19	−1.92*	−0.19
Constant	0.90		0.43		−2.24	
Adj. R^2	0.04		0.28		0.28	

*indicates a coefficient is significant at the $p < 0.05$ level using one-tailed t-test.
[a] Household income was log-transformed.

time 2 for migrants and non-migrants (including designated migrants who have not moved). (As a general estimator of difference in change scores between groups, the DID estimator can also be used to gauge the group difference in the change scores of independent variables.) The results show that both migrants and non-migrants experienced a significant increase in the CES-D score from time 1 to time 2. The average amount of increase for migrants (4.31 points), however, was significantly larger than the corresponding measure for non-migrants (0.82 points).

Migrants and non-migrants also differed in factors associated with depression. Migrants experienced a significant increase in the number of undesirable life events while non-migrants a reduction, resulting in a significant DID score of 0.28. Both groups experienced a significant reduction in mastery. Although the reduction for migrants was larger, there was no significant group difference. During the time period, non-migrants enjoyed a much larger gain in average household income than migrants, resulting in a DID score of −2729 *yuan* in favor of non-migrants. Migrants also suffered a greater relative loss in community resources compared to non-migrants. Although both groups registered some increases in social support over the period, the increase for migrants was considerably smaller. The two groups also experienced significantly different changes in positive coping, with migrants seeing a significant decline but little change for non-migrants. Finally, although both groups reported significant declines in self-rated health, the decline was significantly greater for migrants than non-migrants. In sum, all the DID scores, except for mastery, were statistically significant.

The DID scores reported in the last column of Table 2 clearly show that while migrants experienced a faster increase in depression and negative life events than non-migrants, the opposite was true in terms of resources that safeguard people from depression. The opposite movements of depression and protective resources provide tentative support for the resource erosion argument.

Table 3 presents the results of panel analysis using the difference model. The results indicate that migration status is a significant predictor of changes in the depression score. Model 1 focuses on group differences in depression change score (DID) while

controlling for negative life events as a secondary stressor. The results show that migrants, on average, registered an increase in depression score that was 3.17 points higher than their non-migrant counterparts. In contrast, there was no significant difference in depression change score between designated migrants who had not moved and non-migrants. The increase of undesirable life events also elevated depression significantly. Aside from group differences, a one-unit increase in negative life events led to a 1.67 unit increase in the depression change score.

We added the change scores of protective resources to our model to test the mediation hypothesis. The mediation hypothesis would be supported if the group differences in depression change score observed earlier were reduced when changes in protective resources were controlled (Baron & Kenny, 1986). The results for Model 2 show that the controlling reduced the DID score comparing migrants and non-migrants (from 3.17 to 1.82), but it remained statistically significant. Controlling protective resources also reduced the effect of negative life events (from 1.67 to 1.22). Together, the results suggest that group differences in depression and the effects of negative life events were partially a consequence of variations in protective resources among our respondents.

Our results also indicate that protective resources and depression tended to move in opposite directions. Thus, an increase in protective resources was always accompanied by a decline in depression, regardless of the specific contents of the resources. Such results support the mediation hypothesis. All indicators of protective resources exerted a significant negative effect on depression. Among the six indicators considered, mastery provided the strongest protective effect ($\beta = -0.38$) using the standardized coefficient, and next in line was self-rated health ($\beta = -0.19$); the effects of other protective factors ranged from −0.06 to −0.08.

We addressed possible biases associated with sample attrition by adding a sample *attrition correction* factor into the model and re-estimating the coefficients (Heckman, 1979). The *attrition correction* factor was estimated by a method suggested by Berk (1983) using the selection equation reported earlier. Obviously, adding the *attrition correction* factor into the model (2a) had very little effect on our results.

Instead of examining the difference between migrants and non-migrants in depression change scores, a more direct way to test the hypothesis of migration-depression association was to examine if

there was an association between depression and a direct measure of migration-induced stress (see Table 4). Because the direct measure was available only for migrants ($n = 420$), non-migrants and designated migrants who had not moved were excluded from the additional analysis.

Model 3 examines the gross effects of migration-induced stress and negative life events on depression. Model 4 focuses on their partial effects by adding protective resources into the model as controls. The *attrition correction* factor was included in both models. The results show that migration-induced stresses were indeed responsible for heightened depression. A one-unit increase in migration-induced stress raised the depression change score by 3.49 units (see Model 3). In addition, the negative impact of forced migration may permeate other spheres of life by increasing the incidence of negative life events. The results provide some indirect support for the argument. Thus, a one-unit increase in the change score of negative life events raises depression by an additional 1.95 units. Because migration-induced stresses and negative life events are confounded and it is impossible to sort out what proportion of the latter is attributable to the former, we made no attempt to evaluate the relative importance of the two variables.

The effects of both migration-induced stresses and negative life events were substantially reduced when six indicators of protective resources are added (see Model 4). The effect of migration-induced stresses decreased from 3.49 to 1.91 points and that of negative life events from 1.95 to 1.19. The two variables remained statistically significant despite the reductions. The effects of protective resources variables were quite similar to those reported in Table 3. The only noticeable difference was that the effect of community resource was no longer significant. In addition, the model, which explains 37% of the variation in depression, seems to fit better with a more restricted sample and a direct measure of stressor.

Finally, Table 5 demonstrates the association between two indicators of stressors and six protective resources. The findings showed that migration status exerted a significant negative effect on all resources but mastery. Migration-induced stress, on the other hand, exerted a significant negative effect on only four of the six resources (i.e., mastery, community resources, positive coping, and self-rated health). We also tested the mediation hypothesis using an alternative approach which involved testing the statistical significance of indirect effects (Hwang et al., 2007; Turner & Lloyd, 1999) and reached the same conclusion.

Table 4
Regression analysis of migration-induced depression among migrants ($n = 420$).

Variable	Model 3		Model 4		Model 4a	
	Coeff.	Beta	Coeff.	Beta	Coeff.	Beta
Attrition correction factor	−12.62	−0.08	−8.18	−0.05	−9.81	−0.06
Stressor						
Migration-induced stress	3.49*	0.24	1.91*	0.13	1.56*	0.11
Change in negative events	1.95*	0.16	1.19*	0.10	1.18*	0.10
Psychological resources						
Change in mastery			−0.78*	−0.40	−0.48*	−0.25
Social resources						
Change in household income[a]			−0.72*	−0.07	−0.73*	−0.07
Chang in community resources			−0.10	−0.06	−0.10	−0.06
Change in social support			−0.63*	−0.10	−0.63*	−0.10
Change in positive comparison			−0.32*	−0.09	−0.26	−0.07
Change in health			−2.29*	−0.21	−2.30*	−0.21
Interactions with migration-induced stress						
Change in mastery					−0.32*	−0.21
Constant	−8.33		−5.42		−6.46	
Adj. R^2	0.08		0.37		0.39	

*indicates a coefficient is significant at the $p < 0.05$ level using one-tailed t-test.
[a] Household income was log-transformed.

Table 5
Effects of forced migration on protective resources.

Mediators	Migration status coeff.[a]	Migration-induced stress coeff.[b]
Change in mastery	−0.44	−1.28*
Change in household income	−0.12*	0.05
Change in community resources	−1.47*	−1.73*
Change in social support	−0.24*	0.01
Change in positive comparison	−0.51*	−0.69*
Change in health	−0.20*	−0.16*

*indicates a coefficient is significant at the $p < 0.05$ level using one-tailed t-test.
[a] Coeff. indicates the effect of migration status on protective resources ($n = 1056$).
[b] Coeff. indicates the effect of migration-induced stress on protective resources ($n = 420$).

Testing moderation hypothesis

The preceding analysis focused on the direct and indirect effects of forced migration on depression. However, the effect of forced migration-induced stress can also be reduced by protective resources. We tested the moderation hypothesis by allowing stressor to interact with the six protective resources. The moderation hypothesis would be supported if the positive effect of the stressor on depression was counterbalanced by a negative effect resulted from the interaction of the stressor and resources. The results of the analyses (see Model 4A in Table 4) lend little support for the hypothesis. None of the interaction terms was significant when migration status was used as stressor. Only one of the six interaction terms (i.e., the interaction with mastery) was significant when migration-induced stress was used as a stressor, suggesting that mastery moderated the harmful effect of migration.

Conclusion and discussion

As part of a larger effort to measure the social, economic, and psychological ramifications of the Dam Project, this study showed that forced relocation had an adverse effect on depression in these involuntary migrants. Compared to non-migrants with similar characteristics, migrants registered a significantly higher level of depression. The difference between migrants and non-migrants in depression was somewhat diminished but never eliminated after controlling for a set of factors that were correlated with depression.

Two aspects of our findings warrant further discussion: First, while the group difference in pre- and post-migration difference in depression (or the DID score) was statistically significant, the magnitude of the difference was not especially large. Second, the average depression level of our sample, including non-migrants, was considerably higher than the typical levels observed in the west for non-clinical populations (Beiser, 2005; Radloff, 1977). The higher depression level observed in our sample is understandable because the Dam Project is economically and socially disruptive not only for the migrants but also for non-migrants who live in the affected region. For example, communities adjacent to the areas that would be flooded were disturbed by the auxiliary activities taking place in or near their communities; they were also disturbed by tensions arising from the government's requirements that their limited resources be shared with the newly relocated migrants. Thus, even residents exempted from the forced relocation were nonetheless affected by the Dam Project's ripple effects. In other words, the impact of forced relocation was felt not only by migrants but also by non-migrants.

Despite the possible negative impact of the Dam Project on the non-movers, the difference in depression between forced migrants and non-movers was significant and real. Because our research design effectively controlled pre-existing differences between migrants and non-movers, we argue that the group difference was attributable to the presence or absence of the forced relocation experience.

Our results also showed that among designated migrants, those who experienced more migration-induced stresses were more depressed. Undesirable life events were responsible for a large part of the observed depression among migrants. Because undesirable life events could have resulted from the stressful experience during and after the relocation, it seems useful to view them as a spin-off of forced migration instead of as a distinct stressor. Psychosocial resources, positive coping, and physical health were found to have protective functions against distress in our analysis. Forced migration also exerted a significant indirect effect on depression, via the mediation of psychosocial resources, positive coping, and physical health. Our findings supported the hypotheses that forced migration is conducive to depression; that people with more resources, regardless of their migration status, are more immune to depression; and that forced migration leads to depression not only directly, but also indirectly by weakening the protective resources migrants possessed. Although a definite test of mediation hypothesis requires three waves of data, testing the hypothesis with the difference model at least increases our confidence that the observed concomitant changes in mediators and depression were indeed related to the same exogenous variable—forced relocation. We also examined the hypothesis that protective resources moderate the harmful effects forced migration brings to migrants; our results, however, provided only limited support for the hypothesis.

In conclusion, the study demonstrated that there is a causal relation between forced migration and depression, a topic that has enjoyed a great deal of scholarly interest but for which there is little conclusive supporting evidence. Past studies trying to demonstrate the causal link have been ensnared by methodological pitfalls which we have successfully avoided in this study by using the advantages afforded by a planned involuntary migration instigated by China's Three Gorges Dam Project. However, some of the design features that were possible in this study due to the planned nature of the migration are difficult, if not impossible, to implement when studying voluntary migration. Therefore, while our evidence clearly supports the causal link between planned migration and depression, the extent to which our findings can be generalized to voluntary migration remains an open question that needs to be addressed in future studies.

Acknowledgements

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