How Does Migration Affect Under-5 Mortality in Rural Areas? Evidence from Niakhar, Senegal

Ulrich NGUEMDJO[*,**] **and Bruno VENTELOU**[*,***]

[*]Aix-Marseille Université, CNRS, AMSE, Marseille, France.

[**] Laboratoire Population-Environnement-Développement, Aix-Marseille Université, Marseille, France.

[***] Southeastern Health Regional Observatory.

Correspondence: Ulrich NGUEMDJO, email: ulrich-boris.nguemdjo-kamguem@univ-amu.fr

In high-mortality areas, child survival depends on many factors. Access to health care, sufficient and appropriate food, and good hygiene are crucial and usually provided by the parents. What happens when children are separated from their parents, sometimes for extended periods? Does the migration of the mother, father, or other family members negatively affect the health of the child who has been left behind? Or does it benefit the child, as a source of income and new knowledge? Using data from the Niakhar Health and Demographic Surveillance System in Senegal, the authors provide a rich analysis of the complex relationship between child survival and the migration of the family network.

Although child mortality is high in sub-Saharan Africa compared to the rest of the world, it has declined dramatically over recent decades (World Bank, 2013). Demographic surveys reveal a strong correlation between improvements in maternal and child healthcare and reductions in child mortality (Pison et al., 1993; Lartey, 2008; Donnay, 2000; Amouzou and Hill, 2004; Buor and Bream, 2004; Bhutta et al., 2005; Zupan, 2005; Kanmiki et al., 2014). However, many other factors are involved, especially socio-economic and demographic phenomena, such as migration. Climate conditions, urbanization, and economic vulnerability have drawn attention to the intensification of migration and its impact on the well-being of the migrant's family (De Brauw and Harigaya, 2007; Mertzet al., 2009; Barrios et al., 2010; Marchiori et al., 2012). Generally, migration observed in rural areas is considered a beneficial family strategy, entailing reduced child mortality (Lucas and Stark, 1985; Brockerhoff 1990; Pitt and Sigle, 1998; Amankwaa et al. 2003; Kiros and White, 2004; Yabiku et al., 2012; Böhme et al., 2015). As Yabiku et al. (2012) noted, the relevant literature has usually analysed child mortality, or its potential factors, in migrating versus non-migrating families who 'remain in the village'. For instance, Brockerhoff (1994) investigated the impact of rural-to-urban migration on child survival in 17 developing countries, showing that mothers improve their children's survival chances when moving together from a rural to an urban area.

However, little research has examined the impact of a household member's migration on health outcomes for children left behind when the whole family does not move. Kanaiaupuni and Donato (1999) and Hildebrandt and McKenzie (2005), for example, obtained mixed results for this question in Mexico. When focusing on families left behind, there is room for widely differing hypotheses on the relationship between migration and child mortality. Migration,

particularly short-term, is a well-documented survival strategy rural households adopt to cope with socio-economic vulnerabilities (de Brauw and Harigaya, 2007; Mertz et al., 2009). Through migrants' remittances, families should obtain better nutrition, housing, and access to healthcare and medicine (Yabiku et al., 2012). Besides the economic advantages, migrants, especially women, may return home with better maternal care practices learned in urban areas, thereby improving their children's chances of survival (Ruel et al., 1999; Matthews et al., 2010). However, migration can also have a deleterious effect on child survival, as the absence of parents in the household, especially the mother, may increase the risk of child mortality (DaVanzo and Lee, 1983; Nguyen, 2016).

Through a fixed-effect and lagged-variable analysis, we examine a plausibly causal relationship between the migration of household members and the health outcomes of children left behind in Niakhar, a rural area of Senegal, and specifically explore the impact of maternal migration. Considering the importance of distinguishing types of migration when capturing the full effect of remittances (Oberai and Singh, 1980) and the predominance of short-term migration (related mostly to employment) over permanent migration in Niakhar (Guilmoto, 1998; Delaunay, 2017; Douillot and Delaunay, 2017), we distinguish between long- and short-term migration and analyse their effects on children's health outcomes, thus contributing to the literature on risk-sharing, family structure, and child outcomes.

Given the role of networks in rural development economics (Miracle et al., 1980, Fafchamps, 1992) and that of kinship networks and the ethos of mutual aid in rural sub-Saharan Africa (Miracle et al., 1980; LaFave and Thomas, 2017), this paper includes a new dimension for analysis: the compound, a unit of social organization that comprises one or more family-linked households. Child survival in a household may be influenced by neighbouring household actions and characteristics. Indeed, in a pattern of extended family households, a child is surrounded by a kin organization that goes beyond their mother, father, and other children (nuclear family) to include the parents, siblings, aunts, uncles, and cousins of spouses and offspring (extended family members). This organization could affect the degree of risk-sharing households achieve in response to child mortality (Wilson, 1989; LaFave and Thomas 2017). This second point is reflected in the literature on the sharing of childcare within families or among family networks (Breierova and Duflo, 2004; Ermisch, 2016; LaFave and Thomas, 2017). Following Breierova and Duflo (2004), we hypothesize that a mother's migration may differently affect her child's mortality risk depending on her offspring's age, and we analyse

the effect maternal presence on child survival, particularly when the child is young. Thus, in addition to the immediate family, narrowly defined by parental lineage, the paper evaluates the possible external effects from the migration of neighbouring households on child survival.

In the remainder of the article, we investigate the effect of migration on child mortality in non-migrating households, specifically by using panel data from the Niakhar Demographic Health Surveillance System. Two hypotheses are tested: (a) the positive effect on child survival following the migration of household and extended family members; and (b) the positive effect of a mother's migration on her child's probability of survival.

I. The demographic study area of Niakhar

1. Location and social functioning

Located in west-central Senegal 135 km east of the capital Dakar, the Niakhar study area covers 30 villages. The climate is Sahelian-Sudanese, and the dominant ethnic group is the Serer people, whose rural economy relies on raising crops and livestock (Faye et al., 1999; Lericollais, 1999). After several recent droughts, agricultural production has now been largely reduced to the millet and groundnuts that constitute, respectively, the staple and the cash crops (Adjamagbo et al., 2006; Delaunay et al., 2013).

As Adjamagbo et al. (2006) reported, the traditional agricultural system is no longer stable, and household food security appears at risk. Among the contributing factors are a strong increase in population density, a decrease in precipitation, environmental degradation, soil depletion from intensive agriculture, and limitations on loans and state grants for purchasing agricultural inputs and materials (Delaunay et al., 2013; Lalou and Delaunay, 2015). This situation has given rise to new income-generating activities, such as small businesses and craft production (Adjamagbo et al., 2006). In parallel, migration is increasing, particularly for labour (Delaunay et al., 2016).

2. The compound and the household

Like most rural societies in sub-Saharan Africa, Niakhar's is organized into large units called 'compounds', an English translation of the French word *concession*. Compounds are divided

into one or many subunits called kitchens (*ngak* in Serer). In the Niakhar Health and Demographic Surveillance System (NHDSS), a kitchen is a group of individuals—not necessarily living under the same roof—who eat millet together from a common granary. This is what we will call a 'household' in the rest of this article, as other studies and surveys have done (for example, the Demographic and Health Survey). The households within a compound are occupied by brothers sharing the same mother. Each of them lives with their wives, children, and uterine nephews. Economically, the household is a unit not only of consumption but also of production, as this is where self-sufficiency is organized under the authority of a kitchen chief who controls access to resources and use of the workforce (Gastellu and Diouf 1974; Guigou, 1992). These features make the household a relevant unit for observing socio-economic phenomena.

II. Population and migration characteristics

This article uses data from the NHDSS, set up in 1962 by Senegal's National Research Institute for Sustainable Development to counteract the civil registration system's shortcomings and provide demographic indicators (Delaunay et al., 2013). Since 1983, the NHDSS has covered 30 villages and routinely records information on the region's residents. All the villages are exhaustively observed, and individuals are followed for as long as they remain in the region.[1] This dataset enabled us to investigate household behaviour and to distinguish two types of migration according to their duration. To study the link between them and under-5 child mortality, we used data from 1998 to 2013, particularly on households with at least one child under 5.[2]

Between 1998 and 2013, the region's population increased by 47% (from 29,700 inhabitants to 43,650), and the number of households increased by 29% (from 2,213 to 2,847) at an average of 2 households per compound and 13 individuals per household. Appendix Figure D.3 shows a decreasing trend in under-5 mortality for both sexes, from 310 per 1,000 to 50 per 1,000 births. Improvements in maternal and perinatal healthcare have been observed (Delaunay, 2017), with increases in the shares of women giving birth in health facilities (from 10% in 1984 to 50% in

[1] The only attrition rates are natural: death or permanent migration from the region. Long-term migrants and their status are well identified in our database.

[2] Because both short- and long-term migration began to intensify in the Niakhar region in 1998 (Appendix Figures D.1 and D.2), we chose this year as our starting date. Our study period ends in 2014 as data were not yet available for 2015 and later.

2014) and of those giving birth after benefiting from at least four prenatal consultations as recommended by the health ministry (from 3.6% in 1994 to 13.9% in 2014). A resurgence of malaria occurred in the 1990s but decreased dramatically in the 2000s (Delaunay et al., 2013).

We focus on working-age household members aged 13–59 and distinguish short- from long-term migration, regardless of the reasons. A short-term migrant is defined as a household member leaving the household for less than a year, and a long-term migrant for longer. During the long-term migrant's absence, he or she is no longer considered a resident of the household, unlike short-term migrants.[3] While the NHDSS database does not include the migration destination, cross-sectional studies on the region by Lalou and Delaunay (2015) showed that destinations are the larger cities in Senegal (Dakar, Fatick, Thiès, and Mbour). Through interviews, the authors identified two main motivations for migration between 1983 and 2013. The first and most common relates to family: marriage, divorce, death of spouse, adoption of a child, or holiday. The second is for labour, whereby household members move to look for jobs (Lalou and Delaunay, 2015). The latter typically pertains to young adults who go to larger cities during the dry season to earn a complementary income and/or to alleviate his or her impact on family resources. Family-based mobility is associated more with long-term migration, while labour is linked more to short-term migration.

Tables 1 and 2 present the individual and household characteristics of migration in the Niakhar region between 1998 and 2013. Over this period, 10,681 individuals were involved in long-term migration, and 17,114 individuals in short-term migration. On average, migrants were young and lacked a basic formal education which may reflect the lack of economic opportunities for uneducated people in the region. Three quarters (74.2%) of long-term migrants and 60.4% of short-term migrants had no basic schooling. Compared to long-term migrants and non-migrants,[4] short-term migrants were older (25.9 vs. 17.4 years). Among women, 61.8% were long-term migrants and 40.8% were short-term migrants. Households experienced an average of three (one female and two male) short-term moves, and long-term migration was rare (0.4 moves on average; Table 2).

[3] To be considered a resident in Niakhar, an individual must live in the region for more than a year. Some exceptions exist for seasonal workers who were previously Niakhar residents and still spend at least one month in the region; workers with spouses and children in the zone who visit their families at least twice a year; and students with parents residing in the region.

[4] Non-migrant does not necessarily refer to people who have never migrated, but to the household member who did not migrate during a year.

Table 1. Individual migration characteristics in Niakhar, 1998–2013

	Long-term migration %	Short-term migration %	Non-migrant %
Average age (years)	17.4 (14.03)	25.9 (10.90)	22.3 (18.74)
Males	38.2 (0.04)	59.2 (0.04)	51.2 (0.03)
Females	61.8 (0.07)	40.8 (0.03)	48.8 (0.02)
Total	100	100	100
Education			
None	74.2 (0.04)	60.4 (0.04)	54.6 (0.05)
Preschool and primary	16.1 (0.03)	21.8 (0.01)	23.8 (0.05)
Middle and secondary	6.1 (0.03)	9.4 (0.04)	14.6 (0.03)
Koranic	3.2 (0.02)	7.2 (0.01)	5.8 (0.01)
University	0.4 (0.002)	1.2 (0.003)	1.2 (0.001)
Total	100	100	100
Number of individuals	10,681	17,114	39,858

Note: Standard deviations in parentheses.
Source: Authors' calculations using NHDSS data.

Table 2. Household migration characteristics in Niakhar, 1998–2013

Mean number of moves	Long-term migration	Short-term migration
Any member	0.4 (0.97)	2.9 (2.66)
Any female member	0.2 (0.64)	1.2 (1.45)
Any male member	0.2 (0.50)	1.8 (1.88)
Number of households	1,492	2,737

Note: Standard deviations in parentheses.
Source: Authors' calculations using NHDSS data.

III. Empirical strategy

1. General specification: A fixed-effect model with lagged variables

Econometric models traditionally face a major problem that may affect the statistical inference process: endogeneity. Apart from measurement errors, the two principal causes of endogeneity

are unobserved (omitted) variables and reverse causality. Here, we investigate how migration may affect under-5 mortality in the Niakhar region by running this general equation:

$$ChildMortality_{uvt} = \beta_0 + \beta_1 Mig_{uv(t-1)} + \boldsymbol{X}_{lvt} + \pi_u + v_t + \varphi_{vt} + \varepsilon_{uvt} \quad (\mathbf{1})$$

The indices *u*, *v*, and *t* stand for the units (compound, household, or individual), the village, and the year, respectively. The binary variables π_u are specific time-invariant effects of the units, and they are included for dealing with the omitted variables. They control for any unobserved heterogeneity that may plausibly exist among the decisional units (compounds or households) involved in the two main events under investigation: migration and under-5 mortality. Thanks to this fixed-effect design, we can control for all (time-invariant) inter-unit heterogeneity and study only the variations attributable to distinctive past family migration patterns. Generally, fixed-effect designs help to overcome the problem of unobserved heterogeneity (Hsiao, 2014). In the same vein, we have v_t, which represents time-specific effects common to all units for any plausible unobserved shock at a given point in time. These can account for unobservable factors that may influence the downward trend in under-5 mortality observed in sub-Saharan Africa. Finally, we have φ_{vt}, which represents time-variant village-specific effects that include unobservable factors at the village level. These can change over the years, as with climate variations, and they are the main determinant of household wealth in the region (Lalou and Delaunay, 2015), which is unobserved in our case.

To avoid the reverse causality problem, we used lagged migration variables instead of contemporaneous ones. Migration at $t-1$ may influence child mortality risk at year *t*, but the opposite is not possible here. Using lagged migration variables also enables us to control for any potential multicollinearity that may exist between the primary independent variable and the control variables measured at year *t*.

2. The model in detail

To address the questions in this paper, we ran the following equations using a linear probability model (Caudill, 1988). The indices *i, m, h*, c_{-h}, *v, t* stand for the child, the mother, the household, the compound pertaining to household *h,* the village, and the year.

Equation 2 investigates the link between under-5 mortality and migration at the compound level.

$$ChildMortality_{cvt} = \beta_0 + \beta_1 Mig_{cv(t-1)} + \mathbf{X}_{cvt} + \pi_c + v_t + \varphi_{vt} + \varepsilon_{cvt} \quad (\mathbf{2})$$

Equation 3 investigates the relationship between under-5 mortality and migration at the household level.

$$ChildMortality_{hvt} = \beta_0 + \beta_1 Mig_{hv(t-1)} + \mathbf{Z}_{hvt} + \pi_h + v_t + \varphi_{vt} + \varepsilon_{hvt} \quad (\mathbf{3})$$

In Equation 4, we add an interaction term to migration at the compound and household levels, to indicate all possible crossover effects between them.

$$ChildMortality_{hvt} = \beta_0 + \beta_1 Mig_{hv(t-1)} + \beta_1 Mig_{c_{-h}v(t-1)} + \beta_3 Mig_{hv(t-1)} \times Mig_{c_{-h}v(t-1)} + \mathbf{Z}_{hvt} + \pi_h + v_t + \varphi_{vt} + \varepsilon_{hvt} \quad (\mathbf{4})$$

Finally, Equation 5 focuses on maternal migration decisions at the individual level, specifically by investigating how a mother's short-term migration affects her child's survival. The equation allows us to estimate the extent to which this effect depends on the child's age. We focus on short-term migration here because mothers are reported to rarely leave their children for long periods.

$$ChildDeath_{imhvt} = \beta_0 + \beta_1 ShortMig_{mhv(t-1)} + \beta_3 Age_{imhvt} \times ShortMig_{mhv(t-1)} + \mathbf{Z}_{hvt} + \pi_m + v_t + \varphi_{vt} + \varepsilon_{imhvt} \quad (\mathbf{5})$$

Because the dependent variables are discrete-time variables (described in the next section), the model could have been estimated using a logistic or probit regression. However, a linear probability model allows us to cluster our error terms in Equations 2, 3, 4, and 5 as ε_{cvt}, ε_{hvt}, and ε_{imhvt} by compound or by household. We can thus take into account that observations may be related within compounds or households. We propose some variants of the model using logit regression, Poisson regression, and survival analysis regression methods as alternatives to our approach[5] (see Appendix Tables B.1 and C.1).

3. The variables

Dependent variables

[5] Unlike the survival analysis model, the linear probability model is replicable at all levels of analysis (individual, household, and compound).

In Equation 2, the dependent variable $ChildMortality_{cvt}$ represents a dummy variable coded 1 if at least one child aged between 0 and 5 dies in compound *c* in village *v* in year *t*; or 0 otherwise. The same occurs in Equation 3 with $ChildMortality_{hvt}$, but at the household level.

In Equation 5, the dependent variable $ChildDeath_{imhvt}$ is a dummy variable that takes 1 if child *i*, aged 0–5 with mother *m* living in household *h* in village *v*, dies at year *t*; or 0 otherwise.

Primary independent variables

The primary independent variable in our analysis is migration. Equations 2 and 3 include two migration variables: $Mig_{cv(t-1)}$, the number of all short- and long-term moves by individuals living in compound *c* in year $t-1$; and $Mig_{hv(t-1)}$, the number of all moves by individuals from household *h* in year $t-1$. Equation 4 includes $Mig_{c_{-h}v(t-1)}$, the total moves by individuals from neighbouring households belonging to the same compound as household *h*

In Equation 5, the primary independent variable $ShortMig_{mhv(t-1)}$ is the number of short-term moves by the mother of child *i* living in household *h* in year $t-1$.

Control variables

In Equations 2, 3, and 4, we control for the numbers of at-risk children aged 0–4, children aged 5–12, working-age individuals; and those aged 60 and older. Information on kinship within the household is updated for each year, and any changes in the household demography and migration will also be captured. Indeed, age structure is important because each age group within the household has a specific role to play in its domestic production (e.g. girls and boys can help care for siblings, while adults help in the day-to-day work). These demographic characteristics at the household and compound levels are represented in our equations by, respectively, the time-varying matrices $\mathbf{X}_{cvt}$ and $\mathbf{Z}_{hvt}$.

Equation 5 includes the number of siblings in the household that child *i* shares with mother *m*.[6] Moreover, to investigate the impact of a mother's short-term migration on her child's mortality

[6] The number of children aged 0–5 years in the household is deducted from the number of siblings of child *i*. Siblings are not only born from the same mother but also include foster children in a household under the responsibility of a parent who could be a mother, another woman, or the household head.

risk for each age group, we use Age_{imhvt} to control for age of child i in year t.[7] Although other unobservable factors may also influence child mortality at the household or individual level, this fixed-effect design enables our models to include many time-invariant household characteristics.

IV. Results

1. Effects on child survival of migration at the compound and household levels

The first question addressed in this paper is whether short- and long-term migration both influence under-5 mortality in rural areas. Table 3 provides the estimates from Equations 2 and 3, revealing a negative and significant correlation between child mortality and short-term migration. Estimates for long-term migration are non-significant at the household level and positive at the compound level.[8] We therefore focus on short-term migration while distinguishing between males and females to capture the gender-specific effect.

Table 3. Child mortality and migration (short- and long-term), at compound and household levels, Niakhar, 1998–2013

	Compound	Household
Mean value of dependent variable (child mortality)[a]	8.1	4.5
Number of moves		
Short-term migration	−0.004*** (0.001)	−0.003*** (.000)
Long-term migration	0.009*** (0.002)	0.001 (0.002)
Household demography	Yes	Yes
Compound/household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Year × village fixed effects	Yes	Yes
Observations	33,949	43,055
Number of units	2,295	3,512

[a] 8.1% of compounds have at least one household with a child death, and 4.5% of households have at least one child death.
Note: Robust standard errors in parentheses.
* $p < .10$. ** $p < .05$. *** $p < .01$.

[7] Age at time t is the child's age at the completion of year t.

[8] These positive values seem to show that extended absences do not benefit the child's survival, at least not at the compound level. While rare (extreme) events, they could simply reveal the unit's extreme fragility. Also, using other specifications discussed in Section III.2, the regression results in Appendix Table A.1 show no significant association between long-term migration and child mortality.

***Source**:* Authors' calculations using NHDSS data.

Table 4 provides the estimates from Equation 3 and focuses on the short-term migration of working-age household members while distinguishing between genders. Column 1 shows, for the whole sample at the household level, a negative and significant correlation between child mortality and short-term migration among working-age males and females. The same results are observed for compounds with at least two households (Column 2). For completeness, we also cover households in single-household compounds (Column 3),[9] where the correlation between migration and child mortality is non-significant. Thus, the significant correlation observed in the whole sample between short-term migration and child mortality is likely driven by households in compounds with at least two households. While the non-significance of the correlation for single-household compounds could be due to a problem of statistical power,[10] the results may highlight the importance of support from neighbouring families within the same compound. To test this hypothesis and detect potential external effects on neighbouring households on child mortality, we focused on households in compounds with at least two households and included compound-level migration in the regressions estimated at the household level (Table 5).

Table 4. Child mortality and short-term migration at the household level, Niakhar, 1998–2013 (linear probability model)

	Whole sample (1)	Two or more households in compound (2)	One household in compound (3)
Mean value of dependent variable (child mortality)[a]	4.5	4.7	4.4
Number of moves, household level			
Working-age female migration	−0.003** (0.001)	−0.003* (0.001)	−0.003 (0.002)
Working-age male migration	−0.002** (0.001)	−0.003** (0.001)	−0.001 (0.002)
Household demography	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Year × village fixed effects	Yes	Yes	Yes

[9] Individual households with a large number of family members constitute a compound in themselves, and they comprise 41% of the sample.

[10] Focusing on single-household compounds considerably reduces the sample size and therefore may affect estimates. However, such compounds have characteristics that may explain the non-significance. For example, as single households in the compound, they cannot benefit from neighbouring households looking after their children, which could create heterogeneous effects of migration on child survival.

Observations	42,622	25,074	17,548
Number of households[b]	3,512	2,037	1475

[a] 4.5% of households have at least one child death.
[b] The maximum number of household is 3,664. The loss in household numbers is due to using an unbalanced panel, which also occurs with the subsamples. Consistency among household subgroups depends on the number of observations.
Note: Robust standard errors in parentheses.
* $p < .10$. ** $p < .05$. *** $p < .01$.

Source*:* Authors' calculations using NHDSS data.

Using Equation 4, Table 5 reveals possible crossover effects between household- and compound-level migration events (external effects of neighbouring households on child mortality). Column 2 replicates Column 1 but distinguishes short-term migration by gender. Column 1 shows a negative and significant correlation between short-term migration and child mortality at the household and compound level, whereas in Column 2 the correlation is negative and significant only at the household level. The coefficient of working-age female short-term migration is higher than that of working-age males. Furthermore, the correlation between household child mortality and short-term migration in neighbouring compound households is also significant (Column 1).[11] We reach the same conclusions from a sensitivity test computed with logit and Poisson regression models (Appendix Table C.1).

Columns 3 and 4 provide the estimates from splitting the population into economically advantaged and disadvantaged households according to a list of assets, such as radios, cooking fuel, phones, refrigerators, televisions, bicycles, motorcycles, and cars.[12] We observe a negative and significant correlation between child mortality and both male and female short-term migration in the economically disadvantaged category (Column 3), and no significant correlation for the advantaged households (Column 4). Furthermore, the coefficient of compound short-term migration is negative and significant for both groups. In short, the beneficial results of migration observed at the household level seem to be driven by the poorest households in our sample.

Table 5. Child mortality and short-term migration at the household and compound levels, Niakhar, 1998–2013 (linear probability model)

	All (1)	All (2)	Economically disadvantaged (3)	Economically advantaged (4)
Mean value of the dependent variable (child mortality)[a]	4.7	4.7	5.2	4.4

[11] However, when household and compound short-term moves occur simultaneously, the positive and significant coefficient of the interaction term between them indicates that the aggregate effect is weaker than the sum of their two separate effects.
[12] The consumer assets poverty index was built using the methodology described by Andersson (2014).

Number of moves, household level				
Short-term migration	−0.004*** (0.001)			
Working-age female migration		−0.005** (0.002)	−0.008*** (0.003)	−0.002 (0.003)
Working-age male migration		−0.003* (0.0012)	−0.005** (0.002)	−0.001 (0.003)
Number of moves, compound level				
Short-term migration	−0.002*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)	−0.002** (0.001)
Interactions, household × compound				
Household short-term migration × compound short-term migration	0.001*** (0.000)			
Working-age female migration × compound short-term migration		0.001** (0.000)	0.001 (0.000)	0.001** (0.000)
Working-age male migration × compound short-term migration		0.000 (0.000)	0.001** (0.000)	−0.000 (0.000)
Household demography	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Year × village fixed effects	Yes	Yes	Yes	Yes
Observations	25,074	25,074	16,199	8,875
Number of households	2,037	2,037	1388	649

[a] 4.7% of compounds with two or more households have at least one household with a child death.
Note: Robust standard errors in parentheses.
* $p < .10$. ** $p < .05$. *** $p < .01$.
Source: Authors' calculations using NHDSS data.

2. Effect of maternal migration on child survival

Female migration, particularly among women of reproductive age, is an important factor in reducing child mortality. But what if it is the mother who migrates?

Selecting mothers from our main sample of working-age migrants, we focus on how their short-term moves may impact their own children's mortality. Table 6 provides the estimates from Equation 5, with and without the interaction between a mother's migration and the age of her children.[13] In Column 1, we present the full results, which show a negative and non-significant correlation between a mother's migration and her children's mortality when the children's ages are not stratified. The correlation is significant when controlling for the child's age and the number of moves at both the household and compound levels (Columns 2–4). However, this correlation varies according to the age of the child. To identify the differences, we computed the marginal effect for each child age group (Table 7).

[13] We have included information on relatives' short-term migration (Table 6, Column 4) and controls for unobservable variables like maternity clinics using village × fixed effects.

Table 6. Effect of maternal migration on child mortality, Niakhar, 1998–2013, (linear probability model)

	Maternal migration (1)	Column 1 + child age (2)	Column 2 + village × years fixed effects (3)	Column 3 + compound migration (4)
Mean value of the dependent variable (child mortality)[a]	2.3	2.3	2.3	2.3
Mother's short-term migration	−0.000 (0.001)	−0.004*** (0.001)	−0.004** (.001)	−0.004*** (0.001)
Mother's short-term migration × child's age in years (*Ref.* = 0)				
1		0.007*** (0.002)	0.006*** (0.002)	0.008*** (0.002)
2		0.007*** (0.002)	0.006*** (0.002)	0.006*** (0.002)
3		0.005** (0.002)	0.003* (0.002)	0.004** (0.002)
4		0.004* (0.002)	0.001 (0.002)	0.000 (0.001)
Household migration × mother's short-term migration				0.001** (0.000)
Compound short-term migration × mother's short-term migration				−0.000* (0.000)
Household demography	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Village × year fixed effects	No	No	Yes	Yes
Observations	123,144	123,144	123,144	123,144
Number of children	30,749	30,749	30,749	30,749
Number of mothers	4,620	4,620	4,620	4,620

[a] 2.3% of child deaths among children aged 0–5 over the period in the household.
Note: Robust standard errors in parentheses.
* $p < .10$. ** $p < .05$. *** $p < .01$.
Source*:* Authors' calculations using NHDSS data.

Table 7 presents the marginal effects of the link between the short-term migration of mothers and their children's mortality for different child ages, using the same empirical strategies as for Columns 2–4 in Table 6. Migration and mortality continue to have a negative and significant correlation for a child aged 0 or 4, while it is positive and significant for a child aged 1 or 2.[14] As we are using lagged variables for migration, this situation can be interpreted as follows: on average, and *ceteris paribus*, a mother's migration during her pregnancy appears to increase her child's chances of survival over the first 12 months of life. However, if the mother migrates

[14] Children are considered to be 1 year of age when observed in year t and their mother left in year $t - 1$ (when they were 0 to 11 months old).

when her child is 0 years old, this appears to increase the future mortality risk of her child at age 1; and at 1 year old, it occurs at age 2.[15]

Table 7. Marginal effects of maternal migration on child mortality by child age, household level, Niakhar, 1998–2013

	Model in Table 6, Column 2		Model in Table 6, Column 3		Model in Table 6, Column 4	
Child's age (years)	Marginal effects	$p > Z$	Marginal effects	$p > Z$	Marginal effects	$p > Z$
0	−0.004 ***	.000	−0.003***	.008	−0.004***	.004
1	0.003**	.041	0.003**	.037	0.004**	.019
2	0.003**	.014	0.003**	.035	0.003**	.046
3	0.001	.436	0.000	.966	0.001	.720
4	−0.001	.675	−0.002*	.070	−0.003***	.000

* $p < .10$. ** $p < .05$. *** $p < .01$.
Note: Interpretation of the marginal effect: Maternal migration at $t - 1$ reduces the probability of child mortality by 0.004 at time t when the child is aged 0.
Source: Authors' calculations using NHDSS data.

V. Discussion

While many studies compare the child health outcomes of urban-area migrant families to those of rural-area non-migrant families, others explore the relationship between migration and the health outcomes of children who migrate or of children born in migrant destinations after settlement (Brockerhoff, 1990; Brockerhoff, 1994; Kanaiaupuni and Donato, 1999; Hildebrandt and McKenzie, 2005). But how does migration of household members affect the mortality of under-5 children who remain behind? Our work examined short- and long-term migration in rural areas to answer that question. In doing so, this paper contributes to the literature by assessing the potential benefits of migration for these children. An additional advantage of this study is its panel data structure. Because the statistical design systematically used fixed effects, we could extract from the variations in child health only that which is attributable to distinctive family migration patterns.

[15] When considering the mother's total number of days spent outside the village instead of total number of moves, we arrive at the same conclusions: an increase in number of days is associated with an increase in survival chances over the child's first 12 months of life. However, if this number of days increases when her child is 0 years old, she decreases her child's chance of survival at 1 and 2 years.

Our results first illustrate the importance of distinguishing two types of migration (long- and short-term) to explore links between child mortality and migration in rural areas. The correlation we observed between short-term migration and child mortality was strong and robust across each unit used to measure it (compound and household), unlike what was observed with rarer long-term migration. This may imply that short-term migration can be considered a mechanism in rural villages to improve child well-being—or at least to reduce child mortality significantly. Interestingly, we also found a negative and significant correlation between child mortality in a given household and short-term migration from other households in the same compound (although this potential effect is mitigated when short-term migration also increases in parallel within the household). This result points to crossover effects between family networks and is consistent with the literature on risk-sharing across rural communities, where villagers seem to be able to cope with (some of) the risks they face in their own family by sharing resources or childcare within the larger neighbouring community (Platteau, 1997; Baland and Platteau, 1998; Fafchamps and Lund, 2003).

Gender may also make a difference. When comparing the relative levels of the migration coefficient for working-age women versus active men, we find support for the hypothesis that women migrants play a more important role in reducing child mortality. This asymmetry in the observed effects suggests that migration's benefits to the household economy are distributed differently according to whether migrants are men or women. When women migrate, the benefits to children's well-being are more notable. This result is consistent with the literature on women's empowerment in rural societies, which finds that empowering women contributes to improving children's welfare, health and nutrition in particular (Sethuraman et al., 2006; Duflo, 2012; Lépine and Strobl, 2013; Imai et al., 2014). However, when women increase their labour force participation, there are some exceptions, depending on the job type and the child's age (Brauner-Otto et al., 2019).

Our results also concern the effect of a mother's short-term migration on the mortality risk of her child left behind. A mother's migration seems to improve her child's probability of survival, but not at all child ages. When a mother migrates during her pregnancy, her child's mortality risk is reduced during the first 12 months of life in the village. However, if a migrating mother leaves behind a very young child (0 or 1 year old at year of migration, $t - 1$), her child's mortality risk is not reduced over the following years (up to 3 years old). Instead, it tends to

increase, which Yabiku et al. (2012) showed, although without disentangling short- versus long-term migration effects.

Several explanations may account for our findings. First, in the development economics literature, the most important factor in development is remittances (Stark and Lucas, 1988; Lucas, 1997). Migrant household members, particularly workers, bring back money that can be used to increase the well-being of all family members, especially in terms of young children's nutritional intakes and/or access to healthcare facilities. It is perfectly conceivable that this should lead to a reduction in child mortality at the household level. That this also has a positive effect on other closely connected households is not surprising either. Numerous authors such as Fafchamps (1992), Harrower and Hoddinott (2005), and Park (2006) consider that shocks like health problems are insured through risk-sharing networks and that remittances from labour income act as compensation if negative shocks occur (Lucas and Stark, 1985; Stark and Lucas, 1988; Gertler and Gruber, 2002). Another plausible mechanism is better maternal care practices (Elo, 1992; Lindstrom and Muñoz-Franco, 2006), particularly for women of childbearing and working age. During their period of migration, these women may enjoy better pregnancy monitoring and learn better pre-and postnatal childcare practices that are more easily accessible in urban areas, which could later be beneficial to the children left behind. However, the effect of migration is not favourable to young children. A mother's absence can reduce the time allocated to childcare, thus increasing psychological stress and changes in feeding practices among children (Nguyen, 2016). These are the most probable mechanisms underlying the complex relationship found in our regressions.

Although this study enables us to draw salient conclusions, some of its limitations suggest further avenues for research. First, our study does not explicitly analyse the mechanisms by which migration effects act on to survival probabilities, as in the cases of remittances and healthcare practices. Doing so would require reliable records on the flow of remittances received by households, which the Niakhar database so far does not cover. Moreover, the child's health outcome variable could be more specific. Indeed, the continuum between good health and death must be analysed. While we used the important and well-documented outcome of child mortality, the development economics literature indicates that the quality of children's health is an important factor in education and economic progress. A second limitation could come from the nature of the econometric relationship between migration and child mortality, meaning that correlation does not imply causation. Although we used a fixed-effect design associated with lagged variables to control for endogeneity and deal with selection issues, one

may still believe that child mortality at year t is connected to migration at year $t-1$ through a pre-existing bias in the child's health at $t-1$. In other words, families in need of more financial resources could have decided to migrate at time $t-1$ *because* their child was ill at time $t-1$ (reverse causality). However, considering that the main causes of child mortality in the region are infectious diseases (Delaunay et al., 2001),[16] the risk of a reverse causality effect on migration variables is reduced. Furthermore, in cases of child illness, the person who migrates is usually the father or a relative, who does so to assist the mother financially. Thus, our results on maternal migration should adequately address this selection issue.

We plan to extend this work by incorporating the role of paternal migration and by examining the long-term impact of migration on other child health outcomes in both their own family and more distant contexts. Doing so might provide a useful complement to the literature on migration and child health in rural sub-Saharan Africa.

[16] Malaria and cholera are sudden and acute, thus limiting the connection between the child's health status at time $t-1$ and mortality risk in time t.

Appendix

A. Long-term migration and child mortality

Table A.1 presents the estimates of Equation 4 using long-term migration as the main independent variable. We observe insignificant coefficients; we do not have enough evidence to establish a correlation at the household level between long-term migration at time $t - 1$ and child mortality at time t.

Table A.1. Household and compound long-term migration, child mortality in the household, Niakhar, 1998–2013

	Two or more households in compound	
	(1)	(1)
Mean value of the dependent variable (child mortality)	0.047	0.047
Number of moves, household level		
Household	−0.002 (0.002)	
Working-age female		−0.004 (0.004)
Working-age male		0.001 (0.005)
Number of moves, compound level	0.000 (0.002)	0.000 (0.002)
Interactions, household × compound		
Household migration × compound migration	0.001 (0.002)	
Working-age female migration × compound migration		0.001 (0.002)
Working-age male migration × compound migration		0.001 (0.003)
Household demography	Yes	Yes
Household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Year × village fixed effects	Yes	Yes
Observations	25,074	25,074
Number of households	2,037	2,037

Note: Robust standard errors in parentheses.
* $p < .10$. ** $p < .05$. *** $p < .01$.
Source: Authors' calculations using NHDSS data.

B. Sensitivity analysis: Logit and Poisson regression models

In Table B.1, the dependent variable in the logit regression is a dummy for child mortality (1 if there is at least one under-5 death in the household and 0 otherwise). In the Poisson regression, the dependent variable is the number of under-5 deaths observed in the household for a specific year. Also due to convergence problems, the 'village × year' fixed effect was not included in the logit model. The conclusions are the same and corroborate the findings using the linear probability models, reported in Table 5.

Table B.1. Household short-term migration and child mortality, Niakhar, 1998–2013

	Logit		Poisson	
	(1)	(2)	(3)	(4)
Number of moves, household level				
Household	−0.090*** (0.022)		−0.073*** (0.019)	
Working-age female		−0.132*** (0.045)		−0.110*** (0.037)
Working-age male		−0.064**(0.032)		−0.053* (0.028)
Number of moves, compound level	−0.056*** (0.0113)	−0.056*** (0.0112)	−0.065*** (0.0119)	−0.064*** (0.012)
Interactions, household × compound				
Household migration × compound migration	0.006*** (0.001)		0.006*** (0.001)	
Working-age female migration × compound migration		0.010*** (0.004)		0.011*** (0.002)
Working-age male migration × compound migration		0.004 (0.003)		0.003* (0.001)
Household demography	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Year × village fixed effects	No	No	Yes	Yes
Clustered error	No	No	Yes	Yes
Observations	11,417	11,417	18,979	18,979
Number of groups	785	785	476	476

Note: Numbers in parentheses are robust standard errors.
* $p < .10$. ** $p < .05$. *** $p < .01$.
Source*:* Authors' calculations using NHDSS data.

C. Survival analysis

Table C.1 provides estimates on the effect of maternal migration on child mortality, based on survival analysis. The equation used for these estimates is the following:

$$\log(h_{imt}) = \mu_{imt} + \beta ShortMig_{m} + \theta \mathbf{X}_{mv}$$

where $\log(h_{imt})$ is the conditional failure rate, i.e. the instantaneous rate at which randomly selected child i of mother m, known to be alive at time t – 1, will die at time t. The main independent variable is $ShortMig_m$, which represents all the mother's short-term moves 1 year before the child's incorporation into the study and just before the date of the child's exit. $\mathbf{X}_{mv}$ is the vector of other control variables.

The results show that, at year 0, a negative and significant association exists between maternal short-term migration and the instantaneous probability of a child mortality event, indicating that the mother's short-term migration tends to reduce child mortality. At ages 1 to 4, we observe different relationships, but none of them are statistically significant.

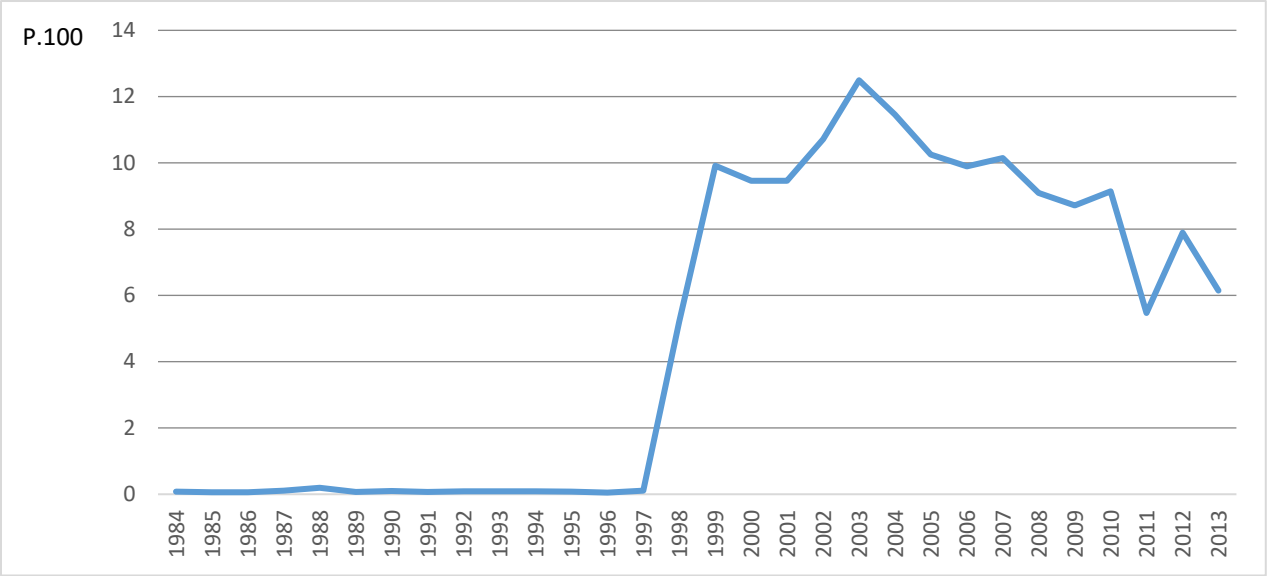
Table C.1. Effects of maternal migration on child mortality by child age, Niakhar, 1998–2013

	Child age				
	0	1	2	3	4
Mother's short-term migration	−0.487*** (0.126)	0.030 (0.099)	−0.048 (0.107)	0.140 (0.151)	0.174 (0.148)
Household demography	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Village × year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	17,380	15,404	14,191	12,735	11,714
Number of failures	670	426	326	131	82

* $p < .10$. ** $p < .05$. *** $p < .01$.
Note: Robust standard errors in parentheses.
Source: Authors' calculations using NHDSS data.

D. Migration trends in Niakhar, 1984–2013

Figure D.1. Short-term migration rate (%)

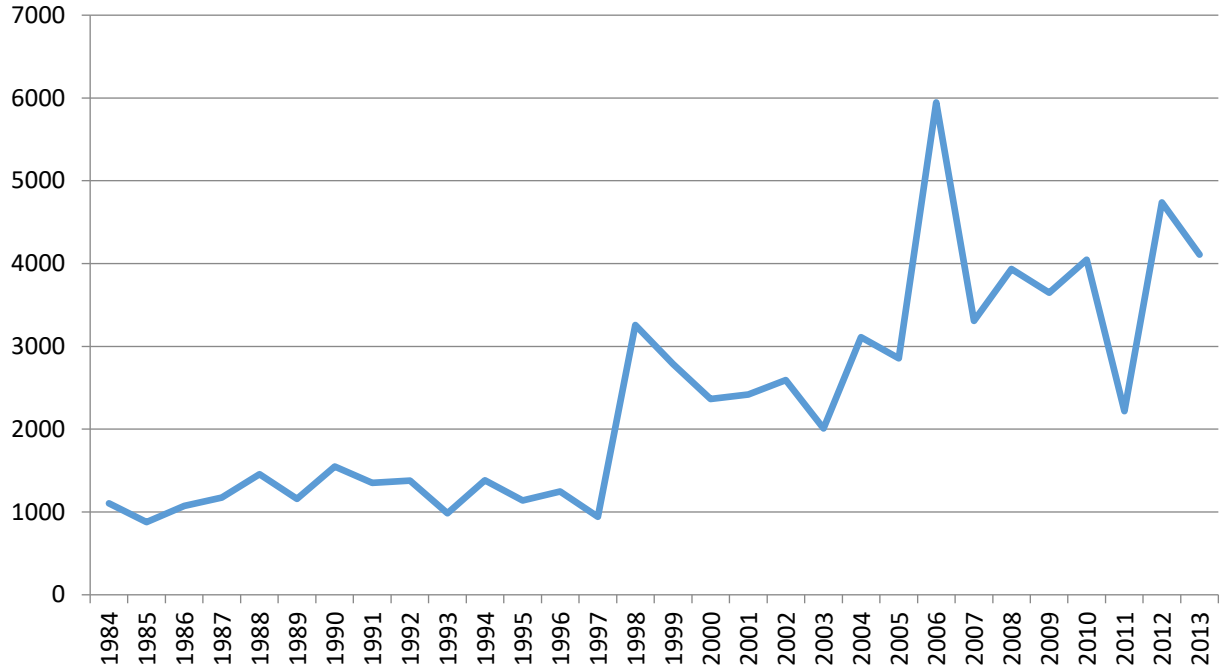


Note: The short-term migration rate is the total number of short-term moves in person years divided by the total number of residents in person years.
Source: Authors' calculations using NHDSS data.

Axe horizontal : Year

Axe vertical : %

Figure D.2. Number of long-term moves



Source: Authors' calculations using NHDSS data.

Axe vertical : virgules après les premiers chiffres (1,000 ; 2,000 etc.)

Axe horizontal, titre : Year

Figure D.3. Under-5 deaths per 1,000 births by sex, Niakhar 1998-2013

Source: Authors' calculations using NHDSS data.

Axe vertical, titre : Per 1,000 (supprimer "mortality rate")

Echelle gauche : de 0 à 400

Légende :

Total
Males
Females

References

Adjamagbo A., Delaunay V., Lévi P., Ndiaye O., 2006, Comment les ménages d'une zone rurale du Sénégal gèrent-ils leurs ressources? *Etudes rurales*, 177(1), 71–90.

Amankwaa A., Bavon A., Nkansah P. T., 2003, Rural–urban migration and its effects on infant and child mortality in Ghana, *African Population Studies*, 18(2), 1–26.

Amouzou A., Hill K., 2004, Child mortality and socioeconomic status in sub-Saharan Africa, *African Population Studies*, 19(1), 1–11.

Andersson L., 2014, *Migration, remittances and household welfare in Ethiopia* (UNU-MERIT, Working Paper Series, No. 2014-004), Maastricht, Maastricht Economic and Social Research Institute on Innovation and Technology and Maastricht Graduate School of Governance.

Baland J.-M., Platteau J.-P., 1998, Division of the commons: A partial assessment of the new institutional economics of land rights, *American Journal of Agricultural Economics*, 80(3), 644–650.

Barrios S., Bertinelli L., Strobl E., 2010, Trends in rainfall and economic growth in Africa: A neglected cause of the African growth tragedy, *The Review of Economics and Statistics*, 92(2), 350–366.

Bhutta Z. A., Darmstadt G. L., Hasan B. S., Haws R. A., 2005, Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: A review of the evidence, *Pediatrics*, 115(Suppl. 2), 519–617.

Böhme M. H., Persian R., Stöhr T., 2015, Alone but better off? Adult child migration and health of elderly parents in Moldova, *Journal of Health Economics*, 39, 211–227.

Brauner-Otto S., Baird S., Ghimire D., 2019, Maternal employment and child health in Nepal: The importance of job type and timing across the child's first five years, *Social Science & Medicine*, 224, 94–105.

Breierova L., Duflo E., 2004, *The impact of education on fertility and child mortality: Do fathers really matter less than mothers?* (Working Paper No. 10513), Cambridge, Mass., National Bureau of Economic Research.

Brockerhoff M., 1990, Rural-to-urban migration and child survival in Senegal, *Demography*, 27(4), 601–616.

Brockerhoff M., 1994, The impact of rural–urban migration on child survival, *Health Transition Review*, 4(2), 127–149.

Buor D., Bream K., 2004, An analysis of the determinants of maternal mortality in sub-Saharan Africa, *Journal of Women's Health*, 13(8), 926–938.

Caudill S. B., 1988, Practitioners corner: An advantage of the linear probability model over probit or logit, *Oxford Bulletin of Economics and Statistics*, 50(4), 425–427.

DaVanzo J., Lee D. L. P., 1983, The compatibility of child care with market and nonmarket activities: Preliminary evidence from Malaysia, in Buvinic M., Lycette M. A., McGreevey W. P. (eds.), *Women and Poverty in the Third World*, Baltimore, Johns Hopkins University Press, 62–91.

de Brauw A., Harigaya T., 2007, Seasonal migration and improving living standards in Vietnam, *American Journal of Agricultural Economics*, 89(2), 430–447.

Delaunay V., 2017, Migration, in Delaunay V. (ed.), *La situation démographique dans l'Observatoire de Niakhar: 1963–2014*, Dakar, Institut de recherche pour le développement, 43–53.

Delaunay V., Douillot L., Diallo A., Dione D., Trape J.-F., Medianikov O., et al., 2013, Profile: The Niakhar Health and Demographic Surveillance System, *International Journal of Epidemiology*, 42(4), 1002–1011.

Delaunay V., Engeli E., Franzetti R., Golay G., Moullet A., Sauvain-Dugerdil C., 2016, La migration temporaire des jeunes au Sénégal. Un facteur de résilience des sociétés rurales sahéliennes? *Afrique contemporaine*, 259, 75–94.

Delaunay V., Etard J-F., Préziosi M.-P., Marra A., Simondon F., 2001, Decline of infant and child mortality rates in rural Senegal over a 37-year period (1963–1999), *International Journal of Epidemiology*, 30(6), 1286–1293.

Donnay F., 2000, Maternal survival in developing countries: What has been done, what can be achieved in the next decade, *International Journal of Gynecology & Obstetrics*, 70(1), 89–97.

Douillot L., Delaunay V., 2017, Mortalité, in Delaunay V. (ed.), *La situation démographique dans l'Observatoire de Niakhar: 1963–2014*, Dakar, Institut de recherche pour le développement, 73–79.

Duflo E., 2012, Women empowerment and economic development, *Journal of Economic Literature*, 50(4), 1051–1079.

Elo I. T., 1992, Utilization of maternal health-care services in Peru: The role of women's education, *Health Transition Review*, 2(1), 49–69.

Ermisch J. F., 2016, *An economic analysis of the family*, Princeton, Princeton University Press.

Fafchamps M., 1992, Solidarity networks in preindustrial societies: Rational peasants with a moral economy, *Economic Development and Cultural Change*, 41(1), 147–174.

Fafchamps M., Lund S., 2003, Risk-sharing networks in rural Philippines, *Journal of Development Economics*, 71(2), 261–287.

Faye A., Lericollais A., Sissokho M. M., 1999, *L'élevage en pays Sereer: du modèle d'intégration aux troupeaux sans pâturages*, in Lericollais A. (ed.), Paysans sereer: dynamiques agraires et mobilités au Sénégal, Paris, Institut de recherche pour le développement, 299–330.

Gastellu J.-M., Diouf M. (eds.), 1974, *Maintenance sociale et changement économique au Sénégal. Vol. 2: Pratique du travail et rééquilibres sociaux en milieu Serer* (ORSTOM Working Paper No. 34), Paris, ORSTOM.

Gertler P., Gruber J., 2002, Insuring consumption against illness, *American Economic Review*, 92(1), 51–70.

Guigou B., 1992, *Les changements du système familial et matrimonial: Les Sérères du Siné (Sénégal)* (Doctoral dissertation), Paris, École des Hautes Études en Sciences Sociales.

Guilmoto C. Z., 1998, Institutions and migrations. Short-term versus long-term moves in rural West Africa, *Population Studies*, 52(1), 85–103.

Harrower S., Hoddinott J., 2005, Consumption smoothing in the Zone Lacustre, Mali, *Journal of African Economies*, 14(4), 489–519.

Hildebrandt N., McKenzie D., 2005, The effects of migration on child health in Mexico, *Economia,* 6(1), 257–289.

Hsiao C., 2014, *Analysis of panel data* (3rd ed.), Cambridge, Cambridge University Press.

Imai K. S., Annim S. K., Kulkarni V. S., Gaiha R., 2014, Women's empowerment and prevalence of stunted and underweight children in rural India, *World Development*, 62, 88–105.

Kanaiaupuni S. M., Donato K. M., 1999, Migradollars and mortality: The effects of migration on infant survival in Mexico, *Demography*, 36(3), 339–353.

Kanmiki E. W., Bawah A. A., Agorinya I., Achana F. S., Awoonor-Williams J. K., Oduro A. R., et al., 2014, Socio-economic and demographic determinants of under-five mortality in rural northern Ghana, *BMC International Health and Human Rights*, 14(1), 24.

Kiros G.-E., White M. J., 2004, Migration, community context, and child immunization in Ethiopia, *Social Science & Medicine*, 59(12), 2603–2616.

LaFave D., Thomas D., 2017. Extended families and child well-being, *Journal of Development Economics*, 126, 52–65.

Lalou R., Delaunay V., 2015, Migrations saisonnières et changement climatique en milieu rural sénégalais: Forme ou échec de l'adaptation? in Sultan B., Amadou S. M., Oumarou A., Soumaré M. A. (eds.), *Les sociétés rurales face aux changements climatiques et environnementaux en Afrique de l'Ouest,* Marseille, Institut de recherche pour le développement, 287–313.

Lartey A., 2008, Maternal and child nutrition in sub-Saharan Africa: Challenges and Interventions, *Proceedings of the Nutrition Society*, 67(1), 105–108.

Lépine A., Strobl E., 2013, The effect of women's bargaining power on child nutrition in rural Senegal, *World Development,* 45, 17–30.

Lericollais A. (ed.), 1999, *Paysans Sereer: dynamiques agraires et mobilités au Sénégal*, Paris, Institut de recherche pour le développement.

Lindstrom D. P., Muñoz-Franco E., 2006, Migration and maternal health services utilization in rural Guatemala, *Social Science & Medicine*, 63(3), 706–721.

Lucas R. E. B., 1997, Internal migration in developing countries, in Rosenzweig M. R., Stark O. (eds.), *Handbook of population and family economics, Vol. 1*, 721–798, Amsterdam, Elsevier.

Lucas R. E. B., Stark O., 1985, Motivations to remit: Evidence from Botswana, *Journal of Political Economy*, 93(5), 901–918.

Marchiori L., Maystadt J.-F., Schumacher I., 2012, The impact of weather anomalies on migration in sub-Saharan Africa*, Journal of Environmental Economics and Management*, 63(3), 355–374.

Matthews Z., Channon A., Neal S., Osrin D., Madise N., Stones W., 2010, Examining the 'urban advantage' in maternal health care in developing countries, *PLoS Medicine*, 7(9), e1000327.

Mertz O., Mbow C., Reenberg A., Diouf A., 2009, Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel, *Environmental Management*, 43(5), 804–816.

Miracle M. P., Miracle D. S., Cohen L., 1980, Informal savings mobilization in Africa, *Economic Development and Cultural Change*, 28(4), 701–724.

Nguyen C. V., 2016, Does parental migration really benefit left-behind children? Comparative evidence from Ethiopia, India, Peru and Vietnam, *Social Science & Medicine*, 153, 230–239.

Oberai A. S., Singh H. K., 1980, Migration, remittances and rural development: Findings of a case study in the Indian Punjab, *International Labour Review*, 119(2), 229–241.

Park C., 2006, Risk pooling between households and risk-coping measures in developing countries: Evidence from rural Bangladesh, *Economic Development and Cultural Change*, 54(2), 423-457.

Pison G., Trape J.-F., Lefebvre M., Enel C., 1993, Rapid decline in child mortality in a rural area of Senegal, *International Journal of Epidemiology*, 22(1), 72–80.

Pitt M. M., Sigle W., 1998, *Seasonality, weather shocks and the timing of births and child mortality in Senegal* (Working Paper No. wp98-02), Providence, RI, Brown University, Population Studies and Training Center.

Platteau J.-P., 1997, Mutual insurance as an elusive concept in traditional rural communities, *The Journal of Development Studies*, 33(6), 764–796.

Ruel M. T., Levin C., Armar-Klemesu M., Maxwell D. G., Morris S., 1999, Good care practices can mitigate the negative effects of poverty and low maternal schooling on children's nutritional status: Evidence from Accra, *World Development*, 27(11), 1993–2009.

Sethuraman K.., Lansdown R., Sullivan K., 2006, Women's empowerment and domestic violence: The role of sociocultural determinants in maternal and child undernutrition in tribal and rural communities in South India, *Food and Nutrition Bulletin*, 27(2), 128–143.

Stark O., 1999, *Altruism and beyond: An economic analysis of transfers and exchanges within families and groups*, Cambridge, Cambridge University Press.

Stark O., Lucas R. E. B., 1988, Migration, remittances, and the family, *Economic Development and Cultural Change*, 36(3), 465–481.

Wilson M., 1989, Child development in the context of the Black extended family, *American Psychologist*, 44(2), 380–385.

World Bank, 2013, *World Development Indicators 2013*, Washington, International Bank for Reconstruction and Development / The World Bank.

Yabiku S. T., Agadjanian V., Cau B., 2012, Labor migration and child mortality in Mozambique, *Social Science & Medicine*, 75(12), 2530–2538.

Zupan J., 2005, Perinatal mortality in developing countries, *New England Journal of Medicine*, 352(20), 2047–2048.

Abstract

Exploring rich panel data from the Niakhar Health and Demographic Surveillance System, this study investigates the effects of migration on child mortality among families left behind in rural areas. Migration, particularly short-term, is positively associated with the survival probability of under-5 children in the household. We also find that the short-term moves of working-age women impact child mortality more than those of working-age men. Moreover, we detect crossover effects between households in the same compound, consistent with the idea that African rural families share part of their migration-generated gains with an extended community of neighbours. Lastly, we investigate the effect of maternal short-term migration on the survival of under-5 children. The aggregate effect is still positive but much weaker. Specifically, maternal migration during pregnancy seems to enhance children's survival immediately after birth, but the probability of survival tends to decrease after age 1 when the mother is absent.

Keywords: Niakhar, Senegal, short-term migration, long-term migration, child mortality