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How do migrations affect under-five mortality in rural areas? Evidence from Niakhar, Senegal [1]

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Abstract

This study analyses the relationship between a household member's migration and child mortality within the family left behind in rural areas. Exploring the richness of the Niakhar Health and Demographic Surveillance System panel, we use high-frequency migration data to investigate the effects of migration on child mortality at the household level over 16 years. Migrations, particularly short-term migrations, are positively associated with the survival probability of under-five children in the household. Also, we find that working age women's short-term migrations impact child mortality more than working age men's short-term migrations. This observation supports hypotheses in the economic literature on the predominant role of women in rural households in obtaining welfare improvements. Moreover, we detect crossover effects between households of the same compound –in line with the idea that African rural families share part of their migration-generated gains with an extended community of neighbors. Lastly, we investigate the effect of a mother's short-term migration on the survival of her under-5 children. The aggregate effect of a mother's migration on child survival is still positive, but much weaker. Specifically, mother migration during pregnancy seems to enhance the wellbeing of the child, considered immediately after birth. However, when the child is older (more than one year), the absence of the mother tends to decrease the probability of survival.

Keywords: Niakhar, Senegal, short- and long-term migrations, child mortality

JEL classification: I15

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1. Introduction

Although child mortality is high in Sub-Saharan Africa compared to the rest of the world, it has declined dramatically over the last decades (World Bank, 2013). Demographic surveys carried out in this part of the world reveal a high correlation between reduced child mortality and improvement in healthcare for mothers and children (Buor and Bream, 2004; Bhutta et al., 2005; Donnay, 2000; Zupan, 2005, Lartey et al., 1996, Pison et al., 1993, Amouzou and Hill, 2004, Kanmiki et al., 2014). However, many other factors are also at play, especially socioeconomic and demographic ones. Migration appears to be a good example: climate conditions, urbanization or economic vulnerability have drawn academic attention to the intensification of migration and its impact on the migrant's family wellbeing (Barrios et al., 2010; Marchiori et al., 2012; Mezt et al., 2009; De Bruaw and Harigaya, 2007). In general, migration observed in rural areas is viewed as a beneficial family strategy (Böhme et al., 2015; Kiros and White, 2004; Yabiku et al., 2012; Brockerhoff 1990; Amankwaa et al. 2003; Lucas and Stark, 1985), one of its benefits being reduced child mortality (Pitt and Sigle, 1998; Brockerhoff, 1990). As noted by Yabiku et al. (2012), the literature examining migration's impact on child mortality usually focuses the analysis on children who migrate. These studies analyze child mortality --or factors that can affect child mortality-- in migrating families as compared to non-migrating families "remaining in the village". For instance, Brockerhoff (1994), looking at the impact of rural to urban migration on child survival in 17 developing countries, shows that mothers improve their children's chances of survival by moving with them from a rural to an urban area.

However, there has been relatively little investigation of the impact of a household member's migration on health outcomes for children left behind, when the whole family does not move. Authors like Hildebrandt et al. (2005) and Kanaiaupuni and Donato (1999) examined the question in Mexico, with mixed results. When only families left behind are considered, there is room for widely differing hypotheses on the link between migration and child mortality. First, the economic channel can be explored: migration, particularly short-term migration, is a well-documented survival strategy adopted by rural households to cope with socioeconomic vulnerabilities (Mertz et al., 2009; De Brauw and Harigaya, 2007). Through migrants' remittances, families should obtain better nutrition, more stable and higher-quality housing and increased access to healthcare and medicines (Yabiku et al., 2012). In addition to economic advantages, migrants, especially female migrants, may return home bringing better maternal care practices from urban areas and thereby improving their children's chances of survival (Matthews et al., 2010; Ruel et al., 1999). However, migration can also have a deleterious effect on child survival.

The absence of parents in the household may increase the risk of child mortality (Nguyen, 2016). This is especially true when it is the mother who is absent (DaVanzo and Lee, 1983).

Through a fixed-effect and lagged variables design, we were able to examine the "plausibly causal" relationship between household members' migration and the health outcomes of children left behind, also exploring the impact of the mother's migration, in a rural area of Senegal. This paper's contribution lies in distinguishing between two migration durations, long- and short-term, analyzing their respective effects on children's health outcomes and enriching the literature on risk-sharing, family structure, and children outcomes. Oberai and Singh (1980), in their study of the impact of remittances on rural development, previously highlighted the importance of distinguishing different types of migration to capture the full effect of remittances. Previous studies and observations on migration in the Niakhar region of Senegal showed the predominance of short-term migration --mostly related to labor-- over permanent migration, an aspect we integrate into the analysis (Guilmoto, 1998; Delaunay, 2017; Douillot and Delaunay, 2017).

In line with the literature emphasizing the role of networks in rural development economics (Miracle et al, 1980, Fafchamps, 1992), this paper also includes a new dimension: the compound, a unit of social organization that regroups one or more households connected by a family link. In addition to the restricted family -narrowly defined by parental lineage- we evaluate possible externalities from migrations of neighboring households on child survival. Given the role of kinship networks and the ethos of mutual aid in rural Sub-Saharan Africa (Miracle et al., 1980; LaFave and Thomas, 2017), it is conceivable that neighboring household actions and characteristics influence child survival in a given household. Indeed, in a pattern of extended family households a child is surrounded by a kin organization that goes beyond the mother, father, and children (nuclear family) to include parental, sibling, avuncular and cousin links of spouses and offspring (extended family members). This organization could affect the degree of risk-sharing that households achieve in response to child mortality (Wilson, 1989; LaFave and Thomas 2017). This second point is reflected in the literature studying childcare sharing within families or among networks of families (extended family) (Ermisch, 2016; Breierova and Duflo, 2004; LaFave and Thomas, 2017). Following Breierova and Duflo (2004), we also hypothesize that a mother's migration may differently affect her child's mortality risk depending on the age of the child; we analyze how the presence of the mother is important for her child's survival, particularly when the child is young.

In the remaining of the article, we will then investigate the effect of migration on child mortality in non-migrating households, using panel data from the Niakhar Demographic Health

Surveillance System (Niakhar is a rural area in Senegal). Two hypotheses are tested here: the positive effect of household -and extended family- members' migrations on child survival and the positive effect of mother migration on her child survival probability.

2. The Demographic observatory of Niakhar

2.1. Location and social functioning

Located in west-central Senegal 135 km east of Dakar, the Senegalese capital, the Niakhar study zone covers 30 villages. The climate is Sahelian-Sudanese and the dominant ethnic group is *sereer*. The *sereer* community is defined as a peasant society whose economy relies on raising crops and livestock (Lericollais, 1999; Faye et al., 1999). Today, after several episodes of drought, agricultural production in the region is largely reduced to millet and groundnuts, respectively the staple and the cash crops of sereer peasants (Delaunay et al., 2013; Adjamagbo et al., 2006).
As reported by Adjamagbo et al. (2006), the traditional agricultural system is no longer stable, and there appears to be a risk to household food security. Among factors cited as responsible for this situation are a strong increase in population density, a decrease in precipitations, environmental degradation, intensive agriculture leading to soil depletion, limitation of credits and state grants for purchasing agricultural inputs and materials (Lalou and Delaunay, 2015; Delaunay et al., 2013). This situation has given rise to the creation of new income-generating activities, like small businesses/stores or crafts (Adjamagbo et al., 2006). In parallel, migration is increasing, particularly labor migration (Delaunay et al., 2016).

2.2. The compound and the household

Niakhar's society, like most rural societies in Sub-Saharan African countries, is organized in large units called compounds, an English translation of "concession" –which is the corresponding French word. Compounds are themselves divided into one or many sub-units called kitchens (*ngak* in Sereer). In the NHSS, a kitchen is defined as a group of individuals –not necessarily living under the same roof- who together eat millet from a common attic. This is what we will call household in the rest of the study, as in other studies or surveys (for example DHS). More precisely, households of a compound are occupied by brothers sharing the same mother. Each of them lives with their wives, children and uterine nephews. The kitchen/household is not only a unit of consumption but also a unit of production: it is there that self-sufficiency is organized, under the authority of a kitchen chief (Guigou, 1992; Gastellu and Diouf 1974). The latter controls access to resources and the use of the workforce. These essential functions make it a relevant unit for observing socio-economic phenomena.

3. The Niakhar database

The data used in this article come from the Niakhar Health and Demographic Surveillance System (HDSS). The Surveillance System was set up in 1962 by the IRD (*Institut de recherche pour le développement*) of Senegal to counteract the shortcomings of the civil registration system and provide demographic indicators (Delaunay et al., 2013). Since 1983, the Niakhar HDSS has covered 30 villages and routinely records information among residents in the region. All the villages are exhaustively observed, and each individual is followed just as long as he stays in the region.[2] This data set enabled us to investigate households' behavior and distinguish two types of migration according to their duration. Data from 1998 to 2013, particularly on households containing at least one child under the age of five, were used to study the link between migrations and under-five child mortality.

1998 was chosen as a starting date because it was the beginning of the intensification of migrations (both long- and short-term) in the region of Niakhar (figures 1 and 2 in appendix). We ended the study in 2014 because data were not yet available for 2015 and later.

Between 1998 and 2013, the population has increased by 47% in the region (29700 inhabitants in 1998 vs 43650 inhabitants in 2013). Also, the number of households in the region has increased by 28.7% (2213 households in 1998 vs 2847 households in 2013) with an average of 2 households per compound and 13 individuals per household over the period. Regarding the level of under-5 mortality in the region, figure 3 in the appendix shows a decreasing trend in both female and male under-5 mortality rate, from 310‰ to 50‰.

We focus on working-age household members (13 to 59 years) and distinguish between two types of migration, short- and long-term, regardless of the reasons. A short-term migrant is defined as a household member leaving the household for less than a year. A long-term migrant is defined as a household member leaving the household for more than a year and sometimes permanently. In the latter case, during his absence, the migrant is no longer considered as resident[3] in the

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[2] In this sense, there is no attrition rate, except the "natural" ones: death or permanent migration from the region

[3] Is a resident in Niakhar, an individual living in the region for more than a year. There are some exceptions: seasonal workers previously resident in Niakhar who still spend at less one month in the region are considered as resident; workers that have wives and children in the zone and that visit his family at least twice a year are considered as

household, contrary to short-term migrants. While the Niakhar HDSS database does not include the migration destination, cross-sectional studies in the region (Lalou and Delaunay, 2015) show that destinations are larger cities in Senegal (Dakar, Fatick, Thiès or Mbour). The authors identified, through interviews, two main motivations for migrations between 1983 and 2013. The first and most common are family reasons: marriages, divorces, death of spouses, adoption of children or holidays. The second is labor migration: household members move away to look for jobs (Lalou and Delaunay, 2015). Typically, is the later are young adult who goes to larger cities, during the dry season, to earn a complementary income and/or to alleviate his impact on family resources. Regarding these reasons, long-term migration seems more related to family-based mobility while short-term migrations are more linked to labor.

Tables 1 and 2 contain individual and household characteristics of migration in the Niakhar region between 1998 and 2013. Over the period, 10681 individuals were involved in long-term migrations, and 17114 individuals in short-term migrations. On average, migrants were young and without basic formal education. Yet, short-term migrants were relatively older, compared to long-term migrants and non-migrants (25.9 and 17.5)[4] which may reflect the lack of economic opportunities for uneducated people in the region. 74.2% (respectively 60.4%) of long-term migrants (respectively short-term migrants) had no basic schooling. On average, more women were involved in long-term migration (around 61.8%) than in short-term migration (about 40.8%). Households in Niakhar experienced an average of about three short-term migrations during the period of study (two male short-term migrations vs one female short-term migration). Long-term migration was rare in these households over the period of study (0.4 long-term migration on average) (Table 2).

Table 1: Characteristics of Individual migration in Niakhar between 1998 and 2013

	Long migration	Short migration	Non-migrant
Average age of migrant	**17.4**	**25.9**	**22.3**
	(14.03)	(10.895)	(18.74)
Proportion (%) of male outmigration	**38.2**	**59.20**	**51.20**
	(.04)	(.04)	(.03)
Proportion (%) of female outmigration	61.8	40.8	48.8
	(.07)	(.03)	(.02)
Education			
No schooling	**.74**	**.60**	**.55**

residents; students whose parents reside in the region are residents in their parents' compound; students whose parents reside outside the zone are resident in the compound where they are entrusted.

[4] Non-migrant did not necessarily refer to people who have never migrate but to the household member who was not involved in migration during a year.

	(.04)	(.04)	(.05)
Preschool and Primary	**.16**	**.22**	**.24**
	(.03)	(.01)	(.05)
Middle and secondary	**.06**	**.09**	**.14**
	(.03)	(.04)	(.03)
Koranic	**.03**	**.07**	**.06**
	(.02)	(.01)	(.01)
University	**.004**	**.01**	**.01**
	(.002)	(.003)	(.001)
Number of individuals involved	**10681**	**17114**	**39858**

The numbers in brackets are standard deviations
Source: Authors' calculations using HDSS data

Table 2: Characteristics of household members' migration in Niakhar between 1998 and 2013

	Long migration	Short migration
Mean number of out migrations from any member of the household	**.38**	**2.94**
	(.97)	(2.66)
Mean number of female out migrations from any female member of the household	**.223**	**1.18**
	(.64)	(1.45)
Mean number of male out migrations from any mal member of the household	**.15**	**1.76**
	(.50)	(1.88)
Number of households involved	**1492**	**2737**

The numbers in brackets are standard deviations
Source: Authors' calculations using HDSS data

4. Empirical strategy

4.1. The general specification: a fixed-effect model with lagged variables

Econometric models traditionally face a major problem that may affect the statistical inference process: the endogeneity issue. Apart from measurement errors, there are two principal causes of endogeneity: unobserved (omitted) variables and the reverse causality problem. Here, to investigate how migration may affect under-five mortality in the Niakhar region, we ran this general equation:

$$ChildMortality_{uvt} = \beta_0 + \beta_1 Mig_{uv(t-1)} + X_{lvt} + \pi_u + \upsilon_t + \varphi_{vt} + \varepsilon_{uvt} \quad (1)$$

The indices u, v, t, stand respectively for the units (compound, household or individual), the village and the year. Binary variables π_u are time-invariant micro-units' specific effects, included to deal with the omitted variables issue; they control for the unobserved heterogeneity plausibly existing among the micro-decisional units (compounds or households) who are involved in the two main events under investigation: migration and under-five mortality. Indeed, the literature emphasizes the role of socioeconomic variables while studying infant mortality. Thanks to this fixed-effect design, we can control for all (time-invariant) inter-unit heterogeneity, studying only the variations that can be attributed to distinctive (past) families' migration patterns. In general, fixed-effect designs allow overcoming the problem of unobserved heterogeneity (Hsiao, 2014). In the same vein, we have v_t, time-specific effects common to all the micro-units, for any plausible unobserved shock occurring at a given point of time. In particular, they can account for unobservable factors that may influence the downward trend in under-five mortality observed in SSA. Finally, we have φ_{vt}, time-variant village-specific effects which include unobservable factors at the village level that could change with years, such as climate variations, the main determinant of household wealth in the region (Lalou et al., 2015) which is unobserved in our case.

To avoid the reverse causality problem, we used lagged migration variables in place 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 allows us to control the potential multicollinearity that may exist between the primary independent variable and the control variables measured at year *t*.

4.2. Other details on the regression methods

To focus specifically on the questions addressed 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 respectively for the child, the mother, the household, the compound household *h* belongs to, the village and the year.

Equation 2 investigates the link between under-five mortality and migrations at the compound level.

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

Equation 3 investigates the link between under-five mortality and migrations at the household level.

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

In equation 4, in addition to migrations at the compound level, we add an interaction term between migration at the compound level and migration at the household level. The objective is to bring to light all possible crossover effects between the migrations of the household and those of its compound.

$$ChildMortality_{hvt} = \beta_0 + \beta_1 Mig_{hv(t-1)} + \beta_1 Mig_{c\_hv(t-1)} + \beta_3 Mig_{hv(t-1)} \times Mig_{c\_hv(t-1)} + Z_{hvt} + \pi_h + v_t + \varphi_{vt} + \varepsilon_{hvt} \qquad (4)$$

The last equation (5) focuses on mothers' migration decisions at the individual level. It investigates how a mother's short-term migration affects her child survival. Besides, it allows to estimate to what extent this effect is depending on the age of the child. We focus on mothers' short migrations here because mothers are reported to rarely leave their children for a long period.

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

As the dependent variables are discrete-time variables (see section 4.3.1), the model could have been estimated using a logistic or probit regression. A linear probability model allows us to cluster our error terms in equations 2, 3, 4 and 5, ε_{cvt}, ε_{hvt}, and ε_{imhvt}, respectively by compound and household, to take into account the fact that observations may be related within compounds or households. However, we propose –tables 9 and 10 in the appendix- some variants of the model using Logit regression, Poisson regression, and Survival analysis regression methods rather than the linear probability approach.[5]

4.3. The variables

4.3.1. Dependent variables

In equation 2, the dependent variable, $ChildMortality_{cvt}$, represents a dummy variable coded 1 if there is at least one child aged between 0 and 5 who dies in compound *c* in village *v* in year *t*. It is the same in equations 3 with $ChildMortality_{hvt}$, but at the household level. As previously stated, we focus our analysis on households with at least one child aged 0 to 5 during the period of study.

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

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

4.3.2. Primary independent variables

The primary independent variable in our equations is migration. In equations 2 and 3, we include two migration variables: $Mig_{cv(t-1)}$ the total number of migrations (long- or short-term) by individuals living in compound *c* in year *t-1,* and $Mig_{hv(t-1)}$, the total number of migrations by individuals from household *h* in year *t-1*. In equation 4, in addition to $Mig_{hv(t-1)}$, we include the total number of migrations by individuals from neighboring households belonging to the same compound as household *h,* $Mig_{c\_hv(t-1)}$.

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

4.3.3. **Control variables**

In equations 2, 3 and 4, we control for the number of children at risk aged 0 to 4, the number of children aged 5 to 12, the number of working age women and men, the number of old men and old women (60+). Information on the kinship within the household is updated each year. If there is any change, it will be captured with an update in the household demography and the household migration. Indeed, the household age structure is important as every age-class has a specific role to play in the domestic production function of the household (e.g. young girls and boys in the household could help take care of their siblings, while adults could help in day to day work). These demographic characteristics at household and compound levels are respectively represented in our equations by time-varying matrices X_{cvt} and Z_{hvt}.

In equation 5, in addition to demographic characteristics at the household level, we include the number of siblings of child *i* of mother *m* in the household[6]. Moreover, we control by age of child *i* in year *t*, Age_{imhvt}, to investigate the impact of the mother's short-term migration on her child's mortality risk for each age group. Other unobservable factors could also influence child mortality at the household or individual level; however, thanks to the fixed-effect design, a lot of time-invariant characteristics of the households are already included as controls in our models.

[6] Note that the number of children aged 0 to 5 years in the household is deducted from the number of siblings of child *i*.

5. Results

5.1. Effects of compound and household level migration on child survival

The first question addressed in this paper is whether both long-term and short-term migration influence under-five mortality in rural areas.

Table 3 gives the estimations from equations 2 and 3, where we included short-term and long-term migrations both at the compound level and at the household level. Columns 1 and 2 show a negative and significant correlation between child mortality and short-term migrations, observed at the compound level and at the household-level. Estimates for long-term migrations (which are rare, table 2) are non-significant at the household level and positive at the compound level[7]. We, therefore, focus on short-term migration, distinguishing male and female migrations to capture the gender-specific effect of migration.

Table 3: Migrations (long & short terms) and child mortality, in the compound or the household, 1998-2013

	Compound level	Household level
Mean value of the dependent variable	*0.081*	*0.045*
Number of migrations		
Short migration	-0.004***	-0.003***
	(.001)	(.000)
Long migration	0.009***	0.001
	(.002)	(.002)
Household demography	Yes	Yes
Compound | household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Year × Village fixed effects	Yes	Yes
Observations	33949	43055
Number of groups	2295	3512

The numbers in brackets are robust standard errors
* $p < 0.10$, **$p < 0.05$, ***$p < 0.01$
Interpretation for mean value of the dependent variable: 8.1% of the compound have at least a household with a death child and 4,5% of the household have at least a death child.
Source: Authors' calculations using HDSS data

Table 4 gives the estimations from equation 3, focusing on short-term migrations of active household members and distinguishing between genders. Column 1 shows estimations for the

[7] These positive values seem to show that extended absences are not beneficial for the wellbeing of the child, at least at the compound level. However, these events are so rare (extreme), that they could simply reveal the extreme fragility of the unit. Also, regression results using other specifications (section 4.2) --in Appendix-- show no significant association between long-term migrations and child mortality.

whole sample, with a negative and significant correlation at the household level between active male/female short migrations and child mortality. In column 2, the correlation concerns households living in compounds with at least 2 households and the same results are observed. For the sake of completeness, we also cover households belonging to a compound of size one (column 3)[8], where the correlation between migrations and child mortality loses its significance. Thus, the significant correlation observed in the whole sample between short-term migrations and child mortality is likely driven by households belonging to compounds composed of more than one household. While the non-significance of the correlation for single-household compounds could be due to a problem of statistical power[9] (column 3), the results shown in table 4 may highlight the importance of neighboring families' support within the same compound. To test this hypothesis, we focused on households in compounds of size two or more and included migrations at the compound level in the regressions estimated at the household level, to detect potential externalities between the families of the compound (Table 5).

Table 4: Household members' short-term migrations and child mortality in the household, 1998-2013 (Linear Probability Model)

	Whole sample	2 households or more in the compound	1 household in the compound
	1	2	3
mean value of the dependent variable	*0.045*	*0.047*	*0.044*
Number of migrations, household level			
Working age women's migration	-0.003**	-0.003*	-0.003
	(.001)	(.001)	(.002)
Working age men's migration	-0.002**	-0.003**	-0.001
	(.001)	(.001)	(.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
Observations	42622	25074	17548

[8] These types of households constitute a compound in themselves, because of their size (a large number of family member in the household)

[9] Focusing on households that belong to concessions of size one considerably reduces sample size and therefore could affect estimates. However, the "single household compounds" are also particular and these particularities could explain *per se* the loss of significance. For example, the fact that they are unique in the concession means that they cannot benefit from the help of neighboring households to look after their children, which indeed could create heterogeneous effects of migration on child survival.

Groups*	3512	2037	1607

*The loss in the number of groups are due to the use of unbalanced panel, that can be observe also in the subsamples. To ensure consistency in subgroups, one should look at the number of observations. Note also that the maximum number of groups is 3664
The numbers in brackets are robust standard errors.
* $p < 0.10$, **$p < 0.05$, ***$p < 0.01$
Interpretation for mean value of the dependent variable: 4.5% of the household have at least a death child.
Source: Authors' calculations using HDSS data

Table 5 presents estimations from equation 4, revealing possible "crossover effects" between household- and compound-level migration events (externalities between households from the same compound). Column 2 replicates column 1 but distinguishes migrations by gender. Column 1 of the table shows a negative and significant correlation between household-level and compound-level short-term migrations and child mortality. In column 2, we observe a significant and negative correlation at household level between active men's and women's short-term migrations and child mortality. Note that the coefficient of active female short-term migrations is higher than that of active males. Besides, the correlation between child mortality in the household and short-term migrations occurring in neighboring households in the compound is also significant, as shown in column 1.[10] (We obtain the same conclusions while computing sensitive test using a Logit and Poisson regression models, table 10 in appendices).

Columns 3 and 4 give estimations when splitting the population respectively into "poor" and "rich" households, separated into two groups according to a list of assets owned (or not) by households, such as radios, cooking fuel, phone, fridge, television, bicycle, motorcycle or car[11]. We observe a significant and negative correlation between men's and women's short-term migrations and child morality in column (3 – "poor") contrary to what we observe in column (4 – "rich"). Besides, the coefficient of compound short-term migrations is significant and negative for both groups. To sum up, the beneficial results of migration –observed at the household level– seems then to be driven by the poorest households of our sample.

Table 5: Short migrations in the household and the compound and child mortality in the household within compounds of size two or more, 1998-2013 (Linear Probability Model)

	All (1)	All (2)	Poor (3)	Rich (4)
Mean value of the dependent variable	*0.047*	*0.047*	*.044*	*.052*
Number of migrations, household level				
Short migration	-0.004***			
	(.001)			
Working age women's migration		-0.005**	-0.008***	-0.002

[10] However, the positive and significant coefficient of the interaction term between household short-term migrations and compound short-term migrations indicates that both migrations occurring at the same time (household and compound) have a weaker *aggregate* effect than the addition of their two *separate* effects.
[11] The consumer assets poverty index was built using the methodology describe by Anderson (2014).

		(.002)	(.003)	(.003)
Working age men's migration		-0.003*	-0.005**	-0.001
		(.0012)	(.002)	(.003)
Number of migrations, compound level				
Short migration	-0.002***	-0.002***	-0.002***	-0.002**
	(.001)	(.001)	(.001)	(.001)
Interaction, Household × compound				
Household short migration × compound short migration	0.001***			
	(.000)			
Working age Women's Migration × compound short migration		0.001**	0.001	0.001**
		(.000)	(.000)	(.000)
Working age Men's migration × compound short migration		0.000	0.001**	-0.000
		(.000)	(.000)	(.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	25074	25074	16199	8875
Households involved	2037	2037	1388	649

The numbers in brackets are robust standard errors.
* p < 0.10, **p < 0.05, ***p < 0.1
Interpretation for mean value of the dependent variable: 4,7% of compound with 2 or more households have at least a household with death child. (col. 1 and 2).
Source: Authors' calculations using HDSS data

5.2. Effect of maternal migration on child survival

The last table (Table 5) shows a stronger correlation for working-age female short migrations than for short migrations by working-age males, implying the importance of female migrations, particularly for women of reproductive age, in reducing child mortality. This raises another question: *what if it is the mother that migrates*? In this section, we select mothers from our main sample of working age migrants, and we focus on how their short-term migrations may impact their own children's mortality. To do so, we apply equation 5, which uses information on the parental link between members of a household.

Table 6 gives estimations from equation 5, with and without interaction between a mother's migration and the age of her children[12]. In column 1, we present full results. We observe a negative and non-significant correlation between a mother's migration and her children's

[12] We have included information on relatives' short migrations (column 4, table 6) and controls unobservables such as maternity clinics using village×times fixed effects.

mortality when we do not stratify the analysis for the age of the children. The correlation becomes significant when controlling for the age of the child and the number of migrations at the household level and compound level (columns 2-4). However, this correlation is affected differently according to the age of the child. To more clearly highlight the difference, we computed the marginal effect for each child age group (table 7).

Table 6: Effect of mother's short migration on own child's mortality in the household (Linear Probability Model)

	1	2	3	4
Mean value of the dependent variable	*0.023*	*0.023*	*0.023*	*0.023*
Mother's short migration	-0.000	-0.004***	-0.004**	-0.004***
	(.001)	(.001)	(.001)	(0.001)
Mother's short migration × Child's age (Ref 0-year-old)				
1 year old		0.007***	0.006***	0.008***
		(.002)	(.002)	(0.002)
2 years old		0.007***	0.006***	0.006***
		(.002)	(.002)	(0.002)
3 years old		0.005**	0.003*	0.004**
		(.002)	(.002)	(0.002)
4 years old		0.004*	0.001	0.000
		(.002)	(.002)	(0.001)
Household migrations × Mother short migration				0.001**
				(0.000)
Compound short migration × Mother short 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	123144	123144	123144	123144
Number of children	30749	30749	30749	30749
Number of mothers involved	4620	4620	4620	4620

The numbers in brackets are robust standard errors
* $p < 0.10$, **$p < 0.05$, ***$p < 0.1$
Interpretation for mean value of the dependent variable: 2.3% of child death in compound with 2 or more households.
Source: Authors' calculations using HDSS data

Table 7 presents the marginal effect of the link between mother's short-term migration and her children's mortality for different child ages under the empirical strategies used in columns 2, 3 and 4 of table 6. We still observe a negative and significant correlation between a mother's short-term migrations and her child's mortality for a child aged 0 or 4, together with a positive and significant correlation between a mother's short-term migrations and her child's mortality for a child aged 1 or 2[13]. As we are using lagged variables for migration, this situation can be interpreted as follows: on average, *ceteris paribus*, a mother's migration during her pregnancy appears to increase her child's chances of survival over the first 12 months of his life. However, if the mother migrates when her child is 0-year-old (respectively 1 year old), this appears to increase the future mortality risk of her child at age 1 (respectively 2)[14].

Table 7: Marginal effects of mother's short migration on own child's mortality by child age in the household

	Model 2		Model 3		Model 4	
Child's age	Marginal effects	P>z	Marginal effects	P>z	Marginal effects	P>z
0-year-old	-.004 ***	0.000	-.003***	0.008	-.004***	0.004
1 year old	.003**	0.041	.003**	0.037	.004**	0.019
2 years old	.003**	0.014	.003**	0.035	.003**	0.046
3 years old	.001	0.436	.000	0.966	.001	0.720
4 years old	-.001	0.675	-.002*	0.070	-.003***	0.000

* p < 0:10, **p < 0:05, ***p < 0:01
Interpretation of the marginal effect: mother migrations at t-1 reduce the probability of child mortality by 0.004 at time t when the child is aged 0-year.
Source: Authors' calculations using HDSS data

6. Discussion

While many studies compare child health outcomes in urban areas for migrant families with child health outcomes in rural areas for non-migrant families, others explore the relationship between migration and health outcomes of children who migrate, or children born in migrants' destinations after settlement (Brockerhoff, 1990; Brockerhoff, 1994; Hildebrandt et al., 2005; Kanaiaupuni and Donato, 1999). Our work examines short- and long-term migrations in rural areas to answer the following question: how do migrations of household members affect the mortality of children under five who remain behind? Thus, this paper contributes to the literature by assessing the potential benefits of migration for children who remain in the village. An important added-value of the study is its panel data structure; the statistical design, made of

[13] Note that for children aged one year, they are aged one year when they are observed in year t while their mother left in year t-1 (when children were 0 to 11 months).

[14] While considering the total number of days spend by the mother in place of the total number of out-migration, we come up with the same conclusions: An increase in the number of days spent outside the village is associated with an increase in the chance of survival over the 12 first months of the child. However, if the mother increases the number of days spend outside when her child is 0-year old, she decreases the survival chance of her child at 1 and 2 years.

systematic use of fixed-effects, allows to extract from the variations in child-health only the part that can be attributed to distinctive (past) families' migrations patterns.

The first part of our results illustrates the importance of distinguishing two types of migrations (long- and short-term) to explore links between child mortality and migration in rural areas. A strong correlation was observed between short-term migrations and child mortality. The correlation was robust across all the two micro-units used to measure it (compound and household), contrary to what was observed with the rarer long-term migrations. This may imply that short-term migration can be seen as a mechanism acting in rural villages to improve child wellbeing –at least, it seems to reduce child mortality to a significant extent. Interestingly, we also found a negative and significant correlation between child mortality in a given household and short-term migration from other households belonging to the compound (although this potential effect is mitigated when, within the household, short-term migrations also increase in parallel). This result points to crossover effects between networks of families. It 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 simply childcare" within the larger neighboring community (Fafchamps and Lund, 2003; Platteau, 1997; Baland and Platteau, 1998).

Gender may also make a difference: the relative level of the coefficient of active women's migrations compared to active men's migrations supports the hypothesis that women migrants play a more important role in child mortality reduction. This asymmetry in the observed effects seems to suggest that the benefits of migration are differently distributed in the household economy according to whether migrants are men or women. When women migrate, the benefits to children's wellbeing are more marked. This result is consistent with the literature on women's empowerment in rural societies: empowering women has been shown to contribute to improving some aspects of children's welfare (health and nutrition in particular) (Duflo, 2012; Sethuraman et al., 2006; Lépine and Strobl, 2013; Imai et al., 2014). However, when women increase their labor-market activities, there are some exceptions depending on the job-type and on the age of the children (Braumer-Otto et al., 2019).

The second part of our results concerns the mother's short-term migration and its effect on the mortality risk of her children who remain behind. A mother's migration seems to improve her children's probability of survival, but not at all child ages. We actually found that 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, we found that if the mother migrates leaving her very young child (0 or 1 year old the year of migration t-1) behind, she does not succeed in decreasing that child's mortality risk over the following year of the child's life. On the contrary, the risk tends to increase, as already shown by Yabiku et al. (2012) but without disentangling short-term vs long-term migration effects.

There are several plausible explanations for the different findings from our analyses, involving different mechanisms. In the development economics literature, the most important factor is remittances (Stark and Lucas, 1988; Lucas, 1997). Household members who migrate, particularly workers, bring back money that can be used to increase the wellbeing of all family members, and in particular, enhance young children's nutritional intakes and/or access to healthcare facilities. It is perfectly conceivable that this will lead to a reduction in child mortality in the household. The fact that there is also 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 of income from labor act as contingent repayments in the event of negative shocks (Lucas and Stark, 1985; Stark and Lucas, 1988; Gertler and Gruber, 2002). Another plausible mechanism is better maternal care practices (Lindstorm and Munoz-Franco, 2006; Elo, 1992), particularly for women of procreation age. During their period of migration, working age women may learn better childcare practices, more easily accessible in urban areas which could later be beneficial to children left behind. Pregnant women may also enjoy better pregnancy monitoring and learn better post-natal childcare practices during their stay in big cities. However, the absence of the mother can also reduce the time allocated to child care, increasing psychological stress among children and change in the feeding practices (Nguyen, 2016). These are the most probable mechanisms underlying the complex relationship found in the regressions estimated on migrating mothers.

Although this study enables us to draw salient conclusions, it also has some limitations that suggest useful future research directions. First, our study does not explicitly analyze the mechanisms behind the transmission of effects from migrations to survival probabilities, such as remittances or health care practices. To do so would require regular records of the flow of remittances received by households, not covered by the Niakhar database so far. Moreover, the child's health outcome variable could be more specific. Indeed, between good health and death, there is a health continuum that needs to be analyzed. Here we used child mortality, which is an important outcome, well documented in a demographic observatory, and easy to handle in quantitative studies. However, the development economics literature indicates that the quality of children's health is an important factor for education and economic progress. A second limitation could come from the 'nature' of the econometric relation that we found: correlation does not imply causation. From a technical point of view, a fixed-effect model design associated with lagged variables has been used to control for endogeneity and deal with selection issues. But one may still think that child mortality at year *t* is connected to migration at year *t-1* through a pre-existing bias in child's health at *t-1*. In other words, families needing more financial resources could have decided to migrate, at time t-1, *because* their child was ill, at time t-1 (reverse causality). However, as the main causes of child mortality in the region are infectious diseases (Delaunay et al., 2001)[15], it lessens the risk of a reverse causality effect on migration variables. Also, in case of child illness, this is mostly the father, or a relative, who migrate to assist the mother financially; thus, our results on mother's migrations should address this selection issue.

We are planning to extend this work by incorporating the role of the father's migration and by looking at the long-run impact of migration on other child health outcomes. Also, investigating other child health outcomes, both within their own family and in more distant surroundings, would be an interesting complement to the literature on migration and child health in rural areas in Sub-Saharan African countries.

Appendices:

Long-term migrations and child mortality

Table 8 presents the estimations of equation 4 using long-term migration as the main independent variable. We observe insignificant coefficients, meaning that we do not have enough evidence to establish a correlation between long-term migration at time t-1 and child mortality at time t at the household level.

Table 8: Household and compound long migrations child mortality in the household, 1998-2013

Dependent variable: dummy for child mortality in the household		
mean value of the dependent variable	*0.047*	*0.047*
Number of Migrations, household level		

[15] Malaria or cholera are sudden and acute; thus, this limits the connection of the child's health status at time *t-1* with mortality risk in time *t*.

Household migrations	-0.002	
	(.002)	
Working age women's migration		-0.004
		(.004)
Working age men's migration		0.001
		(.005)
Number of Migrations, compound level		
Compound migrations	0.000	0.000
	(.002)	(.002)
Interaction, Household × compound		
Household migrations × Compound migrations	0.001	
	(.002)	
Working age women's migrations × Compound migrations		0.001
		(.002)
Working age men's migrations × Compound migrations		0.001
		(.003)
Household demography	Yes	Yes
Household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Year × Village fixed effects	Yes	Yes
Observations	25074	25074
Household involved	2037	2037

The numbers in brackets are robust standard errors.
$* p < 0.10$, $**p < 0.05$, $***p < 0.01$
Source: Authors' calculations using HDSS data

Sensitivity analysis: Logit and Poisson regression models

Note: In the Logit regression, the dependent variable is a dummy for child mortality (1 if there is at least 1 under-5 mortality in the household and 0 otherwise). In the Poisson regression, the dependent variable is the number of under-5 mortality observe in the household for a specific year. Also due to convergence problems, villages×times year fixed effect was not included in the logit model. The conclusions are the same and corroborated the findings using the linear probability models in table 5.

Table 9: Link between household short-term migration and child mortality in the household

	Logit		Poisson	
	1	2	3	4
Number of migrations, household level				
Household migrations	-0.090***		-0.073***	
	(.022)		(.019)	
Working age women's migration		-0.132***		-0.110***
		(.045)		(.037)
Working age men's migration		-0.064**		-0.053*

		(.032)		(.028)
Number of migrations, compound level				
Concession migrations	-0.056***	-0.056***	-0.065***	-0.064***
	(.0113)	(.0112)	(.0119)	(.012)
Interaction, household × concession				
Household migrations × compound migrations	0.006***		0.006***	
	(.001)		(.001)	
Working age women's migrations × compound migrations		0.010***		0.011***
		(.004)		(.002)
Working age men's migrations × compound migrations		0.004		0.003*
		(.003)		(.001)
Household demography	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes
Years fixed effects	Yes	Yes	Yes	Yes
Year × Village fixed effects	No	No	Yes	Yes
Error clustered	No	No	Yes	Yes
Observations	11417	11417	18979	18979
Number of groups	785	785	476	476

The numbers in brackets are robust standard errors.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' calculations using HDSS data

Survival analysis:

This table gives the estimates of the effect of mothers' short-term migrations on their own children's mortality, using survival analysis. The equation used for estimates here is the following:

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

$\log(h_{imt})$ is the conditional failure rate. It is the instantaneous rate at which a 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 the total number of short-term migrations by the mother of child *i,* one year before his incorporation in the study and just before the date of his exit. X_{mv} is the vector of other control variables.

The results show that, at 0-year, there is a significant and negative association between mothers' short-term migrations and the instantaneous probability of the child mortality event (first column), 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 is statistically significant.

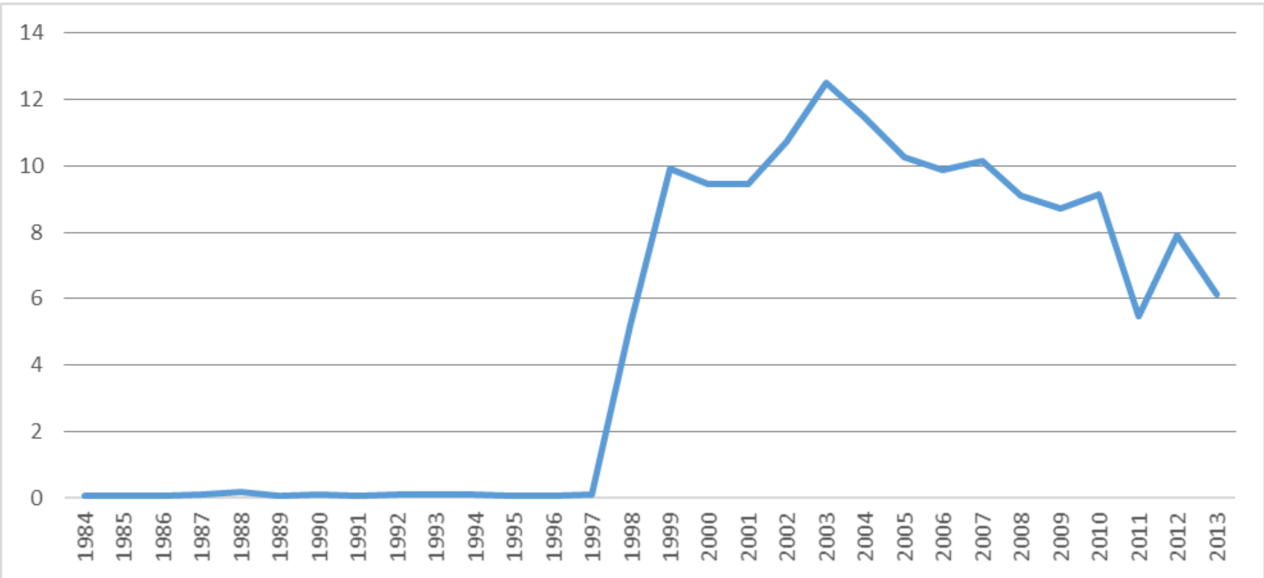
Table 10: Effects of mother's short-term migration on child mortality for each age group

Dependent variable: Days before the death event occurs					
	0 year	1 year	2 year	3 year	4 year
Mother short migration	-0.487***	0.030	-0.048	0.140	0.174
	(.126)	(.099)	(.107)	(.151)	(.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	17380	15404	14191	12735	11714
Number of failures	670	426	326	131	82

The numbers in brackets are robust standard errors
* p < 0:10, **p < 0:05, ***p < 0:01
Source: Authors' calculations using HDSS data

Migrations trend in Niakhar

Figure 1: Short-term migration rate in Niakhar



Note: Short-term migration rate is the total number of short-term migrations in person-year divided by the total number of residents in person-year.

Figure 2: Number of long-term migrations in Niakhar (source: Authors' calculations using HDSS data)

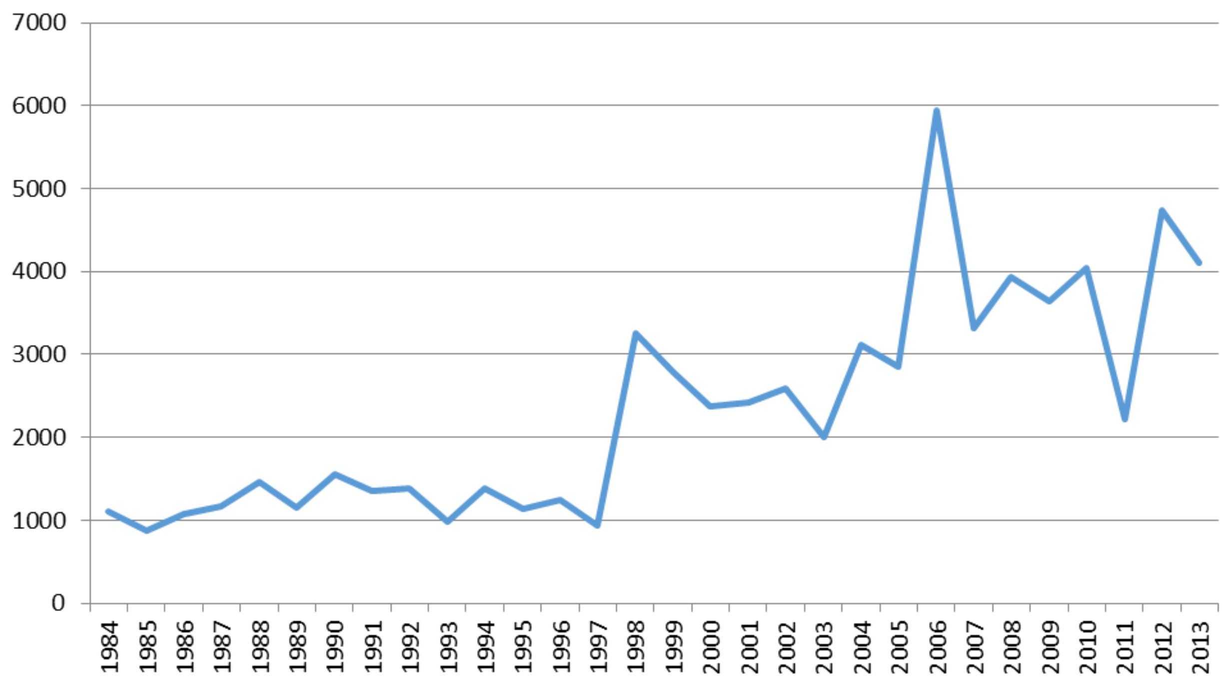
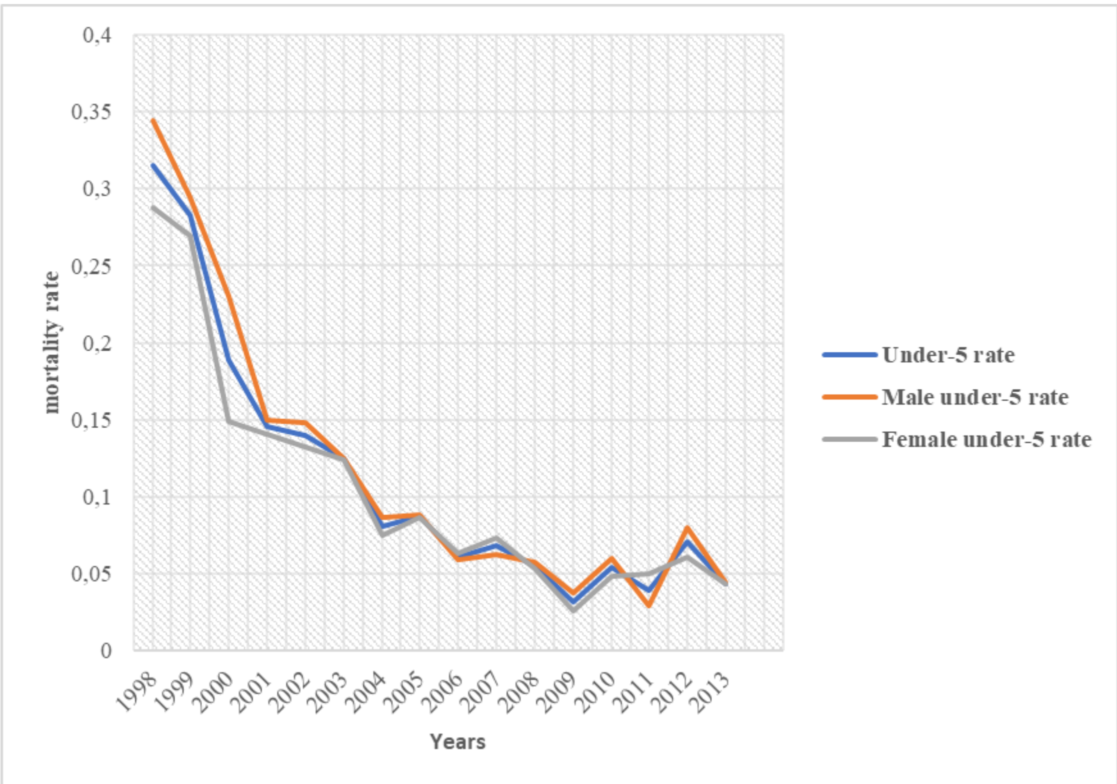


Figure 3: Under-five mortality trend by gender, Niakhar 1998-2013 ((source: Authors' calculations using HDSS data)



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