AIDDATA
A Research Lab at William & Mary

WORKING PAPER 94

May 2020

Impact of Development Aid on Infant Mortality: Micro-level Evidence from Côte d'Ivoire

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Abstract

The empirical literature has failed to reach consensus on the impact of aid on development outcomes based on aggregate cross-country analysis. This study follows the current trend in the literature on the effectiveness of aid to examine the impact of local-level aid on health outcomes. It combines data on World Bank's geo-located aid projects with three rounds of Demographic Health Surveys from Côte d'Ivoire and uses difference-in-difference estimation techniques to explore the effects of aid on infant mortality. The results show that proximity to development aid projects is associated with reduced infant mortality. The results hold whether we consider proximity to any aid project or specifically water and sanitation projects. They are also robust to inclusion of mother fixed effects in the model. The evidence suggests that access to prenatal and postnatal healthcare are possible mechanisms through which aid may have negative effects on infant mortality.

Keywords: *Aid, infant mortality, Côte d'Ivoire*

JEL: *F35; I15; O55.*

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1. Introduction

Infant mortality rate is an important metric for assessing the effectiveness of a country's healthcare system and its level of economic development. However, despite significant commitments by the global community to reduce mortality among children in the context of the 2000 Millennium Development Goals and the 2015 Sustainable Development Goals, 5.4 million children died before their fifth birthday in 2017 (UN IGME, 2018), most of which from preventable causes. Sub-Saharan Africa alone accounted for 50 per cent of these deaths, a rate that is estimated to reach 60 per cent by 2050 (UN IGME, 2018).

Building on recent surge in economic growth following many years of political instability, the Ivorian government adopted a National Development Plan (NDP) for the 2016-2020 period, with the stated goal of the country becoming an emerging economy by the year 2020. To support the country's efforts, international donors pledged $15.4 billion in grants and loans (World Bank, 2017). However, while infant mortality rate has fallen from 104 deaths per 1,000 live births in 1990 to 64 in 2017 (Figure 1), the country is not on track to reach the Sustainable Development Goal 3 of reducing infant mortality rate to 25 deaths per 1,000 live births by 2030 (UN IGME, 2018).

The apparent disconnect between increases in international aid and the pace of social development has fueled the debate on the effectiveness of foreign aid in improving development outcomes such as health and education. The lack of agreement is partly due to the mismatch between instruments and outcomes, as well as differences in methodological approaches employed in various studies. Empirical studies have

traditionally used aggregate level of aid and attempted to test its impact on aggregate outcomes such as economic growth in cross-country analyses. The results from this approach cannot allow to ascertain the link between aid and growth, given that many other factors unrelated to aid might influence growth (Odokonyero, Marty, Muhumuza, Alex, and Moses, 2018). Furthermore, aid interventions, for the most part, are delivered in the form of projects that respond to specific needs such as construction or improvement of roads or healthcare facilities, provision of anti-malaria mosquito nets, immunization campaigns, etc. This direct impact of aid may be more discernable at the sectoral level. Nonetheless, cross-country studies may be useful to understand the impact of per capita aid expenditure on health outcomes in poor countries, even though they may miss out on sectoral and project level information, which micro-level studies are better equipped to deal with (Kotsadam, Østby, Rustad, Tollefsen, and Urdal, 2018; Findley, Powell, Strandow, and Tanner, 2011).

To pursue the micro-level analysis, a number of recent studies have taken advantage of the availability of geo-located aid projects to assess the impact of aid on development outcomes. Odokonyero et al. (2018) examine the impact of aid in Uganda using a difference-in-difference approach with panel fixed-effects regressions applied to a combination of household surveys and geo-referenced subnational aid data. They find that aid is associated with a reduction in disease prevalence and in the number of days of productive work lost because of illness. Based on similar data and methodology, a study by Marty, Dolan, Leu, and Runfola (2017) finds that aid at subnational level reduces malaria prevalence and improves healthcare quality in Nigeria, while Kotsadam et al. (2018) reports that aid reduces infant mortality in that country.

This study follows the recent trend in the empirical literature by assessing the effects of aid at the subnational and sectorial level on infant mortality in Côte d'Ivoire. It combines two datasets: World Bank's geo-located aid projects from the Aid Data v1.4.2 from the Research Lab at William & Mary, which contains World Bank' aid projects at the district level starting from 1995 (AidData, 2017) ; three rounds of Demographic Health Surveys – 1994, 1998-1999, and 2011-2012. The study uses difference-in-difference estimation techniques to explore the effects of proximity to aid projects on infant mortality. Unlike cross-country studies that used aggregate level of aid, this study takes advantage of spatial and time variations in aid-funded projects and uses the difference-in-difference technique to estimate the impact of aid on child wellbeing in Côte d'Ivoire. Because some areas in the country received aid projects while others did not, this approach can mitigate possible estimation bias resulting from unobserved individual heterogeneity and time invariant individual characteristics as well as aid endogeneity (Odokonyero et al., 2018).

The case of Côte d'Ivoire is interesting because of the availability of a rich set of household surveys and sub-national aid data covering the period of analysis. To the best of our knowledge, no previous study has investigated the effects of local-level foreign aid on health outcomes in Côte d'Ivoire. In addition, even though an existing case study on Nigeria drew on the same datasets to examine the effect of subnational aid on infant mortality, the current paper differs in several ways. First, while the former defines aid projects occurring at 774 specific local government areas, this study focuses on 50 provinces in Côte d'Ivoire. This is particularly important because differences in mortality rates within countries can be hidden by geographical boundaries. Furthermore, considering fewer administrative units adds more precision and reduces the likelihood of

errors in the coding and selection of aid projects. Second, while both countries have seen a decline in infant mortality over time, the rates have been consistently higher in Nigeria (figure 1). Nonetheless, neither country is on track to meet the SDG 3.2 target of 25 deaths per 1000 livebirths by 2030. It is important to highlight these differences as project-level interventions that are effective in enhancing child health outcomes in some areas may not necessarily work in other contexts due to cultural or religious differences, justifying the need for more case studies.

Third, the current study is conducted following a decade of political instability in Côte d'Ivoire that was ignited by the 2010-2011 post-electoral violence. Instability has not only reduced the budget allocated to the health sector but also affected the demand and provision for health services, partly explaining why child mortality rates despite a decline from 125 per 1,000 live births in 2005 to 108 in 2012 (UNICEF, 2015; WHO, 2011).

As in Kotsadam et al. (2018), the results from our analysis show that proximity to aid projects is associated with reduced infant mortality. Whereas Kotsadam et al. (2018) consider vaccination or postnatal care as a possible transmission mechanism through which aid may affect infant mortality, we find in this study that both prenatal and postnatal care, education, and access to water and sanitation[3] are possible mechanisms. In addition, as a methodological innovation, rather than limiting ourselves to a 25 or 50 km radius in measuring distance from aid projects, we also experiment with different distance

[3] See Ndikumana and Pickbourn (2017) for an analysis of the impact of aid on access to clean drinking water and modern sanitation.

thresholds and confirm the robustness of the effect of proximity to aid projects on infant mortality.

The rest of the paper is organized as follows. Section 2 gives an overview of the literature on the relationship between foreign aid and development outcomes. Section 3 describes the data and the empirical methodology. Section 4 presents the results and discusses possible transmission mechanisms of the effects of aid on infant mortality, and section 5 concludes.

2. Literature Review

The vast empirical literature on foreign aid has failed to reach a consensus on the effectiveness of foreign aid in developing countries (Doucouliagos and Paldam, 2009). This lack of agreement stems mostly from the different methodological approaches adopted in past studies. A majority of studies have pursued cross-country analysis to examine the aid-growth relationship. For instance, Burnside and Dollar (2000) argue that foreign aid increases growth in developing countries that implement good fiscal, monetary, and trade policies. In contrast, Rajan and Subramanian (2008) find no robust positive relationship between aid and growth, regardless of the geographical location or the type of aid provided. A number of studies conclude that the impact of aid on growth is country-specific, and that it may operate through proximate determinants of growth such as physical capital accumulation and improvements in education and health outcomes, and and that it may depend on whether aid is given directly to a government or non-state actors such as NGOs (Juselius, Møller, and Tarp, 2014; Clemens, Radelet, Bhavnani, and Bazzi,2012; Mekasha and Tarp, 2013; Arndt, Jones, and Tarp, 2015;

Dietrich, 2011). While it may be true in theory that, by stimulating economic growth, foreign aid raises the living standards of the poor, leading to better health outcomes including infant mortality reduction, this mechanism is by no means guaranteed. Targeted interventions such as vaccinations or improved nutrition may be more effective in reducing infant mortality (Boone 1996; Sebastien and Sergio, 2015)

A relatively more recent approach in the aid effectiveness literature examines the impact of disaggregated foreign aid by sector on sector-specific outcomes such as health and education. In this spirit, Mishra and Newhouse (2009) used a panel of 118 countries from 1973 to 2004 and applied Generalized Method of Moments (GMMs) estimation techniques and found that foreign aid to the health sector reduces infant mortality. Similarly, Yogo and Mallaye (2015) concluded that health aid to 34 sub-Saharan African countries over the period 1990-2012 reduces HIV prevalence and child mortality. Gyimah-Brempong (2015) also found evidence of effectiveness of health aid in decreasing under-5 mortality rates in sub-Saharan Africa. Similarly, Pickbourn and Ndikumana (2016) concluded that a significant decline in maternal mortality in developing countries is attributable to an increase in health aid.

In contrast, a few number of studies found no evidence of an impact of aid on health outcomes. According to William (2008), Wilson (2011), and Kosack and Tobin (2006), development assistance for health has not been effective in reducing infant mortality. One issue that complicates the analysis of the impact of foreign aid on economic development is its potential endogeneity. As pointed out by Wilson (2011) aid may simply be chasing success with donors wanting the best bang for their buck. In other words, donors face a

temptation to allocate foreign aid to countries and areas within countries that have a track record of demonstrated capacity to manage and absorb it efficiently. If donors have a strong preference for good policy environment, then the aid-development relationship would run from health outcomes to foreign aid. However, if indeed donors' mission is to promote development, then from an operational perspective, they would allocate foreign aid on the basis of needs. Thus, foreign aid would go to countries and areas within a country exhibiting the lowest level of development or facing the highest levels of deprivation such as high infant mortality. Consequently, the relationship would run from foreign aid to development or health outcomes. The two scenarios buttress the issue of the endogeneity of foreign aid. In a study on the impact of health aid on infant mortality from diarrhea, Pickbourn and Ndikumana (2018) address the issue of endogeneity of aid by using lagged aid as an instrument of current aid. Appropriate diagnostic tests confirm the validity of the instrument. Other studies have also attempted to address the endogeneity of foreign aid using lagged aid as instruments and yet found mixed results regarding the effect of aggregate aid or sector-specific aid on infant mortality. Masud and Yontcheva (2005) for example, disaggregate foreign aid into two components: Bilateral aid and NGO aid. They conclude that only the latter leads to a significant reduction of infant mortality, the reason being that NGO aid bottom up approach makes it more effective at reaching the poor whereas bilateral aid is fungible. Therefore, bilateral health aid may be diverted from its intended goal and used for other non-aid financed government expenditures. This is also supported by Boone (1996) who shows that aggregate aid has no significant impact on infant mortality because of its capture by wealthy political elites. Nonetheless, countries with democratic political regimes have

30% lower infant mortality compared to repressive ones. Sebastien and Sergio (2015) also provide evidence that while total aid has no impact on child mortality, aid specific to the agricultural sector significantly decreases infant mortality.

Besides the potential two-way relationship between foreign aid and health outcomes, other methodological concerns related to the selected number of lags of the aid variable, sampling biases and the level of aggregation may potentially explain the inconclusive, and often biased results obtained in the health aid effectiveness literature. For these reasons, even studies aimed at identifying the relationship between disease-specific aid and disease-specific outcomes have also yielded conflicting results. For instance, Bendavid, Holmes, Bhattacharya, and Miller (2012) report that HIV-AIDS funding (PEPFAR) reduced HIV-specific mortality in Africa. And Hsiao and Connor (2015) concur that HIV-specific and malaria-specific funding reduces HIV and malaria related mortality in developing countries. However, other studies have shown that donors' prioritization of HIV funding crowd-out or divert resources from other health concerns (Shiffman, 2008; Lordan, Tang, and Carmignani, 2011). Lu et al. (2010) go even further by arguing that health aid in general can be an incentive for governments to reduce their own health spending. The crowding out and diversion effects of health aid on government spending may impede progress in health outcomes, yielding an apparent negative relationship between health aid and health outcomes.

Biases in the empirical analysis of the impact of foreign aid on development can also arise from mismatches between the intervention instrument (aid) and the target (development outcome indicators). Most foreign aid is allocated to finance projects or

programs at the sector level. These projects and programs are typically aimed at addressing particular development needs such as immunization, HIV prevention, water supply, education infrastructure, etc. Consequently, recent studies have taken advantage of the availability of aid data at the project level to undertake detailed analysis of the impact of foreign aid on specific development outcomes. Using this framework, Dreher and Lohmann (2015) find a significant correlation between geo-coded World Bank aid projects and economic growth measured as regional nighttime light. Similarly, Civelli, Horowitz, and Teixeira (2018) examine the link between household surveys and geo-located aid disbursements and conclude that aid has a positive and significant effect on nightlight luminosity. Kotsadam et al. (2018) also merge geo-located aid data and household surveys in Nigeria and observe that proximity to subnational aid projects reduces infant mortality, and more so in rural areas and in predominantly Muslim areas. Their findings suggest that aid allocation may help reduce horizontal inequality. While they argue that wealth, access to work and education are potential mechanisms through which foreign aid reduces infant mortality, they also recognize the need for more case studies for more in-depth analysis of the effect of local-level foreign aid on development outcomes, and to examine the type of projects that are associated with higher gains in health outcomes. The present study follows this strand of the literature on aid effectiveness by examining the effect of foreign aid at the subnational level on child mortality in Côte d'Ivoire and by exploring possible mechanisms through which this effect may materialize.

3. Data and Methodology

3.1. Data

The data used in this study to assess the effects of foreign aid at the subnational level on infant mortality in Côte d'Ivoire come from two sources: the AidData project and the Demographic Health Surveys.

The AidData v1.4.2 is available online at the Research Lab at William & Mary, and it contains World Bank' aid projects at the district level. The aid projects covered in the dataset run from 1995 to 2014 with specific start and end dates, as well as GPS information on the exact location of each project. As described in Table 1, aid projects are in various sectors, including water and sanitation support, health, education, agriculture, government and civil society, banking and other services. The dataset includes a total of 144 aid projects over the period 1995-2014. Some of the projects in health, agriculture, energy, education and banking take place in a single location while those in water and sanitation, other infrastructure and government and civil society appear in more than one location in the same district.

The aid dataset is combined with survey datasets consisting of the children samples of the three rounds of the DHS, namely 1994, 1998-1999 and 2011-2012. The DHS datasets contain 3,998 observations in 246 clusters in the first round, 1,992 observations in 248 clusters in the second round and 7,776 observations in 352 clusters in the third round. Even though the surveys do not track the same individual over time, they are still representative of the children across the country. These surveys provide information

about the child, the mother, and household characteristics. The statistics in Tables 2a-2c show that there is a significant difference in the proportion of children who died before their first birthday between those living in the vicinity of aid project sites versus those living farther away from them.

Because the wealth index is not available for each survey round, we use assets available across the three surveys such as access to radio, TV, fridge, bicycle, motorcycle, car, toilet and finished floor. We constructed an asset index using the principal component analysis. The wealth quintiles range from 1 to 5, where 1 is the poorest quintile and 5 is the wealthiest. We code the wealth index as a binary variable – poor or not poor – where poor households are those leaving in the lowest two quintiles. Tables 2a-2c also show significant differences in almost all the child and household characteristics including immunization status, poverty status, mother's characteristics, ethnicity, religion, and rural residency. Those variables will be used as controls or mediating factors in the regression analysis.

An important advantage of using the three rounds of DHS surveys is that they contain the geo-localization of the household clusters in which the children were born. This enables us to match the DHS data with the georeferenced aid data. Figure 2 presents the distribution of aid projects (stars) and the DHS clusters (dots). It also shows the household clusters that are within a 25-km radius of an aid-funded project. According to the map, most of the aid projects are located in the southern and central parts of the country. The map in Figure 3 overlays infant mortality and aid project locations. The map illustrates

substantial variations in infant mortality across the country. It also shows that many areas with the highest mortality rates hosted few projects or no projects at all.

3.2 Empirical Methodology

To determine the effect of aid projects on infant mortality at the subnational level, we take advantage of the spatial-temporal nature of the dataset and use a difference-in-difference estimation strategy. We specifically test whether the likelihood of a child dying before reaching his/her first birthday is influenced by whether he/she was born in the vicinity of an aid project implemented during the period 1995-2012. The information on aid projects is available for the period 1995-2014. However, since the child's year of birth in the surveys ranges from 1991 to 2012 and aid projects are available from 1995 onward, children born between 1995 and 2012 and exposed to an implemented or an ongoing aid will be assigned to the treatment group. The control group will refer to children born between 1995-2012 but not in the vicinity of a completed or an ongoing project. Children born before 1995 are dropped out the sample.[4]

The empirical model is specified as a linear probability of a child dying before the first birthday. For a child i born in provinces or departments j and cluster v, at time t, the model is specified as follows:

[4] It should be noted that the selection of the 1995-2012 time period does not mean that no World Bank projects, or any other government-financed aid project was implemented before 1995 or after 2012. That will, of course, affect the choice of the treatment and control groups. However, those groups were selected based on the data available. This may be revised if more data become available.

$$InfantMortality_{ijvt} = \beta_1\left(Aidproject50km_{jv} * BorrnduringAidproject_t\right) + \theta\, \boldsymbol{X_{ijvt}} + \alpha_j + \delta_t + \lambda_{jt} + \varepsilon_{ijvt} \qquad (1)$$

In the above equation, *InfantMortality* is a binary variable equal to 1 if the child died before his/her first birthday (12 months), ***X*** is a vector of child, mother, and household characteristics, δ_t represents the birth-cohort fixed effects (year of birth fixed effects), α_j stands for the district or province fixed effects, and ε_{ijvt} is a random error term. *BorrnduringAidproject* is a binary variable for children born between 1995 and 2012 or

during an implemented or an ongoing aid project.

$Aidproject50km_{jv}$ (or $Aidproject25km_{jv}$) is a dummy variable taking the value 1 if the child lives in a cluster that is located within a 50km (or 25 km) radius from the project location. The term λ_{jt} represents province-year of birth effects (i.e., the interaction of year of birth dummies with province fixed effects) to capture pre-existing province-specific trends in cohort mortality. The vector of exogenous control variables **X** includes the child's gender and age, and multiple births and birth order.

As a robustness check, we use information from the sibling sample to control for mother fixed effects by estimating the following equation:

$$InfantMortality_{ijvt} = \beta_2\left(Aidproject50km_{jv} * BorrnduringAidproject_t\right) + \theta\, \boldsymbol{X_{ijvt}} + \partial_m + \delta_t + \lambda_{jt} + \varepsilon_{ijvt} \qquad (2)$$

The term ∂_m represents the characteristics of the mother that are constant across siblings such as mother's education, rural residency, ethnicity and religion. The goal here is to estimate the effects of aid on infant mortality by exploiting within-sibling variations. The

model controls for observed and unobserved factors that might be correlated with both infant mortality and aid. In the two models, the coefficients of interest, β_1 and β_2, are expected to be negative, illustrating the benefits of being born in the vicinity of an aid-funded project.

4. Empirical Results

Effects of aid on infant mortality

Table 3 presents the effects of the presence of an aid project on infant mortality in Côte d'Ivoire obtained from a difference-in-difference estimation of equations (1) and (2). The results presented in columns 1 and 2 show that proximity to aid projects is associated with reduced infant mortality. Children born in a household located within 50 km and 25 km of an aid-funded project implemented during the 1995-2012 period faced a likelihood of dying before 12 months that is lower by 2.8 and 1.9 percentage points, respectively. The associated coefficients are statistically significant at 1%. These results are similar in direction and magnitudes to those of Kotsadam et al. (2018).[5]

Columns 3 and 4 of Table 3 present the results with mother fixed effects; they are consistent with those in columns 1 and 2. Being born in areas within 50 km and 25 km of aid-funded projects is associated with infant mortality that is lower by 2.7 and 2.1 percentage points, respectively. In other words, the implementation of aid-funded projects is associated with a fall in infant mortality rate by 27 children per 1000 live births

[5] Results from probit/logit regressions also show a negative impact of aid-projects on infant mortality. The results are not reported in the manuscript due to space limitation. They are available upon request.

(column 3 – within 50km) and 21 children per 1000 live births (column 4 – within 25km), respectively; the coefficients are statistically significant at 1%. In addition, based on the average infant mortality rate in the sample as presented in the summary statistics in Table 2, the results in column 3 imply that for a child born within a 50km radius of an aid-funded project, the odds of dying before 1 year is 0.282, which is lower than the pooled sample average of 0.31. Although this approach is useful for addressing omitted variable bias, there is still a theoretical possibility for these "constant variables" to actually change across siblings. So, to account for time-varying unobserved factors that might bias our results, we experiment by adding mother's age and mother's body mass index in the mother fixed-effects regressions.

Table 8 shows that the coefficients on the indicators of the proximity to aid projects have the expected signs, and the magnitudes are not highly affected by the addition of time varying mother's characteristics. This implies that the results from our empirical model are robust to any potential ommited variable bias.

Heterogeneity of the effects of aid on infant mortality

Previous studies have shown that aid may have different effects depending on the targeted group (boys versus girls or wife versus husband) or the location (urban versus rural areas), with the assumption that the effect will be strongest for the most disadvantaged groups (Kotsadam et al., 2018). Using the mother fixed-effects estimation, we find that the triple interaction between proximity to aid-funded projects, the time of birth, and residency is not significant (Table 4, columns 1 and 2). A similar result is obtained for the triple interaction of proximity to aid-funded projects, time of birth, and

gender (columns 3 and 4). Overall the results in Table 4 suggest that there are no statistically significant differences in the impact of aid on infant mortality along gender and rural vs. urban residency.

As a further robustness check, we explore the linkages between infant mortality and aid measured at the sector level. Given the predominance of water and sanitation aid projects in the sample, we use this sector for illustrative purposes. We re-estimate equations 1 and 2 by considering only aid projects in the water and sanitation sector. The results are presented in Table 5. They show that birth in proximity to aid-funded water and sanitation projects is associated with a reduction in infant mortality by about 2 percentage points, or a reduction of 20 child deaths out of 1,000 live births. These results suggest that aid may improve child health outcomes through improved quality of the household's environment, notably improved hygiene and reduced water-born diseases.[6]

Controlling for endogenous migration

We further explore the robustness of our results by examining the possibility that the effects of aid projects on infant mortality might be biased by endogenous migration. For instance, if children or their mothers moved from areas in proximity to aid projects to areas further away from aid projects areas, the treated children (those within 25 or 50 km from aid projects) will be mistakenly assigned to the control group (those far away from aid project) and vice versa if the displacement occurs from areas far from aid projects towards those closer to aid projects. Information about migration is only available in the 1994 and 2011-2012 DHS surveys. In the 1994 survey, women were asked whether they always

[6] See Pickbourn and Ndikumana (2018) for the case of the impact of aid on child mortality from diarrhea.

lived in their current residence or not, and about the number of years they lived in their current place of residence. In the 2011-2012 DHS, the mothers were asked how many times they spent one or more nights away from their home in the 12 months preceding the survey. We define dummy variables for the propensity to migrate in the 1994 and 2011-2012 surveys and regress the migration status on proximity to aid projects, child, mother and other time-invariant variables.[7] The results in Table 6 show that proximity to aid projects has no effect on the propensity to migrate. This suggests that population migration is not a source of concern for the robustness of the results in this study.

The DHS datasets also provide information on those who lived in their current place of residence when the surveys were conducted. We experiment by restricting the sample to individuals who lived in the current place of residence at the time of the survey. As shown in Table 7, the results are robust: proximity to aid projects is still associated with reduced infant mortality.

Controlling for different thresholds of distance to aid projects

Instead of considering a fixed radius of 25km or 50 km from the aid project, we experiment by using a rolling distance window of 5km. We apply different treatments depending on the level of proximity, i.e., 5km, 10km, ….. 45 km from aid project locations. We therefore conduct 9 difference-in-difference estimations for equations 1

[7] Previous studies such as La Mattina (2017) and Minoiu and Shemyakina (2014) used the migration history of households and defined a binary variable of migrant versus non-migrant (those who have lived continuously in their current place of residence since before or at the start of the shock (proximity to aid project) and estimated separately their models for the full population and the sub-sample of non-migrants and tested whether the effect of the shock on child health is statistically different by migration status. This approach could not be implemented in this study because the information on mothers who lived continuously in the current residence since before aid projects (1995) was not available.

and 2 respectively to assess the effect of proximity to aid projects on infant mortality. As depicted in Figure 4, all the coefficients are negative and statistically significant at 5 percent levels. Overall, the effect of proximity to aid project on child neonatal mortality is consistently negative and robust.

Possible transmission mechanisms

The results presented thus far suggest that aid at project level is associated with a reduction in infant mortality. The results show no differential impact of either gender or rural-vs-urban residency of the household on the aid-infant mortality linkages. To further explore the mechanisms by which aid may affect infant mortality, we estimate the effects of proximity to aid-funded projects on variables that are likely to affect the child's survival such as vaccination, the mother' education, wealth, and access to postnatal and prenatal care. The results obtained using the difference-in-difference approach are presented in Table 9. They show that birth in proximity of aid projects increases the likelihood for the child of being vaccinated (columns 1-4). More specifically, there is a positive and statistically significant association (at 1%) between birth in proximity to aid project and BCG and measles vaccinations.

In addition, birth in proximity to aid projects reduces the likelihood of a child to live in a poor household while mothers' probability of being educated is increased by proximity to aid-funded projects (columns 5 and 6). The results in columns 7 and 8 suggest a positive association between the presence of aid projects and the number of prenatal visits as well as the likelihood of the child being delivered at the hospital, which is expected to improve the odds of the child's survival. The results suggest that changes in mothers'

health seeking behavior and access to vaccination may serve as channels through which aid influences infant mortality.

5. Conclusion

This study sought to examine the impact of development aid on infant mortality in Côte d'Ivoire by merging local-level aid and three rounds of DHS surveys. Using geographical information available in the datasets and the difference-in-difference estimation method, we found that proximity to aid projects is associated with significantly reduced infant mortality. The results are robust to different estimation techniques, control for mother fixed effects, as well as possible endogenous migration. The findings corroborate those of Kotsadam et al. (2018) for the case of Nigeria. However, the results show no heterogeneity of the effect of aid on child health by gender or rural-versus urban residency. The results also suggests that proximity to aid-funded water and sanitation projects may reduce the likelihood of a child dying before his/her first birthday. Furthermore, the empirical evidence indicates that access to prenatal care and immunization are possible transmission channels through which aid can improve child welfare.

Before closing, we note a few relevant issues that were not examined in this paper that will be worth pursuing in future studies. This study did not address how government-sponsored health campaigns might contribute to the improvement of child welfare, or the possible complementarity between foreign aid delivered in the forms of projects and local initiatives. In addition, the study does not also address the issue of coordination among foreign donors. For instance, Côte d'Ivoire might receive significant amounts of aid not

just from the World Bank, but also in the form of bilateral assistance. However, there is no geo-located data on bilateral aid for Côte d'Ivoire. Furthermore, the specification of the empirical model does not incorporate the possibility that some projects might have an immediate impact while others might take a longer time to have an impact on infant mortality. Finally, this paper did not consider other factors that might explain the high rate of infant mortality such as resistance to vaccination due to local customs. All of these issues are potential avenues for future research.

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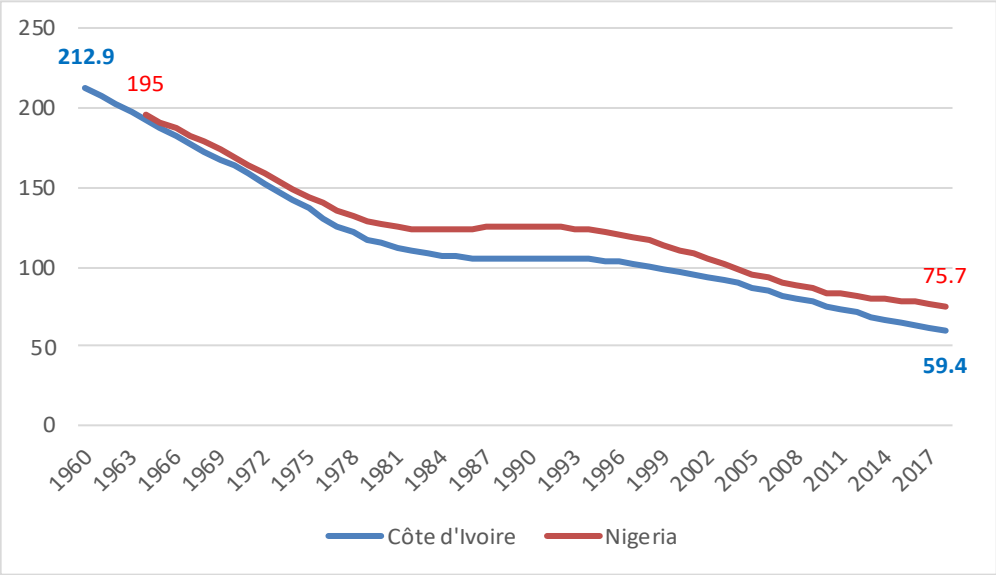
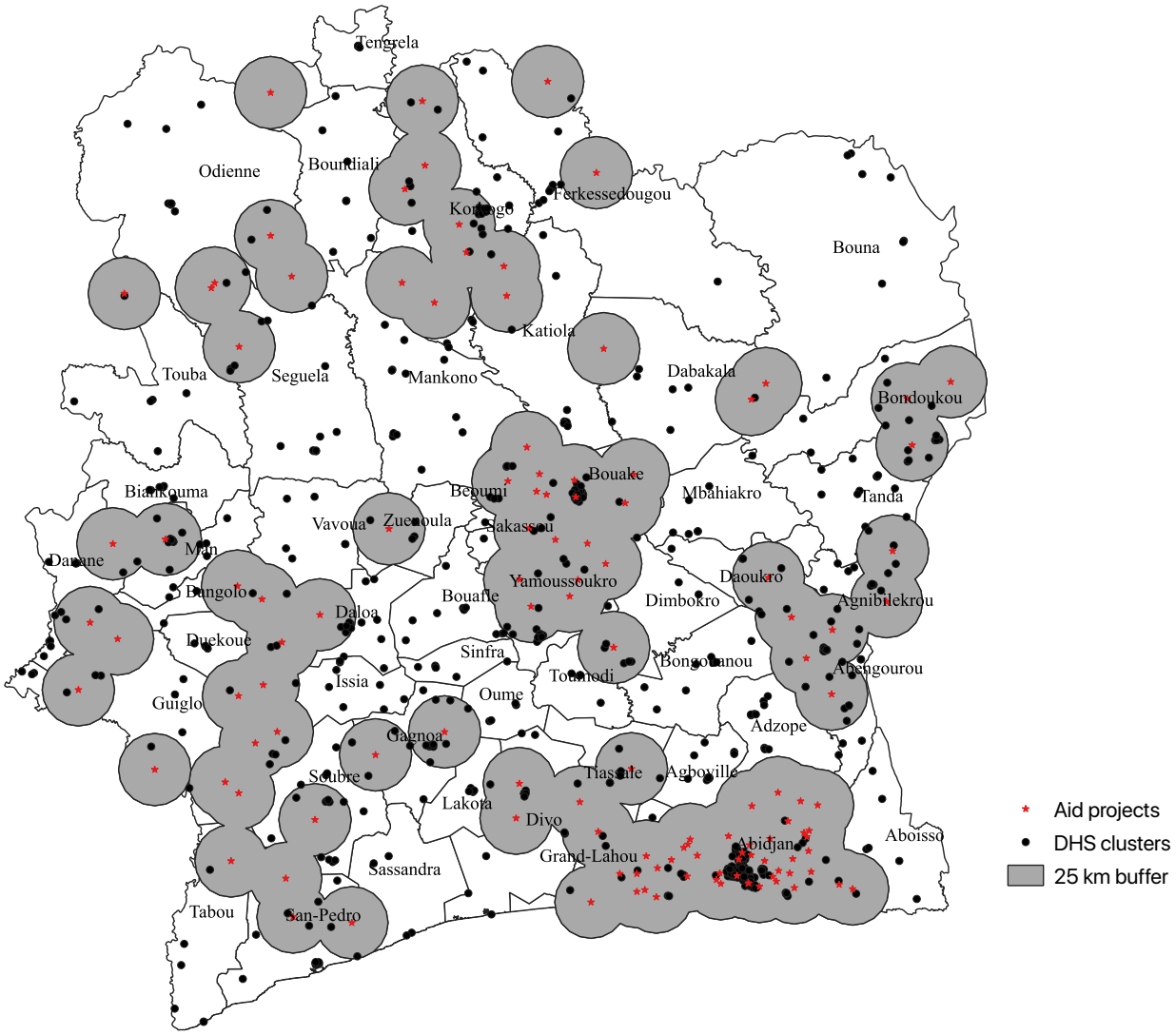
Figure 1: Trend of infant mortality rate (per 1,000 live births) in Côte d'Ivoire and Nigeria



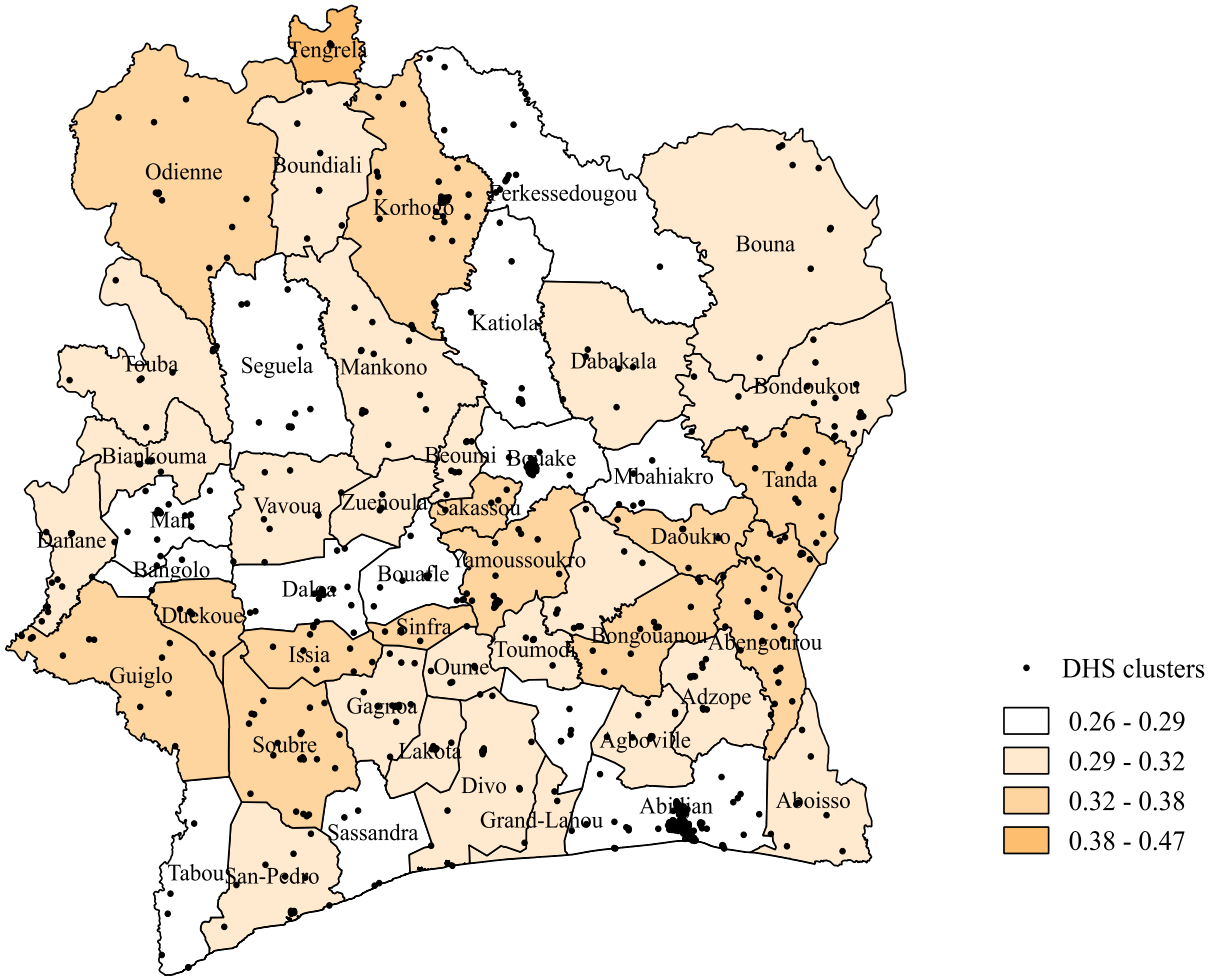
Source: World Bank, World Development Indicators

Figure 2: Aid projects and DHS Clusters distribution



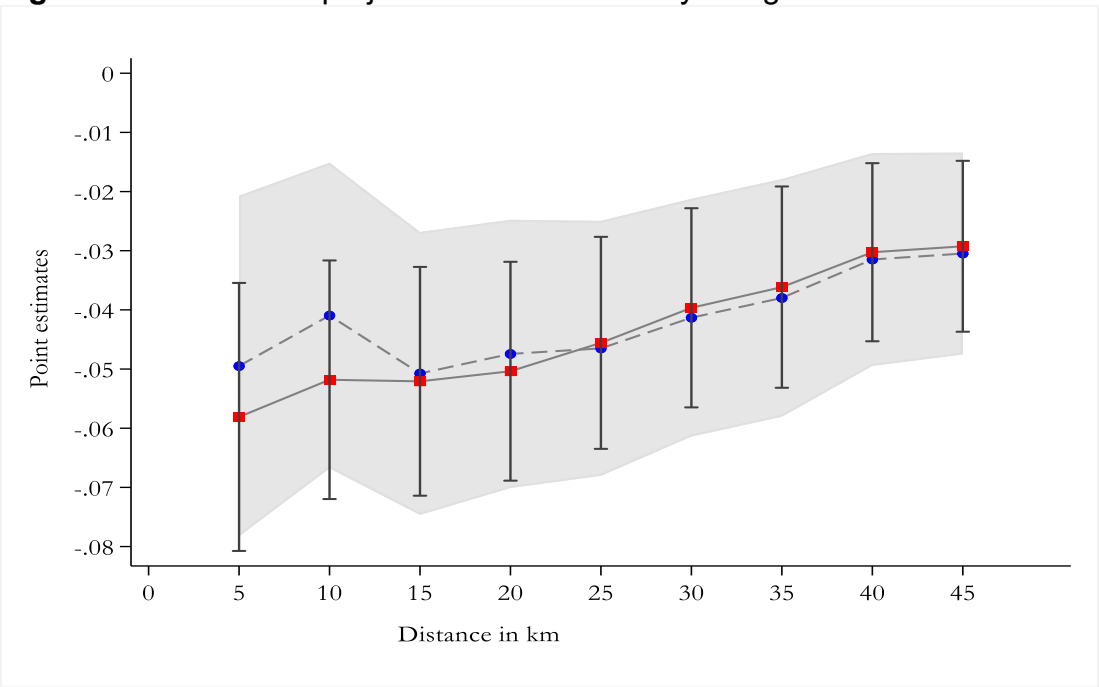
Notes: constructed by the authors using QGIS 3.6
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2

Figure 3: Infant mortality rate based on the three DHS surveys



Notes: constructed by the authors using QGIS 3.6
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS.

Figure 4: Effect of aid projects on infant mortality using different distance thresholds



Notes: The red square markers represent estimates from the regressions of equation 1 and the brackets are the associated 95% confidence intervals. The blue circle markers represent point estimates from equation 2 and the shaded area is the associated confidence intervals.
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2.

Table 1: Types and locations of aid projects (1995-2014)

Type of projects	Numbers of projects	Number of locations
Health	12	12
Agriculture	13	13
Government and civil society	10	4
Banking and financial services	1	1
Education	5	5
Energy generation and supply	8	8
Water and sanitation	76	11
Other social infrastructure and services	19	14

Source: Authors' calculation using Aid Data v1.4.2

Table 2a: Summary statistics

	Mean	Max	Min	St. Dev.	Obs
Infant mortality (=1 if died before 12 months)	0.309	1	0	0.462	13766
Aid projects within 50 km (=1 if yes)	0.674	1	0	0.469	13766
Aid projects within 25 km (=1 if yes)	0.432	1	0	0.495	13766
Rural (=1 if yes)	0.612	1	0	0.487	13766
Child lives in poor household (=1 if yes)	0.510	1	0	0.500	10551
Child vaccinated (=1 if yes)	0.720	1	0	0.449	3905
Child vaccinated against BCG (=1 if yes)	0.780	1	0	0.415	12446
Child vaccinated against Measles (=1 if yes)	0.526	1	0	0.499	12351
Mother has some education (=1 if yes)	0.337	1	0	0.473	13766
Child born during aid project (=1 if yes)	0.687	1	0	0.464	13766
Child is from multiple births (=1 if yes)	0.041	1	0	0.199	13766
Child birth order number	3.658	15	1	2.449	13766
Child age in years	1.623	4	0	1.338	12485
Child is male (=1 if yes)	0.504	1	0	0.500	13766
Ethnic groups					
Akan	0.273	1	0	0.446	13748
Krou	0.087	1	0	0.281	13748
North Mande	0.148	1	0	0.355	13748
South Mande	0.090	1	0	0.286	13748
Voltaiques	0.167	1	0	0.373	13748
others	0.236	1	0	0.424	13748
Religion					
Christian	0.360	1	0	0.480	13741
Muslim	0.432	1	0	0.495	13741
Others	0.208	1	0	0.406	13741

Table 2b: Summary Statistics

Variables	*Obs (1)*	*Near to aid projects (2)*	*Not near to aid projects (3)*	*Difference (3)- (2)*
Child characteristics				
Infant mortality (1994)	3998	0.375	0.408	0.033**
Infant mortality (1998-1999)	1992	0.284	0.300	0.016
Infant mortality (2011-2012)	7776	0.261	0.286	0.025**
Infant mortality (pooled)	13766	0.302	0.318	0.016**
Child is from multiple births (=1 if yes)	13766	0.038	0.045	0.007*
Child birth order number	13766	3.462	3.882	0.420***
Child age in years	12485	1.597	1.654	0.057**
Child is male (=1 if yes)	13766	0.505	0.504	-0.001
Child vaccinated (=1 if yes)	3905	0.764	0.685	-0.079***
Child vaccinated against BCG (=1 if yes)	12446	0.859	0.688	-0.171***
Child vaccinated against Measles (=1 if yes)	12351	0.578	0.465	-0.113***
Child vaccinated against Polio (=1 if yes)	12453	0.838	0.766	-0.072***
Hospital delivery (=1 if yes)	13766	0.667	0.461	-0.206***
Household characteristics (pooled)				
Rural (=1 if yes)	13766	0.415	0.836	0.421***
Poor household (=1 if yes)	10551	0.342	0.700	0.358***
Mother has some education (=1 if yes)	13766	0.405	0.259	-0.146***
Mother's age	13766	27.948	28.574	0.626***
Mother Body Mass Index	9775	2299.915	2211.710	-88.205***
Number of prenatal visits	11325	3.428	2.602	-0.826***
Ethnic groups				
Akan	13748	0.297	0.246	-0.051***
Krou	13748	0.092	0.080	-0.012**
North Mande	13748	0.135	0.162	0.027***
South Mande	13748	0.052	0.133	0.081***
Voltaiques	13748	0.160	0.175	0.015**
others	13748	0.263	0.204	-0.059***
Religion				
Christian	13741	0.396	0.319	-0.077***
Muslim	13741	0.444	0.417	-0.027***
Other	13741	0.159	0.263	0.104***

Notes: "Near aid projects" refers to children who live within 25 km from any aid project sites. "Not near aid projects" refers to children living more than 25 km away from aid project sites.
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 2c: Summary statistics

	Pre-treatment (DHS 1994)				Post-treatment (DHS 1998-1999 and 2011-2012)			
	Aid projects within 25 km		Aid projects over 25 km		Aid projects within 25 km		Aid projects over 25 km	
	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs
Child characteristics								
Infant mortality (=1 if child died before 12 months)	0.375	2365	0.408	1633	0.267	4971	0.288	4797
Child vaccinated (=1 if yes)	0.531	565	0.367	581	0.876	1176	0.802	1583
Child vaccinated against BCG (=1 if yes)	0.788	2166	0.585	1492	0.893	4507	0.724	4281
Child vaccinated against Measles (=1 if yes)	0.457	2145	0.328	1483	0.637	4481	0.513	4242
Child vaccinated against Polio (=1 if yes)	0.752	2165	0.585	1491	0.880	4507	0.830	4290
Child is from multiple births (1= if yes)	0.0347	2365	0.0361	1633	0.0398	4971	0.0477	4797
Child birth order number	3.773	2365	4.116	1633	3.314	4971	3.802	4797
Child age in years	0.995	2167	0.953	1493	1.885	4525	1.897	4300
Child is male (=1 if yes)	0.507	2365	0.500	1633	0.504	4971	0.505	4797
Hospital delivery (=1 if yes)	0.591	2365	0.375	1633	0.704	4971	0.491	4797
Household characteristics								
Mother's age in years	27.07	2365	27.43	1633	28.37	4971	28.96	4797
Mother's body mass index	2249.6	2319	2172.9	1625	2336.8	3164	2235.4	2667
Mother has some education (=1 if yes)	0.394	2365	0.252	1633	0.410	4971	0.262	4797
Number of prenatal visits	2.818	2351	2.308	1621	3.792	3941	2.741	3412
Rural (=1 if yes)	0.455	2365	0.805	1633	0.396	4971	0.846	4797
Poor household (1= if yes)	0.467	1738	0.742	1267	0.287	3883	0.687	3663
Ethnic groups								
Akan (=1 if yes)	0.306	2355	0.280	1633	0.293	4966	0.234	4794
Krou (=1 if yes)	0.124	2355	0.106	1633	0.0771	4966	0.0713	4794
North Mande (=1 if yes)	0.115	2355	0.127	1633	0.145	4966	0.174	4794
South Mande (=1 if yes)	0.0586	2355	0.111	1633	0.0487	4966	0.140	4794
Voltaiques (=1 if yes)	0.116	2355	0.162	1633	0.181	4966	0.179	4794
Others (=1 if yes)	0.280	2355	0.214	1633	0.255	4966	0.201	4794
Religion								
Christian (= 1 if yes)	0.401	2362	0.291	1631	0.394	4956	0.329	4792
Muslim (= 1 if yes)	0.393	2362	0.345	1631	0.469	4956	0.443	4792
other (= 1 if yes)	0.206	2362	0.365	1631	0.137	4956	0.229	4792
Distance to nearest aid project site in km	8.354	2365	47.67	1633	8.060	4971	79.28	4797

Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2

Table 3: Effects of aid projects on infant mortality

	(1)	(2)	(3)	(4)
Aid project 50km*born during Aid project	-0.028***		-0.027***	
	(0.007)		(0.009)	
Aid project 25km*born during Aid project		-0.019***		-0.021***
		(0.005)		(0.006)
Province fixed effects	Yes	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Province specific trends	Yes	Yes	Yes	Yes
Mother fixed effects	No	No	Yes	Yes
Observations	12284	12284	8786	8786
R-squared	0.851	0.851	0.854	0.854

Notes: The dependent variable is infant mortality. Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include province specific trends, year of birth fixed effects, child controls (gender, child age, multiple births dummy and birth order fixed effect). Mother's time invariant characteristics used in the mother fixed effects regressions are mother's education, rural residency, ethnicity, and religion.
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2

Table 4: Effects of aid projects on infant mortality for different groups

	(1)	(2)	(3)	(4)
Aid project 50km*born during Aid project	-0.022**		-0.028***	
	(0.010)		(0.009)	
Aid project 50km*born during Aid project*Rural	-0.006			
	(0.009)			
Aid project 50km*born during Aid project*Male			0.002	
			(0.008)	
Aid project 25km*born during Aid project		-0.017**		-0.023***
		(0.008)		(0.008)
Aid project 25km*born during Aid project*Rural		-0.005		
		(0.009)		
Aid project 25km*born during Aid project*Male				0.006
				(0.008)
Province fixed effects	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Province specific trends	Yes	Yes	Yes	Yes
Mother fixed effects	Yes	Yes	Yes	Yes
Observations	8786	8786	8786	8786
R-squared	0.854	0.854	0.854	0.854

Notes: The dependent variable is infant mortality. Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include province specific trends, year of birth fixed effects, child controls (gender, child age, multiple births dummy and birth order fixed effect), mother controls (education, rural residency, ethnicity and religion). Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 5: Effects of water and sanitation aid projects on infant mortality

	(1)	(2)	(3)	(4)
Aid project 50km*born during Aid project	-0.018***		-0.020***	
	(0.006)		(0.007)	
Aid project 25km*born during Aid project		-0.020***		-0.020***
		(0.005)		(0.006)
Province fixed effects	Yes	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Province specific trends	Yes	Yes	Yes	Yes
Mother fixed effects	No	No	Yes	Yes
Observations	12284	12284	8786	8786
R-squared	0.851	0.851	0.854	0.854

Notes: The dependent variable is infant mortality. Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include province specific trends, year of birth fixed effects, child controls (gender, child age, multiple births dummy and birth order fixed effect). Mother's time invariant characteristics used in the mother fixed effects regressions are mother's education, rural residency, ethnicity and religion.
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 6: Effects of aid projects on migration

	1994 DHS		2011-2012 DHS	
	(1)	(2)	(3)	(4)
Aid project 50km		-0.015		0.003
		(0.015)		(0.021)
Aid project 25km	-0.009		0.004	
	(0.012)		(0.017)	
Child controls	Yes	Yes	Yes	Yes
Mother controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes
Observations	12246	12246	12246	12246
R-squared	0.237	0.237	0.487	0.487

Notes: The dependant variable is the propensity to migrate (a dummy variable for population displacement). Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include year of birth fixed effects, province fixed effect, child controls (gender, child age, multiple births dummy and birth order fixed effect), mother controls (education, rural residency, ethnicity and religion).
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 7: Effects of aid projects on infant mortality using residence at the time of the survey

	(1)	(2)	(3)	(4)
Aid project 50km*born during Aid project	-0.029***		-0.027***	
	(0.007)		(0.009)	
Aid project 25km*born during Aid project		-0.020***		-0.021***
		(0.005)		(0.006)
Province fixed effects	Yes	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Province specific trends	Yes	Yes	Yes	Yes
Mother fixed effects	No	No	Yes	Yes
Observations	11751	11751	8545	8545
R-squared	0.850	0.850	0.854	0.854

Notes: The dependent variable is infant mortality. Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include province specific trends, year of birth fixed effects, child controls (gender, child age, multiple births dummy and birth order fixed effect). Mother's time invariant characteristics used in the mother fixed effects regressions are mother's education, rural residency, ethnicity and religion.
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 8: Effects of aid project on infant mortality

	(1)	(2)	(3)	(4)
Aid project 50km*born during Aid project	-0.028***		-0.029***	
	(0.007)		(0.011)	
Aid project 25km*born during Aid project		-0.019***		-0.024***
		(0.005)		(0.009)
Province fixed effects	Yes	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Province specific trends	Yes	Yes	Yes	Yes
Mother fixed effects	No	No	Yes	Yes
Observations	12284	12284	6427	6427
R-squared	0.851	0.851	0.854	0.854

Notes: The dependent variable is infant mortality. Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include province specific trends, year of birth fixed effects, child controls (gender, child age, multiple births dummy and birth order fixed effect). Mother's time invariant characteristics used in the mother fixed effect regressions are mother's education, rural residency, ethnicity, and religion. We also add in the mother fixed-effect regressions some time-variant characteristics such as mother's age and mother's body mass index.
Data sources: 1994, 1998-1999 and 2011-2012 editions of the Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 9: Effects of aid projects on other variables of interest (mediating factors)

	Vac. (1)	BCG (2)	Measles (3)	Polio (4)	Poor (5)	Mother ed. (6)	Prenatal visits (7)	Hospital delivery (8)
Aid project 25km*born during Aid project	0.028	0.102***	0.064***	0.009	-0.258***	0.061***	0.598***	0.106***
	(0.023)	(0.020)	(0.020)	(0.015)	(0.048)	(0.021)	(0.106)	(0.032)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3848	12245	12151	12252	9414	12284	10290	12284
R-squared	0.344	0.159	0.304	0.197	0.333	0.125	0.169	0.174

Notes: Robust standards errors are in parentheses, clustered at the DHS cluster level. All regressions include province specific trends, year of birth fixed effects, child controls (gender, child age, multiple births dummy and birth order fixed effect).
Data sources: 1994, 1998-1999 and 2011-2012 Côte d'Ivoire DHS, and Aid Data v1.4.2
* significant at 10%, ** significant at 5%, *** significant at 1%