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MOTHER SINGLEHOOD AT FIRST BIRTH AND MORTALITY RISKS OF FIRST- AND LATER-BORN CHILDREN: THE CASE OF SENEGAL

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Abstract This paper investigates the extent to which being born to a single mother affects a child's survival rate in Senegal, a context where girls' premarital sexual relationships are still widely stigmatized. It also examines whether any negative effect persists up to affecting the survival rate of children of higher birth order born after the mother has married. Using data from Demographic and Health Survey, we find that the mortality rate is higher for first-born boys, but not for first-born daughters, whose mother was single at the time of their birth, and lower for second-born children whose sister, but not brother, was born out of wedlock. The latter effect is actually driven by children from older cohorts of women. Therefore, strategies to mitigate the negative consequences of the stigma associated with a premarital birth seem to exist but vary with the gender of the child born premarital in Senegal. In addition, persisting negative effects appear to have decreased over time. Potential channels through which boys born from a single mother are at a higher risk of death in the country are discussed. Overall, our findings indicate that social programs targeting single mothers, especially when they gave birth to a boy, would help avoiding dramatic events as the death of a child.

Keywords: Premarital Fecundity, Marriage, Child Mortality, Senegal

1. INTRODUCTION

Child mortality in Sub-Saharan Africa (SSA) is the highest in the world and exhibits low rates of decline.[1] Understanding better the factors driving these persisting high levels of child mortality is therefore a clue. While the role of women's poor

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education [for a review, see Hobcraft (1993)], as well as the role of adolescent childbearing [Bledsoe and Cohen (1993)], has been widely studied, the role of single motherhood at first birth has received relatively little attention. In this paper, we aim at filling this gap and for the context of Senegal, we investigate how children's well-being, captured by the survival rate during infancy, varies with their mother's marital status when she gave birth for the first time.

Premarital births are not rare in SSA. According to Demographic and Health Survey data from 25 countries, an average of one in five mothers in SSA gave birth before marriage [Garenne and Zwang (2006)]. This average has steadily increased over the last decades [Garenne (2008)], whereas in most countries, total fecundity has been decreasing. In Senegal, over the period 2010–2011, we estimate that one in seven women gave birth before their first marriage. This proportion is 2 percentage points higher compared to the one observed in 1992. This upward trend is closely linked to rising age at first marriage in contexts where policies aiming at improving the use of modern contraceptive methods, notably for the youth, have been more or less successful. It also reflects the deep changes that affect family structures and organization in the subcontinent, driven notably by rapid urbanization and increased education [Van de Walle and Meekers (1994), Gage and Meekers (1994), Calves (1996), Thiriat (1999), Locoh (2003)].

These patterns are, however, often at odds with social acceptance of premarital sex that varies between groups depending on norms and local contexts. In Senegal, procreation is considered socially acceptable within marital unions [Adjamagbo et al. (2004), Dial (2008)], and therefore, premarital sexual relationships are strongly disapproved, even condemned, for women [Adjamagbo and Koné (2013)].[2] Where women's premarital sexuality is stigmatized and where the choice of suitable spouse falls onto the elders of the family more than on the bride-to-be herself, the arrival of a premarital pregnancy can turn into a real tragedy for family members, especially for the future mother [Adjamagbo et al. (2014)], raising much concern in public spaces and in public health circles [Faye et al. (2013)].[3]

In Senegal, concerns are relative to women's health following abortion, attempted secretly given the restrictions imposed by the abortion law,[4] and to children's health. Negligence due to stigma could be one cause, and lack of resources during the child's first years of life could be another one. Indeed, following a premarital birth, a delay in marriage has been observed in different contexts in SSA [Calvès (1999), Johnson-Hanks (2005)] as well as in rural Senegal [Adjamagbo et al. (2004)]. No or delayed marriage implies for the child born out of wedlock to grow up, while her mother has a potentially reduced access to economic resources, in particular from the (absent) child's father. Besides, if a premarital birth challenges the marriage initially planned by parents, whoever the mother marries (including the child's father), the couple may not receive the same support from her family as the couple would have received if her partner was the one chosen by her family. Therefore, one might also worry that all children, not only the one born outside marriage, of a mother who had a premarital birth may be at a higher risk of vulnerability.

In this paper, our objective is twofold. First, we examine whether children born before their mother's first marriage have a different mortality rate at two year old compared to other first-born children within marriage. Second, we investigate the extent to which having an eldest sibling born outside marriage affects the mortality rate of children born second and within marriage. Combining data from Senegal Demographic and Health Survey (SDHS thereafter) collected in 2010/2011 and in 2015, we find that mortality is *higher* for first-born boys whose mother was single at the time of their birth. We also find that mortality at 2 is *lower* for children born later if their elder sister was born out of wedlock. Additional tests suggest however that this last result is driven by children born to mothers belonging to older cohorts.

Several threats might challenge the interpretation of these results. First, information on abortion and date of abortion is missing in these surveys (only the date of last pregnancy termination, for whatever reasons, is available). This could be an issue if within the group of second-born children whose mother never had a premarital birth, those whose mother had a premarital pregnancy she could terminate differ from those whose mothers never had a premarital pregnancy. Yet, if the former are more vulnerable than the later, notably because abortions damage women's health, then our estimates of the average effect of having an elder sibling born while the mother was single are biased toward zero. Besides, apart from abortion attempts, mothers giving birth to a child while being single could be a selected group of mothers. However, our results are robust to including different sets of controls. Finally, and most importantly, conditional on the absence of in-utero sex selection, which is likely in our setting, and of sex-biased misreporting, there is no reason these issues drive the observed gender-differentiated effects.

Our finding relative to first-born children suggests that strategies to mitigate the negative consequences of the stigma associated with a premarital birth exist but vary with the gender of the child born premarital in Senegal. In addition, persisting negative effects appear to have decreased over time. Overall, our findings indicate that social programs targeting single mothers, especially when they gave birth to a boy, would help avoiding dramatic events such as the death of a child.

This work contributes to the empirical literature on the link between mothers' singlehood at (first) birth and children's well-being in developing countries [Meekers (1994), Emina (2011), Clark and Hamplová (2013), Ntoimo and Odimegwu (2014)], extending existing results by looking at second-born children and accounting for the sex of the child born premarital, which is likely exogenous in our context.[5] It also contributes to the larger literature investigating linkages between children's living arrangements or family structure and children's well-being in developing countries: Wagner and Rieger (2015), Gibson and Mace (2007), and Omariba and Boyle (2007) have notably analyzed the role of polygyny status, Delprato et al. (2017), Sekhri and Debnath (2014), and Guilbert (2013) the role of early marriage, Beck et al. (2015), Coppoletta et al. (2012), Marazyan (2011), and Castle (1995) the role of child fostering, among others.

The remainder of the paper is organized as follows. Section 2 presents the data and some summary statistics. Section 3 presents the empirical models associated with the questions we raise. Sections 4 and 5, respectively, present and discuss the results. Section 6 concludes.

2. THE SDHS 2010 AND 2015

We use the most recent SDHS data, collected in 2010/2011 and in 2015 in the country, both representative at the national level. Interested in analyzing the well-being of first- and second- born children, we restrict the sample to children whose mother is 25 year and older each year of interview. Indeed, at 25 year old, 92% of mothers have at least two ever-born children. We test the robustness of our main results to reducing the sample to children whose mothers is aged 30 or more in Section 4 (at 30, 98% of mothers have at least two ever-born children). We exclude sibships when the child born first was born as a twin.[6]

We define premarital births as all births that occurred up to one month before a woman's first marriage. In our sample, 12% of mothers gave birth to their first child while not being married.[7]

2.1. Premarital Births: Mother and Household Level Correlates

We expect mothers who ever had a premarital birth to differ in many dimensions from other mothers: in their ability to avoid a premarital pregnancy while having sexual relationships, in their ability to cope with the economic consequences of having a premarital pregnancy, in the extent to which the norm stigmatizing premarital births is enforced for them, and so on. Yet, the SDHS data provide only few baseline information that is information on mothers before they ever gave birth. Most information is contemporary, and thus potentially explained by the fact that the mother had a premarital birth and/or by the survival status of children. For these variables, the interpretation of differences between subgroups of mothers should therefore be taken with caution. We describe in Tables A.1 and A.2 in the appendix characteristics of mothers and of their household, respectively. We first describe characteristics predetermined at first birth, and then those potentially endogenous.

Mothers differ significantly in terms of ethnic group. Mothers who ever gave birth to a child before being married are more likely to be Mandingue, Diola, or Sarakhole than Wolof or Fulani. This could reflect ethnic differences relative to the norm stigmatizing premarital sexual activity. This is worth to comment further. According to Murdoch's Ethnographic Atlas , premarital sex is prohibited (although weakly censored) among the Wolof and permitted among the Diola, the Fulani, and the Serere. However, given the younger age at which Fulani women marry, control over Fulani women's sexual activity is likely important.[8] For our purpose, these differences along ethnic groups are important to account for as these ethnic groups are also located in different areas across the country. Yet, access to health facilities, key for children's health outcomes, is likely to vary between geographic areas. Besides, mothers who ever had a premarital birth were younger when they first gave birth. This is also key since teenage births are important determinants of children's mortality and morbidity [WHO (2014)].

At the day of the interview, women with premarital birth appear to be more educated. This is all the more true as they gave birth first to a boy. Yet, the difference appears for the highest level of education (having more than primary education). They have fewer children ever born. They are also more likely to live in a urban area, to belong to a household headed by a female (but not by themselves), and, in this household, to not be the spouse of the household head. Finally, they are less likely to belong to poorest households, even more if they gave birth first to a girl.[9]

These findings could suggest that mothers who were single at first birth are somehow positively selected (in a context where premarital sexual activity for women is stigmatized, women with more resources can afford—economically and socially—to give birth while not being married). Alternatively, and contrary to expectations, they show that giving birth before being married is not associated with a posteriori negative consequence on mothers' economic trajectory. Further evidence in favor of a positive selection is provided in Table A.3 in the appendix. It describes mothers' opinion relative to domestic violence (the information is available for all ever-married mothers). When they had a premarital birth, mothers are less likely to consider beating, for any reason, as justified. For a subsample of births,[10] the survey provides information on the extent to which births were desired, as declared at the date of the interview by the mother.[11] We report in Table A.4 in the appendix this information for first births depending on whether the birth was premarital or not. Premarital births, and premarital male births in particular, are less likely to be reported as desired. The question being asked retrospectively, one may wonder whether the observed gender gap among premarital births is actually driven by the difficulty faced by women as the caretaker of children born out of wedlock depending on the gender of the child, with the birth of a boy creating more complications. Yet, surprisingly in a context where premarital sex is expected to be stigmatized, the proportion is not zero. This could support the hypothesis that a share of mothers giving birth before marriage are positively selected.

In what follows, we investigate the correlates of being born from a single mother or from a married mother.

2.2. Premarital Births: Correlates at First-Born Children's Level

Whether first-born children, born to a single or a married mother, face a different mortality risk is described in Table 1. Boys and girls have different mortality rates at birth [Mahy (2003)]. Therefore, information is provided distinguishing boys and girls to not confound the effect of premarital birth status with the one of sex.

We find that girls born to single mothers have a significantly lower probability to be deceased at 2 year old compared to other girls. We find the opposite for boys (although not significant). The double difference is significant. This indicates that girls have a higher survival rate at 2 year old than boys, and this is even more true if girls were born before their mother's first marriage. This finding calls for few

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TABLE 1. First-born children characteristics

	First child = Girl			First child = Boy			Diff.
Variables	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
Child died before 2 year old	0.09	0.11	0.02*	0.14	0.13	− 0.01	− 0.03*
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Child: born during dry season	0.66	0.66	− 0.01	0.66	0.65	− 0.01	0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Child: succeeding birth interval (in month)	43.32	35.56	− 7.76***	45.71	35.42	− 10.29***	− 2.53*
	(1.12)	(0.32)	(1.16)	(1.27)	(0.31)	(1.31)	(1.35)
Child: birth year in 1981 or before	0.04	0.03	− 0.01	0.08	0.03	− 0.05***	− 0.04***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Child: birth year between 1982 and 1986	0.11	0.08	− 0.02*	0.11	0.09	− 0.02*	0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Child: birth year between 1987 and 1991	0.18	0.14	− 0.04**	0.15	0.15	− 0.00	0.04*
	(0.02)	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
Child: birth year between 1992 and1996	0.20	0.19	− 0.00	0.20	0.19	− 0.01	− 0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Child: birth year between 1997 and 2001	0.22	0.24	0.03	0.22	0.24	0.02	− 0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Child: birth year between 2002 and 2006	0.22	0.22	0.00	0.17	0.22	0.04***	0.04*
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Child: birth year between 2007and 2011	0.04	0.09	0.04***	0.07	0.08	0.01	− 0.03**
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Child: birth year in 2012 or after	0.00	0.01	0.00	0.00	0.01	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of observations	644	4,865	5,509	689	4,968	5,657	11,166

Note: The table compares characteristics of first-born children across sex and premarital birth status (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1)− (2) are reported for the test of equality between diff.(1) and diff.(2).

remarks: (1) In-utero sex selection being unlikely in Senegal, the above patterns should not be driven by women who can afford having a child while being single and who select having daughters.[12] But, if women giving birth before being married are positively selected, i.e., their socioeconomic characteristics allow them to provide better care to their children, this could explain the lower mortality risk found for daughters born before their mother's marriage. Yet, one would have expected to observe the same pattern for boys. (2) If stigma associated with a premarital birth is on average manageable, explaining why we observe premarital births in Senegal, our results may indicate that actually stigma is managed differently depending on the gender of the child.

Other interesting patterns relate to birth intervals to next-youngest sibling. We find that around 35 months separate a first-born child and her next-youngest sibling when the first child was born from a married mother. The interval is similar whether the first child is a girl or a boy. This indicates that preference for son, if it exists, does not affect second-birth timing. The interval increases when the first child was born from a mother not already married. This is expected if stigma (on the marriage market) follows a premarital birth[13] or if women having a premarital birth are positively selected (they would have married later and had longer birth intervals in any case). This interval is found to be even higher when a boy was born before the mother's first marriage (almost 46 months). Since longer succeeding birth intervals are expected to decrease children's mortality risk [Winikoff (1983)], these difference should again be considered when analyzing children's mortality. That being said, a child's mortality could also affect the timing of others births, e.g., succeeding birth interval could be endogenous in a model explaining mortality.

All in all, the finding relative to boys born before their mother's first marriage is worrisome: for what reasons boys born to single mothers do not benefit, as girls seem to, from having a mother with relatively better characteristics, and from longer succeeding birth interval?

2.3. Premarital Births: Correlates at Second-Born Children's Level

In this section, we investigate the extent to which the differentiated patterns observed at the level of first-born children persist at the level of second-born children. In Table 2, we describe characteristics of second-born children to provide preliminary insights on this question.

An important result is that second-born children whose elder sibling is a boy born before the mother's first marriage have the highest mortality rate. In contrast, second-born children whose elder sibling is a girl born before the mother's first marriage have the lowest mortality rate. The double difference is significant. In other words, if mothers who start their fertile life as single are positively selected, neither the boy born out-of-wedlock, nor the boy's next-younger sibling, seems to benefit from this positive selection. Alternatively, stigma associated with a premarital birth is manageable, but to a lesser extent for boys and for their next-younger sibling.

TABLE 2. Second-born children characteristics

Variables	First child = Girl			First child = Boy			Diff.
	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
Child died before 2 year old	0.07	0.08	0.02	0.11	0.09	− 0.02	− 0.03**
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Child: girl	0.49	0.47	− 0.02	0.47	0.48	0.02	0.03
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Child: born before mother's first marriage	0.43	0.00	− 0.43***	0.48	0.00	− 0.48***	− 0.06***
	(0.02)	(0.00)	(0.02)	(0.02)	(0.00)	(0.02)	(0.01)
Child: twin birth	0.05	0.03	− 0.02	0.03	0.04	0.01	0.02*
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Child: born during dry season	0.63	0.65	0.01	0.63	0.64	0.01	− 0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Child: preceding birth interval (in month)	43.34	35.63	− 7.71***	45.71	35.46	− 10.25***	− 2.54*
	(1.11)	(0.32)	(1.16)	(1.27)	(0.30)	(1.30)	(1.34)
Child: birth year in 1981 or before	0.01	0.01	− 0.00	0.03	0.01	− 0.02**	− 0.01**
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)
Child: birth year between 1982 and 1986	0.05	0.05	− 0.01	0.07	0.06	− 0.01	− 0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Child: birth year between 1987 and 1991	0.13	0.10	− 0.02*	0.13	0.10	− 0.03**	− 0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)

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TABLE 2. Continued

	First child = Girl			First child = Boy			Diff.
Variables	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
Child: birth year between 1992 and 1996	0.16	0.16	0.00	0.18	0.17	− 0.01	− 0.01
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Child: birth year between 1997 and 2001	0.21	0.21	0.00	0.16	0.21	0.05^{***}	0.04^{*}
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Child: birth year between 2002 and 2006	0.23	0.25	0.02	0.22	0.24	0.01	− 0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Child: birth year between 2007 and 2011	0.19	0.18	− 0.00	0.17	0.18	0.01	0.01
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Child: birth year in 2012 or after	0.03	0.04	0.01	0.05	0.04	− 0.01	-0.02^{*}
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Number of observations	654	4,921	5,575	697	5,038	5,735	11,310

Note: The table compares characteristics of second-born children across two characteristics of first-born children: their sex and their premarital birth status (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

Our subgroups of second-born children actually differ in other dimensions that could explain part of the differences in their mortality rates. In particular, the data reveal that close to half of second-born children are also born from a single mother. This proportion actually varies with the gender of the first child born before the mother's first marriage (43% when a girl was born and 48% when a boy was born). These last statistics also work in favor of a stronger stigma following the birth of a boy out of wedlock and that would make the marriage of one's mother less likely to happen rapidly.

So far, these data invite us to compare mortality rates of first-born children depending on their premarital birth status *and* on their gender as well as mortality rates of second-born children depending on the premarital birth status of their elder sibling, as well as their own, *and* on the elder sibling's gender.

3. THE EMPIRICAL MODELS

In this section, we present the empirical models used to go beyond descriptive analysis and to answer the two following questions: (1) do children born first to a mother who was single at that date have a different mortality rate than other first-born children? (2) Does having an eldest sibling born out of wedlock affect the mortality rate of second-born children?

3.1. On the Consequences of Being Born to a Single Mother

On the sample of first-born children (among ever-born), we estimate the following model:

$$\text{Mort}_{i,m} = \alpha_0 + \beta_1 \text{Girl}_{i,m} + \beta_2 \text{PMB}_{i,m} + \beta_3 \text{Girl}_{i,m} * \text{PMB}_{i,m} + \beta_4 X1_{i,m} + \varepsilon_{i,m}, \quad (1)$$

where $\text{Mort}_{i,\,m}$ is a dummy that equals one if the child died before reaching 2 year old and zero otherwise; PMB is a dummy that equals one if the child was born before his mother's first marriage and zero otherwise; $\text{Girl}_{i,\,m}$ is a dummy to indicate whether the child is a girl and zero otherwise. $\text{Girl}_{i,\,m}$*$\text{PMB}_{i,\,m}$ is the interaction term that captures the specific effect of being born out-of-wedlock for girls. $X1_{i,\,m}$ is a vector of child and mother level characteristics, predetermined at the birth of the child, to ease their interpretation (they are not affected by potential reverse causality). It includes information on the child's year of birth,[14] and season of birth (dry versus rainy). It also includes measures relative to the mother's characteristics: her age at first birth and, importantly, her ethnic group.[15] $\varepsilon_{i,\,m}$ is the error term.

Conditional on all variables included, the coefficient on $\text{Girl}_{i,\,m}$*$\text{PMB}_{i,\,m}$ is identified if a child's premarital birth status is independent from her gender that is if parents do not practice in-utero sex selection. This condition is likely to hold in our context.

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We estimate two additional specifications of equation (1) that include characteristics potentially affected by the child's premarital birth and/or survival status. In these specifications, coefficients should therefore be interpreted with caution. In a second specification, we control for mother's education (whether she has no education, whether she has incomplete primary education, the reference category being whether the mother has more than primary education). In a third one, we control for birth interval with the next-youngest sibling.[16]

3.2. On the Consequences of Being the Youngest Sibling of a Child Born Premarital

To evaluate whether any stigma affecting a premarital birth affects also later-born children, we estimate the following model on second-born children (among ever-born):

$$\begin{aligned}\text{Mort}_{i,m} = {} & \alpha'_0 + \beta'_1\text{SibGirl}_{i,m} + \beta'_2\text{SibPMB}_{i,m} + \beta'_3\text{SibGirl}_{i,m} * \text{SibPMB}_{i,m} \\ & + \beta'_4 X1_{i,m} + \varepsilon'_{i,m},\end{aligned} \quad \textbf{(2)}$$

where $\text{SibPMB}_{i,\,m}$ is a dummy that equals one if the child's elder sibling was born before their mother's first marriage and zero otherwise, and $\text{SibGirl}_{i,\,m}$ is a dummy that equals one if the child's elder sibling is a girl and zero otherwise. $\text{SibGirl}_{i,\,m}*\text{SibPMB}_{i,\,m}$ is the interaction between the two later defined dummies. $X1_{i,\,m}$ is a vector of child and mother level characteristics similar to the one included in equation (1). It also includes a dummy to indicate whether the child was born as a twin.[17]

$\text{SibGirl}_{i,\,m}*\text{SibPMB}_{i,\,m}$ measures whether the second-born children's mortality varies with the premarital birth status of their first-born sibling in a different way given the gender of the first-born sibling. Conditional on all variables included, it is identified on the same condition as the one stated above: that parents do not practice in-utero sex selection.

In a second specification, we control for a measure of birth interval with the older sibling and for a dummy indicating whether the second-born child was him/herself born before the mother's first marriage or not. In a third specification, we control additionally for mother's education. All these characteristics are potentially affected by the premarital birth status of the first-born child. Therefore, they can be understood as different channels through which a premarital birth may affect the mortality of later-born children.

All above-mentioned models are estimated in ordinary least squares with standard errors clustered at the mother level.

3.3. On the Choice of the Outcome

Mortality rate comparison before 2 year old is justified to overcome the fact that in SDHS we do not know whether dead children where residing with their mother or with someone else at the time of their death. In Senegal, children are used to being fostered out starting from age 2 [Coppoletta et al. (2012)]. Since both probabilities to be fostered out and born before the mother's union could be positively correlated,[18] looking at mortality rate differences at higher ages raises the risk of confounding the effect of being born before the marriage of one's mother and of having been fostered out. This risk is minimized by examining, for first-born children, the mortality before 2 year old. A priori the issue raised being of less importance for second-born children, mortality at 5 year old is also investigated for them.[19]

4. RESULTS

4.1. Main Results

Estimation results of equation (1), and of its various specifications, are presented in Table 3. We first comment results from the first specification, and then results from the second and the third ones. The two later including potentially endogenous characteristics, the interpretation of the estimated effects, call for caution.

In the first specification, the double difference (or the interaction term) is significant at 15% level. Boys and girls do not have the same mortality at 2, with girls having a higher probability to survive. This gender gap is slightly higher among children born to a single mother. The widening of the gap is driven by girls: If they were born before their mother's first union, their survival probability is even higher. These findings confirm those obtained looking at descriptive statistics. They raise the question of why boys born to a single mother do not benefit, as girls, from any positive selection of their mothers. Note the negative effect of age at first birth on mortality.

In the second specification, which controls for mother's education, point estimates of the three coefficients of interest remain relatively similar. The interaction term becomes significant at 10% level. Low education, itself, has a positive effect on mortality. In the third specification, which controls for succeeding birth interval, the point estimate of the coefficient capturing the effect of being a boy born to a single mother increases in size and becomes significant at 10% level. A downward bias is corrected by introducing succeeding birth interval since we saw in descriptive statistics that succeeding birth interval is the longest for boys born to a single mother and since longer birth intervals have on average a significant negative effect on mortality. In addition, the size of the coefficient on the interaction term (as well as on the gender dummy) remains quite similar, which is reassuring regarding our identification hypothesis. However, since reverse causality could be at play, the interpretation of the coefficient sizes in this last model is challengeable.[20]

Estimation results of equation (2), and of its various specifications, are presented in Table 4. The average effect of being the later-born sibling of a child born from a single mother is also presented (specifications 1 and 5). Mortality at

Table 3. First-born children's mortality at 2 year old: Linear probability model

	(1)	(2)	(3)
Child: born before mother's marriage × child is a girl	– 0.028 (0.02)+	– 0.030 (0.02)*	– 0.033 (0.02)*
Child: born before mother's first marriage	0.001 (0.01)	0.012 (0.01)	0.025 (0.01)*
Child: girl	– 0.023 (0.01)***	– 0.022 (0.01)***	– 0.022 (0.01)***
Child: born during dry season	0.006 (0.01)	0.005 (0.01)	0.007 (0.01)
Mother: Age at first birth	– 0.004 (0.00)***	– 0.003 (0.00)***	– 0.003 (0.00)***
Mother: No education		0.069 (0.01)***	0.059 (0.01)***
Mother: Incomplete primary		0.033 (0.01)***	0.027 (0.01)***
Succeeding BI (month)			– 0.002 (0.00)***
Constant	0.223 (0.05)***	0.167 (0.05)***	0.213 (0.05)***
Diff. if girls (*p*-value)	0.02	0.13	0.50
N	11,166	11,166	11,166
R	0.01	0.02	0.03

Note: Ethnic group, year of interview and categories of birth year are controlled for (coefficients not shown).
Diff if girls indicates the *p*-value of the test testing the equality of the coefficient on being born before a mother's marriage and of the coefficient on being born after, for girls.
Standard errors are clustered at the mother level. Significance levels are denoted as follows: + $p<0.15$, $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

TABLE 4. Second-born children's mortality: Linear probability model

	Mortality at 2				Mortality at 5			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Child: Mother had a PMB	– 0.006 (0.01)	0.011 (0.01)	0.006 (0.01)	0.013 (0.01)	– 0.005 (0.01)	0.009 (0.01)	0.003 (0.01)	0.011 (0.01)
Child: girl	– 0.012 (0.01)**	– 0.012 (0.01)**	– 0.012 (0.01)**	– 0.011 (0.01)**	– 0.013 (0.01)**	– 0.013 (0.01)**	– 0.012 (0.01)**	– 0.012 (0.01)**
Child: was born as a twin	0.220 (0.03)***	0.220 (0.03)***	0.224 (0.03)***	0.224 (0.03)***	0.216 (0.03)***	0.216 (0.03)***	0.220 (0.03)***	0.219 (0.03)***
Child: born during dry season	– 0.014 (0.01)**	– 0.014 (0.01)**	– 0.015 (0.01)***	– 0.015 (0.01)***	– 0.015 (0.01)**	– 0.015 (0.01)**	– 0.016 (0.01)***	– 0.016 (0.01)***
Mother: Age at first birth	– 0.002 (0.00)***	– 0.002 (0.00)***	– 0.003 (0.00)***	– 0.002 (0.00)***	– 0.002 (0.00)***	– 0.002 (0.00)***	– 0.003 (0.00)***	– 0.002 (0.00)**
Child: Mother had a PMB × first-born sibling is a girl		– 0.034 (0.02)**	– 0.035 (0.02)**	– 0.035 (0.02)**		– 0.029 (0.02)+	– 0.030 (0.02)*	– 0.030 (0.02)*
Child: First-born sibling is a girl		– 0.003 (0.01)	– 0.003 (0.01)	– 0.003 (0.01)		– 0.007 (0.01)	– 0.007 (0.01)	– 0.006 (0.01)
Child: born before mother's first marriage			0.024 (0.02)+	0.026 (0.02)*			0.027 (0.02)+	0.030 (0.02)*
Preceding BI (month)			– 0.001 (0.00)***	– 0.001 (0.00)***			– 0.001 (0.00)***	– 0.001 (0.00)***
Mother: No education				0.049 (0.01)***				0.060 (0.01)***
Mother: Incomplete primary				0.012 (0.01)+				0.020 (0.01)**
Constant	0.098 (0.02)***	0.098 (0.02)***	0.155 (0.02)***	0.110 (0.02)***	0.105 (0.02)***	0.108 (0.02)***	0.166 (0.02)***	0.110 (0.02)***
Diff if first-born is a sister (*p*-value)		0.04	0.02	0.07		0.10	0.05	0.15
N	11,310	11,310	11,304	11,304	11,310	11,310	11,304	11,304
R	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.04

Note: PMB stands for premarital birth.

Ethnic group, year of interview and categories of birth year are controlled for (coefficients not shown).

Diff if first-born is a sister (p-value) indicates the *p*-value of the test testing the equality of the coefficient on having an elder sister born before a mother's marriage and of the coefficient on having an elder sister born after.

Standard errors are clustered at the mother level. Significance levels are denoted as follows: + $p < 0.15$, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

age 2 is examined in specifications 1–4 and mortality at age 5 in specifications 5–8.

Analyzing mortality at age 2, being the second-born sibling of a child born before the mother's first marriage has on average no effect on children's mortality. However, being the second-born sibling of a girl born to a single mother decreases the mortality rate relative to being the second-born sibling of a girl born to a married mother (column 2). The premarital status at the birth of an elder brother does not have any effect. The double difference is significant at 5% level. These point estimates are similar across specifications, which is, again, reassuring regarding our identification hypothesis. These observations apply when analyzing mortality at age 5. It is interesting to note that the observed effect is not driven by second-born children who are also born out of wedlock, as we control for this in specifications 3 and 4 (7 and 8). Children born second to a mother still single at the time of their birth have a higher risk of dying before reaching 2 year old.

4.2. Robustness Analysis

We perform two robustness analysis. First, to evaluate the role of premarital birth status and of gender on first-born children's mortality at 2 year old, we estimate the following alternative model:

$$\text{Mort}_{i,m} = \alpha_0 + \gamma_1 \text{PreMarBirth}_{i,m} + \gamma_2 X1_{i,m} + \mu_m + \varepsilon_{i,m}, \quad \textbf{(3)}$$

where μ_m indicates mother fixed effects. $\text{PreMarBirth}_{i,m}$ is a dummy indicating whether the child was born before the mother's first marriage and zero otherwise, and $X1_{i,m}$ is a vector of child level characteristics, similar to the one included in equation (2). All characteristics can be considered as predetermined at child's birth. Given the challenges linked with its interpretation, a measure of succeeding birth interval is introduced only in a second specification. The model is estimated on all children ever born, whatever the mother's age. The coefficient of interest γ_1 is identified on the subsample of children whose mother ever married and had at least one child born while being single and another one born while being married. Last-born children are excluded to maintain sample size comparable across specifications controlling and not controlling for succeeding birth interval. Note that the coefficient on the dummy indicating whether the child is born first is identified, while we control for whether the child is born to a single mother, as we have children born out of wedlock of birth rank 2 (and more). Adding fixed effects to our model allows us to control for mother's fixed and unobserved characteristics. Doing so, we reduce any bias driven by the potential positive selection of mothers. Results are presented in Table A.7 in the appendix.

According to specification (1), a child's mortality is not affected by his premarital status at birth. We observe a significant effect when succeeding birth interval is accounted for [specification (3)]. The first result was likely downward biased. We do not find a gender-differentiated effect [specifications (2) and (4)]. However, the estimated difference in mortality rates between boys depending on their premarital birth status in specification (4) (2.6) is very similar to the one obtained when estimating equation (1) (2.5) [specification(3) in Table 3].

For second-born children, we re-estimate the mortality equation [equation (2)] reducing the sample to children whose mother is 30 year old or more (each year of interview).[21] Results are presented in the appendix in Table A.8. When analyzing mortality at age 2, coefficients on the interaction term is still negative and significant (and still relatively constant across specifications). Point estimates are higher than those obtained in Table 4.

5. HETEROGENEITY AND DISCUSSION

5.1. Heterogeneity

We investigate whether the patterns found hold for more recent cohort of mothers. To do so, we re-estimate equations (1) and (2) on the subsample of mothers aged 25–35 year old (each year of interview).[22] Note that the number of first-born children born before their mother's first marriage, *of a given sex*, experiencing a death could be below 30 (similarly for the number of second-born children with a sibling *of a given sex* born before marriage). Therefore, interaction terms should be interpreted with caution.[23] For first-born children, results are shown in Table A.9, for second-born children, in Table A.10.

As regards first-born children, the effect of premarital birth status on a child's mortality appears still to be gender differentiated (the coefficient on the interaction term has increased in size) but its significance has reduced. As regards second-born children, the only effect we observe is that having a first-born sibling (whatever his sex) born before the mother's marriage decreases second-born children's mortality. The effect is no longer differentiated along the sex of the first-born child (coefficient of the interaction term has significantly decreased). Positive selection could drive the result found. Therefore, the benefit of being the next-youngest sibling of a girl born to a single mother relative to a girl born to a married mother seems to be driven by children of older cohorts of mothers.

5.2. Discussion

5.2.1. Measure quality. Information on abortion and date of abortion is absent in these surveys (only the date of last pregnancy termination is available). This could be an issue if within the group of second-born children whose mother never had a premarital birth, those whose mother had a premarital pregnancy she could terminate differ from those whose mother never had a premarital pregnancy. Yet, if the former are more vulnerable than the later, notably because abortions damage women's health, then our estimates of the average effect of having an elder sibling born while the mother was single are biased toward zero.

5.2.2. Channels of effect?. Our results relative to first-born children could be interpreted in two major ways. First, one might argue that boys have an innate survival rate during infancy even more lower if they were born from a single mother: The mother's stress due to her singlehood status could transmit to the child through in utero channels Reynolds et al. (2013), Wadhwa et al. (2011) more when the child is a boy, than when the child is a girl, due to boys' higher physiological vulnerability. To evaluate the extent to which this channel can be at work, we present in Table A.11 in the appendix children's weight at birth (in gram) and height at birth (in centimeter) as reported by mothers for the last six births. Although available on a small number of observations, the patterns reported in the table confirm that first-born boys born premarital have a lower weight at birth than girls born in the same conditions and boys born within marriage. However, the differences observed between subgroups of children are not significant. In addition, this hypothesis hardly explains the persistence of an effect up through second-born children.

Second, one might suspect that mothers face different difficulty and marginalization depending on the sex of the child born premarital. This would materialize both in the support the woman receives while raising her child while single and in the marriage she contracts following the birth. The marriage that follows the birth of a boy may systematically differ from the marriage that follows the birth of a girl: The characteristics of the husband could be at stake, as well as the characteristics of support provided by parents to the couple. Our result suggest these characteristics are relatively better when a girl was born to a nonmarried mother. Unfortunately, with data in hand, we cannot test formally for such a channel of effect.[24]

6. CONCLUSION

This paper investigates the extent to which being born to a single mother in a context where premarital sexual relationships are more common but still socially disapproved, affects a child' survival probability. We expand the analysis by looking at heterogenous effect along the sex of the child and by examining whether a lasting effect exists through the survival probability of second-born children. We find that the mortality rate is higher for first-born boys but not for first-born daughters, whose mother was single at the time of their birth, and lower for second-born children whose sister, but not brother, was born out of wedlock. The latter effect is actually driven by children from older cohorts of women. These results are robust to a set of robustness checks and are unlikely to be driven solely by a selection effect, in-utero sex selection being uncommon in Senegal.

Therefore, strategies to mitigate the negative consequences of the stigma associated with a premarital birth seem to exist but to vary with the gender of the child born premarital in Senegal. Persisting negative effects appear also to have decreased over time. Overall, our findings indicate that social programs targeting single mothers, especially when they gave birth to a boy, would help avoiding dramatic events such as the death of a child.

With the data in hand, we cannot without ambiguity disentangle between different potential channels through which boys born to a single mother are at a higher risk of death. We provide some evidence that this effect is not due to an innate survival rate during infancy that is even more lower for boys when they were born to a single mother. Marriage quality does not seem to differ also between groups of mother depending on the gender of the first-born child and on their marital status at birth. A channel left for future analysis is whether the support provided by the family decreases when the couple formed by the daughter is somehow forced, notably following the birth of a boy.

NOTES

1 Based on the 2012 United Nations report on the Millennium Development Goals, the mortality rate reduced by 2.4% over the period 2000–2010 in Sub-Saharan Africa.

2 Men and women are not equal in this respect. Premarital sexual relationships are even encouraged for men to prove their manhood. As indicated in Adjamagbo et al. (2014), this double standard is reflected in the legal regulations of marriage and sexuality. Senegalese men and women are not equal in marriage: For women the legal age at marriage (allowed from 16 years) corresponds to that of sexual majority, whereas it is 20 years for men (four years after sexual majority).

3 Not all premarital pregnancies are unintended. Ethnographic evidence suggests that pregnancies that are premarital can also be planned, e.g., thought as a mean for a couple to impose their union to their family [Abega et al. (1994), Dramé (2003), Adjamagbo and Koné (2013)]. Yet, if such a pregnancy is desired by the couple, it is usually in contexts where it is not desired by the family.

4 The country's criminal code completely prohibits pregnancy termination. However, the code of medical ethics allows an abortion if three doctors testify that the procedure is necessary to save a pregnant womans life.

5 Single motherhood at (first birth) has been widely investigated in developed countries, in particular in the United States. See for instance Lester (1992) for an early investigation on consequences on child mortality.

6 This ensures to have first and second born children to be comparable in terms of sibship size. This exclusion should not be an issue since twin births are likely random in our setting.

7 In the SDHS data, the question reported is "what is the date of first *cohabitation*?". This labeling was chosen to be inclusive of all women potentially coresiding with their partners, even the one who are not married. However, the question does capture the date of marriage and not the date of cohabitation for married couple. Careful comparison of questionnaires and database for Senegal 1992, 2005, and 2010 confirms this conclusion, so does the absence of missing values for women married but who might have not yet started living with their husband.

8 In SDHS 2010 data, Fulani women marry at 16.63, whereas other groups at 18.23. The difference is statistically significant at 1% level.

9 DHS survey do not measure income but measure housing characteristics and material asset holdings. The wealth indicator is a categorial variable distributing households within five groups. This follows a principal component analysis including information relative to housing and material holdings.

10 The information is provided only for the births a mother had during the last 5 years.

11 In DHS, respondents are asked whether the child was wanted at the time of pregnancy, whether the pregnancy was wanted to arrive later, or whether the child was not wanted at all. We here consider that a pregnancy was desired only if the child was wanted at the time of the pregnancy.

12 Note that the proportion of girls is similar between children born first from a single mother and other first-born children.

13 This phenomenon is documented by Mondain and Delaunay (2006) for the Sereer in rural Senegal.

14 Categories of birth year (4-year interval) are included. The reference category is children born in 1981 or before.

15 Dummies to indicate whether the mother is Wolof, Serere, or Fulani are included. The reference category is all other ethnic groups.

16 We do not control for more potentially endogenous characteristics to keep tractable changes in the coefficients of interest. Besides, all variables that appear to be significantly different across groups in the descriptive analysis are introduced. There is one exception: first quintile of wealth. But this is correlated with the mother's level of education.

17 Twins born second are both considered as second-born children in this analysis.

18 By fostering out the child born premarital, a mother might look at reducing the stigma of having a premarital birth. Emina (2008) has worked on the implication of premarital childbearing on the household structure. He found for Cameroon that children born premarital are more likely to be fostered out than children born in wedlock. In our data, we observe that among first-born 39% of those born to a single mother have been fostered out against 29% of those born to a married mother.

19 In DHS data, anthropometric variables are recorded only for children born during the 5 years preceding the survey. This limitation heavily affects the number of observations we could rely on for the analysis and would prevent us from conducting heterogeneity analysis. Therefore, we decided to work with mortality outcome, which presents both advantages and disadvantages. On one hand, death is a dramatic event, which means that variation in our outcome of interest is not trivial and would capture a strong relationship with premarital birth events. On the other hand, being an indicator of extreme vulnerability, mortality is not an outcome that varies widely that raises precision issue for the analysis, this is all the more true as we investigate the link between mortality and premarital births that are not a widespread phenomenon. As a consequence, we propose to look at the significance of our results up to 15%.

20 It is difficult to evaluate the extent to which reverse causality between mortality and succeeding birth interval in our model is an issue. Though we describe in Tables A.5 and A.6 the distribution of succeeding birth interval across children's premarital birth status and survival status, for boys and girls, respectively, we do not find patterns suggesting that mortality affects succeeding birth interval in a different way depending on the child's premarital birth status, and on the child's gender.

21 Recall that at 30 year old, 98% of mothers have at least two ever-born children.

22 Subsample size issues (notably linked with a relatively low mortality rate at 2 year old) prevent us from looking at whether the effect found for second-born children is differentiated by their gender, and whether these effects vary with ethnic groups.

23 We modify the set of controls: We replace the eight dummies to indicate the birth year interval by one dummy: whether the child was born between 2012–2015 or not.

24 As indirect evidence for a channel of effect through the "quality" of the husband, we compare in Tables A.12 and A.13, past and current marriage characteristics of mothers, depending on whether they ever had a premarital birth and on the sex of the first-born child (information is provided on the subsample for which data are available on all characteristics included in the tables). We find that mothers currently married have spouses with different characteristics and have a different level of autonomy when they gave birth before being married (consistent with a positive selection), but the patterns do not significantly vary with the sex of the first child.

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APPENDIX A

A.1. Baseline

TABLE A.1. Mothers characteristics

	First child = Girl			First child = Boy			Diff.
Variables	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) − (1)
Mother is Wolof	0.25	0.34	0.08***	0.20	0.34	0.14***	0.06**
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother is Fulani	0.23	0.34	0.11***	0.24	0.34	0.10***	− 0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother is Serere	0.15	0.13	− 0.02	0.15	0.12	− 0.03**	− 0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Mother is Mandingue–Diola–Sarakhole	0.23	0.11	− 0.12***	0.28	0.12	− 0.16***	− 0.04**
	(0.02)	(0.00)	(0.02)	(0.02)	(0.00)	(0.02)	(0.02)
Mother is from another ethnic group	0.14	0.08	− 0.06***	0.14	0.08	− 0.06***	0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Mother: No. years of education	2.22	1.25	− 0.98***	2.44	1.23	− 1.21***	− 0.24
	(0.13)	(0.04)	(0.13)	(0.13)	(0.04)	(0.14)	(0.16)
Mother: No education	0.61	0.78	0.18***	0.60	0.79	0.19***	0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Mother: Incomplete primary	0.25	0.14	− 0.11***	0.22	0.13	− 0.09***	0.03
	(0.02)	(0.00)	(0.02)	(0.02)	(0.00)	(0.02)	(0.02)
Mother: Completed primary	0.05	0.03	− 0.02***	0.05	0.02	− 0.03***	− 0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Mother: More than primary	0.09	0.05	− 0.04***	0.13	0.06	− 0.08***	− 0.04***

TABLE A.1. Continued

	First child = Girl			First child = Boy			Diff.
Variables	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) − (1)
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Mother: Age at first birth	18.57	19.58	1.00***	18.39	19.53	1.14***	0.14
	(0.16)	(0.06)	(0.17)	(0.16)	(0.06)	(0.17)	(0.23)
Mother: Age	34.71	34.87	0.16	35.30	35.10	− 0.20	− 0.35
	(0.26)	(0.10)	(0.28)	(0.26)	(0.10)	(0.28)	(0.40)
Mother: Never married	0.08	0.00	− 0.08***	0.09	0.00	− 0.09***	− 0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Mother: Ever had a terminated pregnancy	0.22	0.25	0.03*	0.23	0.25	0.02	− 0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother: Number of children ever born	4.87	5.04	0.17*	4.88	5.10	0.22**	0.05
	(0.09)	(0.03)	(0.10)	(0.09)	(0.03)	(0.10)	(0.14)
Number of observations	644	4,868	5,512	689	4,969	5,658	11,170

Note: The table compares characteristics of mothers across the sex of the first born child and incidence of premarital birth (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

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A.2. Main Results

Table A.2. Household characteristics of mothers

	First child = Girl			First child = Boy			Diff.
Variables	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) − (1)
Mother is the hh head	0.10	0.10	− 0.00	0.09	0.09	− 0.00	− 0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Mother is a spouse of the hh head	0.43	0.51	0.08***	0.45	0.52	0.08***	− 0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Household head: female	0.26	0.21	− 0.04**	0.24	0.20	− 0.04**	0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Household head: age	53.58	52.26	− 1.32**	53.16	51.92	− 1.24**	0.08
	(0.56)	(0.20)	(0.59)	(0.54)	(0.19)	(0.57)	(0.81)
number of household members (listed)	13.69	13.77	0.08	13.28	14.04	0.76**	0.69
	(0.33)	(0.12)	(0.35)	(0.32)	(0.12)	(0.34)	(0.50)
Household: Rural	0.57	0.68	0.12***	0.58	0.69	0.11***	− 0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)

Table A.2. Continued

	First child = Girl			First child = Boy			Diff.
Variables	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) − (1)
Household: First quintile of wealth index	0.18	0.29	0.11***	0.24	0.28	0.05***	– 0.07**
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Household: Second quintile of wealth index	0.27	0.25	– 0.02	0.23	0.25	0.02	0.03
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Household: Third quintile of wealth index	0.26	0.21	– 0.05**	0.25	0.21	– 0.04**	0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Household: Fourth quintile of wealth index	0.21	0.15	– 0.06***	0.18	0.15	– 0.03*	0.03
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Household: Fifth quintile of wealth index	0.09	0.10	0.01	0.10	0.10	0.01	– 0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
Currently in Dakar	0.10	0.07	– 0.03**	0.08	0.07	– 0.01	0.02
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Number of observations	644	4,868	5512	689	4,969	5,658	11,170

Note: The table compares characteristics of households across the sex of the first born child and incidence of premarital birth (PMB stands for premarital birth). Wealth index quintiles are not weighted. Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

A.3. Robustness Analysis

TABLE A.3. Mothers characteristics

	First child = Girl			First child = Boy			diff.
Variables	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) – (1)
Mother: ever married	0.92	1.00	0.08***	0.92	1.00	0.08***	0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
beating justified if wife goes out without telling husband	0.43	0.55	0.12***	0.45	0.54	0.09***	– 0.03
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
beating justified if wife neglects the children	0.44	0.54	0.10***	0.45	0.53	0.08***	– 0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
beating justified if wife argues with husband	0.44	0.57	0.13***	0.46	0.56	0.10***	– 0.03
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
beating justified if wife refuses to have sex with husband	0.48	0.59	0.12***	0.48	0.59	0.10***	– 0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
beating justified if wife burns the food	0.26	0.31	0.05***	0.24	0.32	0.07***	0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Number of observations	636	4,833	5,469	683	4,937	5,620	11,089

Note: The table compares characteristics of mothers across the sex of the first born child and incidence of premarital birth (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p< 0.10$, $^{**}p <0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

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A.4. Discussion

TABLE A.4. First-born children characteristics: desired pregnancy

	First child = Girl			First child = Boy			Diff.
Variables	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
Pregnancy intended	0.63	0.96	0.32**	0.55	0.95	0.40***	0.08
	(0.11)	(0.01)	(0.11)	(0.11)	(0.02)	(0.11)	(0.08)
Number of observations	19	251	270	22	219	241	511

Note: The table compares characteristics of first-born children across sex and premarital birth status (PMB stands for premarital birth) for children born during the last 5 year only. Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

TABLE A.5. First-born boys: succeeding birth interval

	First born boy = deceased			First born boy = survived			Diff.
Variables	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
Succeeding BI (month)	40.14	28.84	− 11.30***	46.63	36.39	− 10.24***	1.06
	(3.05)	(0.78)	(3.15)	(1.39)	(0.33)	(1.43)	(2.72)
Number of observations	98	640	738	591	4,328	4,919	5,657

Note: The table compares characteristics of children across sex, birth status and survival status (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for t-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

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TABLE A.6. First-born girls: succeeding birth interval

	First born girl = deceased			First born girl = survived			Diff.
Variables	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
Succeeding BI (month)	37.47	28.32	− 9.15***	43.87	36.41	− 7.46***	1.69
	(2.90)	(0.80)	(3.01)	(1.19)	(0.34)	(1.24)	(3.37)
Number of observations	55	513	568	589	4,352	4,941	5,509

Note: The table compares characteristics of children across sex, birth status and survival status (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

TABLE A.7. (All mothers) Children's mortality at 2 year old (last born child is excluded): Linear probability model with mother fixed effects

	(1)	(2)	(3)	(4)
Child: born before mother's first marriage	0.010 (0.01)	0.017 (0.01)+	0.020 (0.01)**	0.026 (0.01)**
Child: first born	– 0.009 (0.00)*	– 0.009 (0.00)*	– 0.028 (0.01)***	– 0.028 (0.01)***
Child: girl	– 0.020 (0.00)***	– 0.019 (0.00)***	– 0.019 (0.00)***	– 0.019 (0.00)***
Child: twin birth	0.159 (0.01)***	0.159 (0.01)***	0.167 (0.01)***	0.167 (0.01)***
Child: born during dry season	– 0.003 (0.00)	– 0.003 (0.00)	– 0.001 (0.00)	– 0.001 (0.00)
Child: preceding birth interval (in month)	– 0.001 (0.00)***	– 0.001 (0.00)***	– 0.002 (0.00)***	– 0.002 (0.00)***
Child: born before mother's marriage × child is a girl		– 0.015 (0.01)		– 0.012 (0.01)
Child: succeeding birth interval (in month)			– 0.002 (0.00)***	– 0.002 (0.00)***
Constant	0.110 (0.01)***	0.110 (0.01)***	0.172 (0.01)***	0.172 (0.01)***
N	48,228	48,228	47,852	47,852
R	0.03	0.03	0.04	0.04
Diff if girls (*p*-value)		0.83		0.25

Note: Categories of birth year are controlled for (coefficients not shown).
Diff if girls indicates the *p*-value of the test testing the equality of the coefficient on being born before a mother's marriage and of the coefficient on being born after, for girls.
Standard errors are clustered at the mother level. Significance levels are denoted as follows: + $p<0.15$, $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

TABLE A.8. (Mother 30+) Second-born children's mortality: Linear probability model

	Mortality at 2				Mortality at 5			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Child: Mother had a PMB	0.001 (0.01)	0.021 (0.02)	0.018 (0.02)	0.026 (0.02)+	0.001 (0.01)	0.017 (0.02)	0.013 (0.02)	0.023 (0.02)
Child: girl	– 0.016 (0.01)**	– 0.016 (0.01)**	– 0.016 (0.01)**	– 0.016 (0.01)**	– 0.016 (0.01)**	– 0.016 (0.01)**	– 0.016 (0.01)**	– 0.016 (0.01)**
Child: was born as a twin	0.239 (0.04)***	0.239 (0.04)***	0.243 (0.04)***	0.243 (0.04)***	0.234 (0.04)***	0.235 (0.04)***	0.239 (0.04)***	0.239 (0.04)***
Child: born during dry season	– 0.014 (0.01)**	– 0.014 (0.01)**	– 0.015 (0.01)**	– 0.015 (0.01)**	– 0.018 (0.01)**	– 0.018 (0.01)**	– 0.019 (0.01)***	– 0.019 (0.01)***
Mother: Age at first birth	– 0.001 (0.00)	– 0.001 (0.00)	– 0.002 (0.00)**	– 0.001 (0.00)+	– 0.001 (0.00)	– 0.001 (0.00)	– 0.002 (0.00)**	– 0.001 (0.00)+
Child: Mother had a PMB × first-born sibling is a girl		– 0.041 (0.02)**	– 0.042 (0.02)**	– 0.043 (0.02)**		– 0.033 (0.02)+	– 0.034 (0.02)+	– 0.035 (0.02)*
Child: First-born sibling is a girl		– 0.004 (0.01)	– 0.005 (0.01)	– 0.005 (0.01)		– 0.008 (0.01)	– 0.008 (0.01)	– 0.009 (0.01)
Child: born before mother's first marriage			0.017 (0.02)	0.019 (0.02)			0.019 (0.02)	0.021 (0.02)

TABLE A.8. Continued

	Mortality at 2				Mortality at 5			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Child: preceding birth interval (in month)			– 0.001 (0.00)***	– 0.001 (0.00)***			– 0.001 (0.00)***	– 0.001 (0.00)***
Mother: No education				0.052 (0.01)***				0.065 (0.01)***
Mother: Incomplete primary				0.011 (0.01)				0.019 (0.01)*
Constant	0.068 (0.03)***	0.069 (0.03)***	0.150 (0.03)***	0.108 (0.03)***	0.075 (0.03)***	0.077 (0.03)***	0.162 (0.03)***	0.107 (0.03)***
N	8,431	8,431	8,425	8,425	8,431	8,431	8,425	8,425
R	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.04
Diff. if first-born is a sister (*p*-value)		0.13	0.11	0.25		0.28	0.21	0.45

Note: PMB stands for premarital birth.
Ethnic group, year of interview and categories of birth year are controlled for (coefficients not shown).
Diff if first-born is a sister (p-value) indicates the *p*-value of the test testing the equality of the coefficient on having an elder sister born before a mother's marriage and of the coefficient on having an elder sister born after.
Standard errors are clustered at the mother level. Significance levels are denoted as follows: $+\,p<0.15$, $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

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TABLE A.9. (Mother 25–35) First-born children's mortality at 2 year old: Linear probability model

	(1)	(2)	(3)
Child: born before mother's marriage × child is a girl	– 0.039 (0.02)*	– 0.038 (0.02)+	– 0.039 (0.02)+
Child: born before mother's first marriage	0.007 (0.02)	0.016 (0.02)	0.030 (0.02)+
Child: girl	– 0.010 (0.01)	– 0.010 (0.01)	– 0.010 (0.01)
Child: born during dry season	0.002 (0.01)	0.001 (0.01)	0.002 (0.01)
Child: birth year in 2012 or after	0.046 (0.04)	0.058 (0.04)	0.043 (0.04)
Mother: Age at first birth	– 0.007 (0.00)***	– 0.006 (0.00)***	– 0.007 (0.00)***
Mother: No education		0.065 (0.01)***	0.052 (0.01)***
Mother: Incomplete primary		0.026 (0.01)**	0.018 (0.01)+
Child: succeeding birth interval (in month)			– 0.002 (0.00)***
Constant	0.249 (0.03)***	0.175 (0.03)***	0.272 (0.03)***
N	6,236	6,236	6,236
R	0.01	0.02	0.03
Diff. if girls (*p*-value)	0.04	0.16	0.58

Note: Ethnic group, year of interview and categories of birth year are controlled for (coefficients not shown).
Diff. if girls indicates the *p*-value of the test testing the equality of the coefficient on being born before a mother's marriage and of the coefficient on being born after, for girls.
Standard errors are clustered at the mother level. Significance levels are denoted as follows: + $p<0.15$, $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

TABLE A.10. (Mother 25–35) Second-born children's mortality at 2 year old: Linear probability model

	Models with interaction terms			Models with no interaction		
	(1)	(2)	(3)	(4)	(5)	(6)
Child: Mother had a PMB × first-born sibling is a girl	– 0.010 (0.02)	– 0.011 (0.02)	– 0.010 (0.02)			
Child: First-born sibling is a girl	– 0.001 (0.01)	– 0.000 (0.01)	– 0.000 (0.01)			
Child: Mother had a PMB	– 0.019 (0.01)	– 0.019 (0.01)	– 0.015 (0.01)	– 0.024 (0.01)**	– 0.025 (0.01)**	– 0.021 (0.01)*
Child: girl	– 0.011 (0.01)*	– 0.011 (0.01)*	– 0.011 (0.01)*	– 0.011 (0.01)*	– 0.011 (0.01)*	– 0.011 (0.01)*
Child: was born as a twin	0.186 (0.04)***	0.190 (0.04)***	0.189 (0.04)***	0.186 (0.04)***	0.190 (0.04)***	0.189 (0.04)***
Child: born during dry season	– 0.013 (0.01)*	– 0.015 (0.01)**	– 0.015 (0.01)**	– 0.013 (0.01)*	– 0.015 (0.01)**	– 0.015 (0.01)**
Child: birth year in 2012 or after	– 0.019 (0.01)*	0.001 (0.01)	0.004 (0.01)	– 0.019 (0.01)*	0.001 (0.01)	0.004 (0.01)
Mother: Age at first birth	– 0.005 (0.00)***	– 0.006 (0.00)***	– 0.006 (0.00)***	– 0.005 (0.00)***	– 0.006 (0.00)***	– 0.006 (0.00)***
Child: born before mother's first marriage		0.025 (0.02)	0.027 (0.02)		0.026 (0.02)	0.027 (0.02)+
Child: preceding birth interval (in month)		– 0.001 (0.00)***	– 0.001 (0.00)***		– 0.001 (0.00)***	– 0.001 (0.00)***
Mother: No education			0.033 (0.01)***			0.033 (0.01)***
Mother: Incomplete primary			0.011 (0.01)			0.011 (0.01)
Constant	0.190 (0.02)***	0.256 (0.03)***	0.217 (0.03)***	0.190 (0.02)***	0.256 (0.03)***	0.217 (0.03)***
N	6,322	6,320	6,320	6,322	6,320	6,320
R	0.02	0.03	0.04	0.02	0.03	0.04
Diff if first-born is a sister (*p*-value)	0.04	0.04	0.08			

Note: PMB stands for premarital birth.
Ethnic group, year of interview is controlled for (coefficients not shown). *Diff. if first-born is a sister (p-value)* indicates the *p*-value of the test testing the equality of the coefficient on having an elder sister born before a mother's marriage and of the coefficient on having an elder sister born after.
Standard errors are clustered at the mother level. Significance levels are denoted as follows: + $p<0.15$, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

TABLE A.11. First-born children characteristics: Weight and height at birth

	First child = Girl			First child = Boy			Diff.
Variables	PMB	No PMB	Diff.(1)	PMB	No PMB	Diff.(2)	(2) − (1)
birth_weight	3166.67	3000.60	− 166.07	2937.50	3036.56	99.06	265.13
	(281.77)	(59.64)	(288.02)	(166.84)	(64.86)	(179.00)	(341.01)
birth_size	2.79	3.19	0.40	2.91	3.05	0.14	− 0.26
	(0.25)	(0.07)	(0.26)	(0.23)	(0.08)	(0.24)	(0.38)
Number of observations	19	251	270	22	221	243	513

Note: The table compares characteristics of first-born children across sex and premarital birth status (PMB stands for premarital birth) for children born during the last 5 year only. Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p< 0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

TABLE A.12. Ever-married mothers characteristics

Variables	First child = Girl			First child = Boy			Diff.
	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) − (1)
Currently in union/living with a man	0.93	0.95	0.02*	0.93	0.95	0.01	− 0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Formerly in union/living with a man	0.07	0.05	− 0.02*	0.07	0.05	− 0.01	0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Number of observations	593	4,868	5,461	630	4,969	5,599	11,060

Note: The table compares characteristics of mothers across the sex of the first born child and incidence of premarital birth (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).

TABLE A.13. Currently married mothers characteristics

	First child = Girl			First child = Boy			Diff.
Variables	Had a PMB	No PMB	Diff.(1)	Had a PMB	No PMB	Diff.(2)	(2) − (1)
Mother: coreside with husband/partner	0.72	0.73	0.01	0.76	0.74	− 0.02	− 0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother: in a polygynous union	0.41	0.45	0.05**	0.40	0.45	0.05**	0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother: first rank spouse (among polygynous)	0.15	0.21	0.06***	0.14	0.22	0.07***	0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Husband/partner: No. years of education	2.84	1.47	− 1.37***	2.48	1.49	− 0.99***	0.38
	(0.21)	(0.06)	(0.22)	(0.19)	(0.06)	(0.20)	(0.25)
Husband/partner: age	47.54	48.07	0.53	48.19	48.21	0.01	− 0.52
	(0.57)	(0.18)	(0.59)	(0.57)	(0.18)	(0.60)	(0.79)
Mother: has no say about her own heath care	0.71	0.73	0.02	0.67	0.73	0.06***	0.04
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother: has no to say about large purchase	0.72	0.75	0.03	0.68	0.76	0.08***	0.05*
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Mother: has no to say about visits to family/relatives	0.62	0.66	0.05*	0.57	0.66	0.09***	0.05
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Number of observations	468	4,188	4,656	511	4262	4,773	9,429

Note: The table compares characteristics of mothers across the sex of the first born child and incidence of premarital birth (PMB stands for premarital birth). Standard errors are in parentheses and significance levels are denoted as follows: $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. The significance levels for coefficients in columns diff.(1) and diff.(2) are reported for *t*-tests. The significance levels for coefficients in column diff. (1) − (2) are reported for the test of equality between diff.(1) and diff.(2).