Demand for informal care and human capital accumulation: Evidence from elderly adult deaths in Senegal

Thomas THIVILLON*

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Abstract

Does girls' education suffer when they have to take care of dependent elderly relatives? This paper uses panel data on a sample of 1,064 schoolchildren from Senegal to address this question. I exploit negative shocks of demand for care work following the death of an old age household member to identify the effect of female children's caring responsibilities on their school enrollment and educational attainment. Using a triple difference strategy (DDD) combined with children fixed-effects, I find that the effect of being exposed to this type of shock amounts to 0.5 years of additional education completed, a 23% gain over a period of 4 years. I also find a direct effect of the death shocks on the intensive margin of caring: female children who lost an elderly household member experience a decrease in care work of 0.7 hours per week during the study period while weekly care work increases by half an hour among girls in the comparison group. I present evidence that changes in demand for informal care within the household are one of the mechanisms through which elderly adult deaths impact education, by showing that deaths of less productive - and therefore most likely less autonomous - individuals account for most of the effects on both educational attainment and informal care hours. These results call for increased attention to specific forms of female child labor in public policies in order to reduce gender inequalities in education.

Keywords: child labor, aging, death shocks, education, Senegal.

JEL: I15, J14, J22

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*Paris Dauphine University, PSL University, LEDa, CNRS, IRD, [DIAL research team]. Email: thomas.thivillon@dauphine.eu. Mailing address: DIAL, 4 rue d'Enghien, 75010 PARIS, FRANCE. Phone: +336 10 48 24 98.

Introduction

Life expectancy at birth increased by more than 20% in sub-Saharan Africa between 1995 and 2015. A newborn African child can now expect to live until the age of 61, a ten-year gain compared to the previous generation[1]. As a result, more and more Africans live old enough to experience the burden of chronic illness and physical impairment. United Nations projections suggest that the African population above working age will exceed 100 million by 2050, a fourfold increase compared to its 2010 level (Canagarajah 2014). Few African countries are equipped with the formal institutions required to take care of a large dependent population. In Senegal, the focus of this paper, there were only two retirement homes for a total population of 12 million in 2010 (Hane 2011). As a result, most elderly people rely on their family network to care for them in their old days. In a context where households are large and often include members of the extended family (De Vreyer and Nilsson 2019), this means that children often end up residing with elderly relatives and attending to their needs (Antoine and Gning 2014).

There is evidence in the qualitative literature that girls in particular are expected to help their dependent elders accomplish basic health and personal activities such as bathing, eating, dressing up, using the toilet or taking medications for instance (Evans 2010, Evans et al. 2016). This raises the question of how female children cope with the workload and with the constant attention required by such caring responsibilities. Indeed, if informal care claims a significant share of the time of the girls who reside with young children, elderly adults or chronically ill relatives, it might displace other activities such as schooling. Even for those who dedicate small amounts of time to informal care, the surveillance required by dependent relatives might constrain the time spent outside of home and result in a higher rate of school absenteeism relative to "non-caring" children. The stress induced by such responsibilities, and the associated "cognitive load", are another channel through which the school progression of young caregivers could be impacted (Mani et al. 2013, Mani and Lichand 2020).

This paper's main contribution is to assess the effect of co-residence with elderly adults on female children's supply of informal care work and educational attainment. To do so, I build on the rich body of literature on the impacts of adult mortality on children's school attendance

[1] Source: World Bank Data Bank, Microdata Catalog.
https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=ZG [Accessed 09/18/2020]

in Africa (De Vreyer and Nilsson 2019, Case et al. 2004, Case and Ardington 2006, Senne 2013). However, instead of evaluating the effect of prime-age adult deaths on schooling outcomes as is typically the case in most of the existing research, I look at the impact of the deaths of elderly adults on co-residing school children aged 6-17 in Senegal between 2007 and 2010. The assumption behind this approach is that old age individuals are net positive consumers of informal care, i.e they consume on average more informal care than they provide to their co-residents (I discuss the plausibility of this assumption later in the paper). As such, the death of an elderly household member should result in a negative shock of informal care demand for the remaining members of the household. My testable prediction is that this shock will result in better educational attainment for treated children relative to other children with elderly co-residents. I expect this effect to exist mainly for girls since very few boys have caring responsibilities: 7% of them do any care work in the baseline sample of interest.

22% of the Senegalese schoolgirls who resided with adults aged 60 or more in 2007 experienced the death of an elderly household member during the period under consideration. To evaluate the effects of this death shock (the "treatment") I use a triple difference strategy (DDD) which compares treated and untreated children across time and gender. I find that being exposed to the death of an elderly household member results in approximately 0.5 years of extra education for the treated girls at the end of my study period, a 23% gain compared to the years of schooling completed by female children in the control group. I also find a direct effect of death shocks on the intensive margin of caring: the female children who lost an elderly household member experienced a decrease in care work of 0.7 hours per week between 2007 and 2010 while weekly care work increased by half an hour among non-treated girls. These results are entirely driven by changes in the probability of dedicating a very large number of hours (>15 hours) to caring activities per week which suggests that all the changes take place at the right end of the distribution of informal care hours.

I show that the effects of the treatment are concentrated among girls aged 12-17 at baseline and that younger girls are largely unaffected by the treatment. Indeed, the role of older girls in caring for dependent members of the household is highlighted in the literature on informal care in sub-Saharan Africa (Evans et al. 2016, Edmonds, Mammen and Miller 2005). I also present evidence that deaths of less productive - and therefore most likely less autonomous - individuals account for most of the effects on both educational attainment and informal care hours. These two findings suggest that changes in demand for care work are likely to be one of the

mechanisms of impact explaining the relationship between elderly adult deaths and educational attainment.

The analysis uses two waves of panel data over the period 2006-2012 for a sample of 1,064 schoolchildren who reside with elderly adults at baseline. The proposed approach involves two main challenges. First, death events are unlikely to occur randomly in the households hosting the sampled children and they could be correlated both with the outcomes of interest and with variables that I don't observe. Second, the data only include two observations per child so that I can't assess differences in trends along observable variables between treated girls and children in the different control groups prior to the death shocks. To partly address the first problem, I estimate individual fixed-effects models so that differences between treated and control children along time-invariant unobservable variables are controlled for. This leaves the issue of unobserved time-varying variables unsolved. The triple difference strategy provides a solution to this problem (as in Jayachandran and Lleras-Muney 2009). Because my research hypothesis is that elderly deaths affect schooling through care work and very few male children work as informal caregivers, I expect their educational outcomes to be largely unaffected by the treatment. Adding boys to the analysis as a second comparison group therefore allows me to control for differential trends between 1) girls and boys in the control group and 2) treated boys and control boys in the male group. The main identifying assumption behind this strategy is therefore that there are no unobserved time-varying variables which are correlated with the treatment and have gender specific-effects (either male specific or female specific) on schooling and care work outcomes. The strategy allows for gender neutral effects of the treatment on the other hand.

To the best of my knowledge, this is the first study of the impact of female children's caring responsibilities on their educational attainment in the field of development economics. This is also the first in depth investigation of the effects of the death of elderly dependent household members on their relatives in sub-Saharan African context. The paper thus contributes to two main streams of literature. First, it adds to the existing literature on the causal relationship between work and children's schooling (Beegle et al. 2009, Dumas 2009, Gunnarson et al. 2006, Ravallion and Wodon 2000). While most existing research focuses on the impacts of market work, I contribute original evidence on the effects of domestic work and especially care work on educational attainment. I also show that gender inequalities in child labor contribute

to gender inequalities in schooling attainment. Second, the paper also complements the rich body of research on the impacts of adult deaths on children's school participation and educational attainment (Ainsworth et al. 2005, Case et al. 2004, Case and Ardington 2006, De Vreyer and Nilsson 2019, Evans and Miguel 2007, Senne 2013, Yamano and Jayne 2005). The bulk of what has been published on this topic focuses mainly on the effects of prime-age adult deaths on children's schooling and concludes that the loss of adult household members negatively affects children's schooling. My contribution is to show that the effects of elderly adult deaths on children's schooling differ markedly from what has been observed for younger adults, and can in fact result in children completing more years of education.

The remainder of this paper is organized as follows. The next section reviews the literature on informal care in sub-Saharan Africa and on the relationship between child labor and education more broadly. Section II describes the data and provides some descriptive statistics for elderly adults and for the sample of children under study. Section III discusses the econometric specifications used in the analysis and presents the results. Section IV presents some robustness checks. Section V concludes.

I. Informal care and children's schooling

A. Children's caring roles in sub-Saharan Africa

Qualitative evidence suggests that children take on a significant share of the burden of caring for dependent relatives in many sub-Saharan African communities (Evans 2010). A rich body of ethnographic research documents the role of 'young caregivers' in supporting HIV-infected parents in several Southern and Eastern African countries which faced high HIV prevalence in the 1990s and 2000s (Akintola 2008, Robson 2004, Robson et al. 2006). This stream of literature also suggests that caring roles are highly differenced by gender with women and girls often in charge of providing personal care and emotional support while men and boys more frequently meet the costs of supporting their sick or elderly relatives financially.

Several evaluations of the impact of parental or adult deaths on primary school participation in the context of the AIDS epidemic have documented the relationship between chronic illness among adult household members and children's education (Ainsworth et al. 2005, Evans and

Miguel 2007). They show that negative effects on school attendance appear before the death of a chronically ill parent and that girls tend to be the most affected (Yamano and Jayne 2005). There are indications in this literature that an increase in the demand for informal care could be one of the mechanisms behind this pre-death absenteeism. Ainsworth, Beegle and Koda (2002) for instance provide evidence that adult morbidity in the household results in a temporary reduction in school hours prior to the death of an adult household member but not in higher drop-out rates. This fact suggests that children and girls in particular might be staying at home more frequently to support their sick parents. It is harder to reconcile with potential alternative mechanisms such as cuts in schooling expenditures due to the increased poverty associated with chronical illness.

The literature on children caregivers in AIDS-affected households mainly documents the role of children in caring for prime-age adults. Unfortunately, much less has been published on children's involvement in caring for their old relatives and this paper aims to fill this gap in the literature. Ruth Evans and her co-authors provide a rare qualitative account of the role of girls and first born daughters in particular in caring for the elderly in the context of urban Senegal (Evans et al. 2016). Edmonds, Mammen and Miller (2005) are another exception. Using census data from South Africa, they find support for the hypothesis that younger women aged 18-23 have a comparative advantage in caring for children and elderly household members relative to women in their 30s.

It is also hard to find quantitative assessments of the extent and intensity of the care work supplied by children in any African country. Ainsworth, Beegle and Koda's study of the impact of adult mortality on primary school enrollment in Northwestern Tanzania is one of the rare contributions to shed light on this question (Ainsworth et al. 2002). Using data from the Kagera Health and Develoment Survey for the period 1991-1994, they find that 3.7% of all children aged 7-14 provided care to sick relatives in the seven days preceding the survey. However, this certainly underestimates the total proportion of children involved in caring as it doesn't account for the care provided to dependent but non-sick individuals, including children and elderly household members. The data used in this paper, which I describe in greater details in the next section, show that 22% of girls and 7% of boys aged 6-17 dedicated some of their time to caring for children, elderly or sick individuals in 2006-2007 in Senegal. Those of the girls who did any

care work were spending close to 8 hours per week on this activity on average while care work accounted for approximately 4 hours of the time of young male caregivers[2].

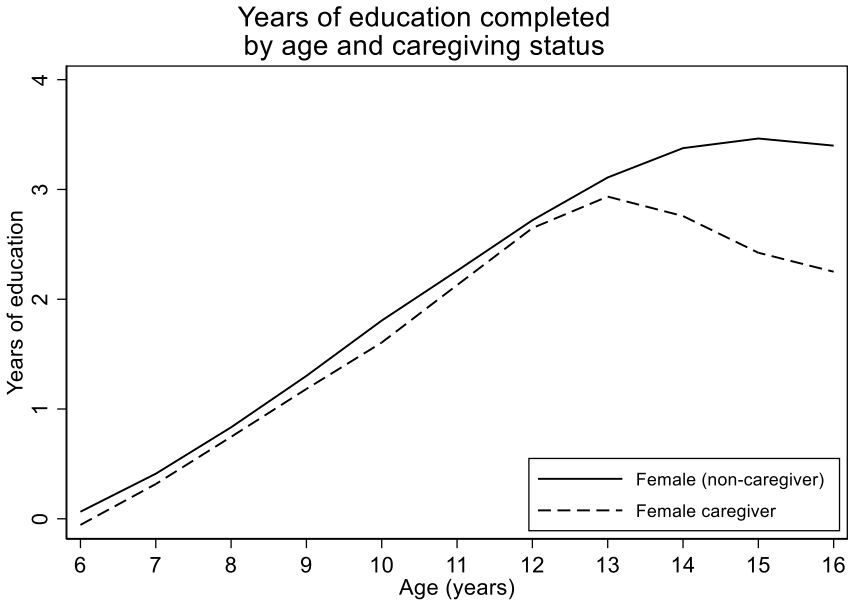
B. Caring responsibilities and children's schooling

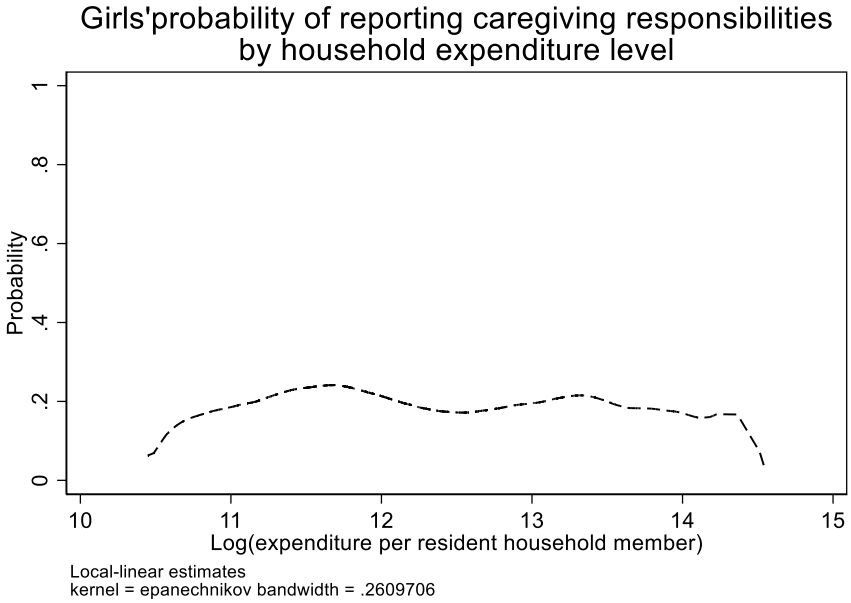
Although the findings reported above suggest that caring represents a relatively small fraction of children's time, child caregivers differ markedly from other children on their educational attainment. In Senegal, female child caregivers consistently lag behind other girls in terms of grade-for-age and the gap increases markedly as they enter into teenage years (Figure 1, top panel). This difference is unlikely to be explained by economic inequalities alone since the probability of conducting care work doesn't vary much between girls from lower and higher income groups (Figure 1, bottom panel). It could of course reflect the fact that female children with lower innate learning capacities are selected into care work as they become teenagers. However, theory and the empirical literature in development economics also suggest that the burden of caring for elderly or dependent relatives could have a causal effect on girl's ability to attend school regularly and to learn as they would in the absence of caring responsibilities.

First, demand for care work within the household could compete with school time and constrain children to drop out of school or miss school frequently as is the case for other types of child labor (Ravallion and Wodon 2000). Consider for instance a present-biased household whose adult members derive more utility from their present labor market participation than from future returns to the investments they make in their children's education. Let's also assume that this household is resource constrained. When faced with the need to cut on some of its members' work or school hours due to the sudden loss of autonomy of another member, such a household would start by reducing the school hours of its children. The sibling rivalry theory suggests that the children who have the lowest perceived returns to education would be disproportionately affected, and that girls in particular would be constrained to spend less time studying (Garg and Morduch 1998). Depending on the workload generated by the functionally dependent member and on the assumptions made regarding the returns to a partial or delayed education, this household might decide to remove its female children from school or to keep them in school but to reduce their attendance rate.

[2] Author's calculations using data from the first round of Senegal's "Poverty and Family Structure" panel survey ("Enquête pauvreté et structure familiale" or PSF in French). See Table A1 in the appendix.

Figure 1: Educational attainment and caring responsibilities among girls aged 6-17 in the baseline sample





Source: PSF Survey, wave 1. Sample: female children aged 6-17. Top panel: Non-parametric estimation of the expected educational attainment by age group conditional on caring responsibilities. Bottom panel: non-parametric regression of an indicator variable equal to 1 if a child conducts care work and 0 otherwise on the natural logarithm of the annual per capita expenditure of the household of residence. Spending is reported in Francs CFA and trimmed for 1% extreme values

Second, the relationship between informal care time and schooling hours may not be proportional. In cases where a girl's caring responsibilities only reclaim a handful of hours of work per week, the distribution of these caring hours during the week or their low predictability could result in disproportionate impacts on school attendance. This would be the case if the time at which specific tasks need to be conducted is fixed and coincides with school hours, for example if a child was in charge of helping a grand-parent to bath, to dress up, to eat or to take a medication. Unforeseen tasks such as attending to the needs of a relative whose condition suddenly deteriorated or taking her to a medical appointment could also be expected to be negatively associated with schooling. In these two types of situations, low intensity care work could nevertheless lead to increased absenteeism and affect learning, exam performances and school progression in the medium term. In a sample of third and fourth graders from nine different Latin American countries, Victoria Gunnarsson and her co-authors (2006) find that children who only work on an occasional basis nevertheless score 7 to 7.5 points lower on language and mathematics examinations (Gunnarsson et al. 2006).

Third, even in situations where female children were able to conduct care work without missing school, caring could still compete with time dedicated to homework and affect learning and educational attainment through this channel. There is evidence in the empirical literature that school children who work underperform in reading and mathematics tests and have a lower educational attainment than non-working children, even when potential sources of endogeneity are taken into account (Akabayashi and Psacharopoulos 1999, Beegle et al. 2009, Psacharopoulos 1997, Gunnarsson et al. 2006).

Finally, the responsibility of caring for a dependent relative requires significant mental attention and can generate stress for a child who suddenly becomes in charge of the life of another person. This implies that caring responsibilities can be a source of '*cognitive load*' as defined by Mullainathan and Shafir (2013): reduced available attention to matters other than care work in our case. Such cognitive load could affect learning and educational attainment through reduced in-class attention among female child caregivers. Although this hypothesis has never been directly tested, recent research in behavioural economics has shown that income uncertainty or a lack of time can impede the cognitive functions of affected individuals and lower their performances on learning and reasoning tasks (Mani et al. 2013, Mani and Lichand 2020). It has also been shown that children's performances in standardized educational assessments declines as the cognitive load induced by the format of the test increases (Howard et al. 2017).

There are thus reasons to believe that learning can be negatively affected even if children caregivers attend school as regularly as other children.

II. Data and descriptive statistics

This paper uses data from the Poverty and Family Structure survey (in French "Enquête pauvreté et structure familiale", henceforth PSF), a two-wave panel survey covering a nationally representative sample of 1800 households in the first wave. The data were collected from April 2006 to July 2007 (wave 1) and between October 2010 and December 2012 (wave 2). The survey uses a standard two-stage cluster sampling strategy: 150 districts were randomly drawn from the map of Senegal's census districts and 12 households were then randomly selected in each district. A specific feature of this survey is that 220 "secondary households' were added to the baseline household. These are the households in which non-resident spouses of the 1800 primary household heads happened to be living at the time of the survey. These households were included in the sample because one of the goals of the research team who designed the survey was to study the intra-household allocation of resources in Senegal, accounting for the complex structure of polygamous households (see De Vreyer and Lambert 2020). Although this paper has a different focus, my analysis includes the individuals who belong to these secondary households to ensure that children living in polygamous households aren't underrepresented in the sample.

13,365 (82.4%) of the 16,210 individuals who were interviewed at baseline were tracked and re-interviewed in the second wave of the survey. Panel observations include 3,920 children who were aged 6 to 17 in the first wave of PSF and who are the focus of this paper. Six years of age is the lower age bound for which PSF collected domestic work information in both waves. It also corresponds to the age at which children are expected to start primary school in Senegal. I restrict my analysis to individuals aged less than 18 because I am interested in identifying the effect of conducting care work *during childhood and teenage years* on educational outcomes.

The PSF questionnaire collected the usual data on each individual's education and market work. It also contains a detailed domestic work module which records the time dedicated to home production activities for all individuals aged six and above. The domestic tasks covered by the

module include: purchasing food and cooking meals, collecting wood, fetching water, cleaning the house, washing clothes, doing home improvements, looking after cattle, as well as caring for children, elderly or sick individuals. For each of these tasks, self-reported weekly hours of unpaid work are recorded with the following question: "*During a normal week of the past month, how many hours (in the week) did you spend on [activity's name]?*". This paper makes extensive use of the data on caring which is defined as "*time dedicated to children, elderly or sick people*" in the survey questionnaire. This definition isn't specific enough to exclude the possibility that hours of work reported as care work overlap with hours reported for other domestic activities such as cooking, cleaning or doing the laundry. To take this risk into account, I treat care work separately from other domestic tasks in my analysis and therefore report descriptive statistics and regression results separately for "*care work*", "*domestic work*" other than care work, and "*market work*" in what follows.

Self-reported time use data can be subject to social desirability bias (Nederhof 1985). For instance, in the case of children reporting their hours of domestic work, male respondents might be tempted to underreport their time spent on activities which are more frequently ascribed to women while female respondents might be doing the opposite. Although this can be an issue when working with cross-sectional data, this paper uses longitudinal data and its main results are based on econometric models which incorporate individual fixed effects. Assuming that an individual's sensitivity to social desirability is stable over time, the fixed effects should control for this unobservable characteristic. Another issue with time use data is the fact that summing the time reported by an individual for all of her activities can result in totals which exceed the maximum number of hours available in a week (112 hours if one assumes 8 hours of sleep and leisure per day). This can be due to the fact that some activities can be conducted concomitantly but also reflects measurement error with individuals reporting an unrealistically high number of hours for some activities. To deal with this problem, I winsorize all time use variables, including informal care time, at the 99th percentile[3].

The analysis focuses on two main outcomes of interest: current school enrollment and educational attainment. School enrollment is measured by an indicator variable equal to one if a child is currently enrolled in school at the time of the survey and to zero otherwise[4].

[3] Trimming these variables for the top 1% highest values yields qualitatively similar results (not shown in the paper).
[4] The variable is also coded 0 if the child only attends koranic school.

Educational attainment or "years of education" is a variable equal to the number of years of formal education completed at the time of the survey. The variable ranges from 0 to 17 which reflects the fact that the Senegalese schooling system includes 6 years of primary school, 4 years of middle school, and 3 years of high school. Higher education is recorded up to 4 years after high school.

Finally, my treatment variable of interest is an indicator variable equal to one in wave 2 if the wave 1 household hosted an individual aged 60 or more who died between the two waves of the survey (and to zero otherwise). I choose to set the lower bound of the "elderly" age category at 60 because this corresponds to the 95th percentile of the age distribution in the baseline sample of PSF (see Figure A1). Interestingly, 60 is also a threshold at which an individual's health condition and productivity are likely to start declining markedly as illustrated by the self-reported data from PSF wave 1 displayed in Figure A2. The average hours of market work reported per week for the 60-69 age category in particular drop below the sample mean of 26 hours per week [5] while the proportion of individuals who consider themselves in "*bad*" or "*very bad health*" reaches 13% (less than 5% among prime age adults). This suggests that household members are likely to become increasingly dependent, require more informal care and generate less income after reaching the age of 60. Working with this age limit increases the probability that the death of a household member results in a negative shock of demand for care work. It also lowers the likelihood that such a death generates a negative income shock, which could threaten our identification strategy.

Table A1 provides some descriptive statistics for the broader sample of children who were between 6 and 17 years old at the time of the first survey, in 2006 or 2007, and who were re-interviewed in 2010-12. The average sample children had only two years of education at baseline. A third of the children had never attended school. Considering that pupils are expected to enter primary school at age six in Senegal and that the mean age is 11 in the sample, we would expect the mean years of schooling to be close to five if children were on track with the Senegalese schooling curriculum. While children were four years older on average at the time of the second wave of PSF, the mean schooling attainment only increases by two years between the two survey waves. The data also show that the gender disparities in education were non-negligible in the generation of children under study. Compared to boys, girls are four percentage

[5] Among adults.

points (0.80-0.76) less likely to have ever attended school at the time of the second survey wave[6].

The descriptive statistics on child labor also reflect important differences between genders. In line with the qualitative literature on child labor in Senegal (Evans 2016) I find that girls tend to specialize in domestic work and care work while boys are more likely to be doing market work. These differences increase as children grow older so that girls are 37 percentage points (0.82-0.45) more likely to report some domestic work and 20 percentage points (0.46-0.26) less likely to be doing market work at the end of the study period. Turning to care work in particular, it is striking that this is an almost exclusively feminine activity. Only seven percent of boys were doing any care work at all at baseline, while nearly a quarter of girls were providing informal care to a relative. As a result, the time spent on informal care is close to zero for boys while girls dedicate 1.7 hours of their time to this activity every week on average. This corresponds to close to 8 hours of care work per week for the subgroup of female caregivers (1.7/0.22=7.7). Importantly, when market work, domestic work and informal care are taken into account, the average number of work hours supplied by female children (16.7 hours per week) is much larger than what male children report (14 hours per week). When informal care is kept out of the comparison to take potential overlaps with other domestic tasks into account, girls still work 1 extra hour per week.

Table 1: Coresidence with household members aged 60 or more in wave 1 by sex - Children aged 6-17

	All		In school		Girls in school		Boys in school	
Survival status and identity of the coresiding household member:	Frequency	*% of sample*	Frequency	*% of sample*	Frequency	*% of sample*	Frequency	*% of sample*
Deceased or alive at wave 2:								
Any elderly household member	1944	*49.6%*	1064	*27.1%*	511	*13.0%*	553	*14.1%*
Elderly household head	1201	*30.6%*	681	*17.4%*	325	*8.3%*	356	*9.1%*
Elderly woman	1186	*30.3%*	701	*17.9%*	342	*8.7%*	359	*9.2%*
Elderly man	1143	*29.2%*	620	*15.8%*	297	*7.6%*	323	*8.2%*
Deceased between wave 1 and wave 2:								
Any elderly household member	381	*9.7%*	238	*6.1%*	110	*2.8%*	128	*3.3%*
Elderly household head	168	*4.3%*	107	*2.7%*	46	*1.2%*	61	*1.6%*
Elderly woman	178	*4.5%*	108	*2.8%*	52	*1.3%*	56	*1.4%*
Elderly man	211	*5.4%*	135	*3.4%*	60	*1.5%*	75	*1.9%*
Observations	3919		2228		1086		1142	

Source: PSF Survey, wave 1 and wave 2. Author's calculations. Sample: Children aged 6-17 in wave 1 (panel observations only).

[6] Both differences are significant at the 1% level in unequal variance t tests on the equality of means.

III. Empirical strategy and results

A. Identification strategy and estimating equations

My empirical strategy uses the deaths of elderly resident household members which occurred between the two waves of PSF as a source of variation in demand for care work. To exploit these death shocks, I restrict my sample of interest to the children who resided with an elderly adult at baseline. This ensures that all the children considered in the analysis had a non-zero probability of being treated and share the unobservable characteristics associated with this type of co-residence. I further restrict the sample to the children who were in school at the time of the first survey because I am mainly interested in the effect of variations in care work on educational attainment *conditional* on attending school at baseline. Table 1 shows that the resulting sample includes 1,064 school children of whom 238 (22.4%) were exposed to the death shock of interest between the two waves. An important feature of this sub-sample is that it is only marginally affected by attrition: 97.7% of the children who were interviewed at baseline were re-interviewed during the follow-up survey.

I estimate the impact of the death shocks on schooling outcomes by comparing the girls who were exposed to the shock (treated girls) to those who didn't lose an elderly household member between wave 1 and wave 2 (control girls). The second dimension of the comparison is over time. The main identifying assumption behind difference-in-differences estimation methods is that the treatment and comparison groups' outcomes would have followed parallel trends in the absence of treatment, i.e that the girls who lost an elderly co-resident adult between 2007-2010 would have experienced the same changes in school enrollment and educational attainment as the rest of the sample in the absence of this death. It is difficult to providence evidence in support of this assumption because PSF is a two-wave survey. In Table 2, I compare treated and control girls on their observables as a first check of the pre-treatment differences between the two groups. It is reassuring to notice that treated and control households are very similar in terms of per capita consumption or human capital of adult members.

Table 2: Baseline characteristics by treatment status

	Treated (T)		Control (C)		Difference (T) - (C)	
	Mean	*SD*	Mean	*SD*	Mean	*SE*
Girls						
Age	10.7	*3.0*	10.6	*3.0*	0.0	*0.3*
Married [yes=1]	0.000	*0.000*	0.003	*0.050*	-0.003	*0.003*
Years of education	2.5	*2.4*	3.0	*2.4*	-0.46	*0.31*
Ever worked (market work) [yes=1]	0.103	*0.305*	0.138	*0.345*	-0.035	*0.050*
Currently working (market work) [yes=1]	0.037	*0.191*	0.100	*0.300*	-0.063**	*0.028*
Currently doing domestic work [yes=1]	0.680	*0.469*	0.572	*0.495*	0.108*	*0.063*
Currently doing care work [yes=1]	0.255	*0.438*	0.150	*0.357*	0.105*	*0.056*
Hours of market work per week	0.54	*3.40*	2.33	*9.26*	-1.79**	*0.79*
Hours of domestic work per week	6.36	*10.38*	6.58	*11.23*	-0.22	*1.29*
Hours of care per week	1.47	*4.09*	0.93	*3.18*	0.54	*0.470*
Urban [yes=1]	0.582	*0.496*	0.499	*0.501*	0.083	*0.081*
Household size	16.3	*8.0*	14.4	*7.0*	1.9	*1.4*
Household head female [yes=1]	0.100	*0.301*	0.252	*0.435*	-0.152***	*0.049*
Household head has some education [yes=1]	0.264	*0.443*	0.302	*0.460*	-0.038	*0.067*
Maximum number of years of education achieved by an adult member of the household	7.3	*5.0*	6.9	*5.3*	0.3	*0.8*
Log(expenditure per resident household member)	12.174	*0.800*	12.272	*0.781*	-0.097	*0.139*
Observations	110		401			
Boys						
Age	11.9	*3.3*	11.0	*3.2*	0.8**	*0.3*
Married [yes=1]	0.000	*0.000*	0.000	*0.000*	0.000	*0.000*
Years of education	3.7	*2.6*	3.0	*2.4*	0.8***	*0.3*
Ever worked (market work) [yes=1]	0.262	*0.441*	0.261	*0.440*	0.001	*0.064*
Currently working (market work) [yes=1]	0.222	*0.417*	0.183	*0.387*	0.039	*0.058*
Currently doing domestic work [yes=1]	0.357	*0.481*	0.341	*0.475*	0.016	*0.069*
Currently doing care work [yes=1]	0.078	*0.269*	0.045	*0.207*	0.033	*0.038*
Hours of market work per week	2.12	*5.81*	4.02	*12.82*	-1.90	*1.22*
Hours of domestic work per week	1.74	*4.03*	2.83	*7.85*	-1.10	*0.69*
Hours of care per week	0.34	*1.71*	0.20	*1.40*	0.14	*0.17*
Urban [yes=1]	0.563	*0.498*	0.461	*0.499*	0.101	*0.083*
Household size	16.6	*9.0*	14.3	*7.0*	2.3	*1.6*
Household head female [yes=1]	0.125	*0.332*	0.209	*0.407*	-0.084	*0.057*
Household head has some education [yes=1]	0.320	*0.468*	0.315	*0.465*	0.005	*0.075*
Maximum number of years of education achieved by an adult member of the household	8.2	*4.9*	6.5	*5.2*	1.7**	*0.8*
Log(expenditure per resident household member)	12.211	*0.856*	12.153	*0.711*	0.058	*0.134*
Observations	128		425			

Source: PSF Survey wave 1. Notes : Treated individuals are the children who experienced the death of a household member aged 60+ between waves. The standard errors on the differences are estimated from running the corresponding least squares regression allowing for the standard errors to be clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1

However, Table 2 also shows that treated girls are approximately 11 percentage points more likely to conduct domestic work and care work and 6 percentage points less likely to be involved in market work than the control group. As a result, they dedicate two hours less of their time to market work. This is consistent with a situation in which the elderly adults with whom treated girls were living at baseline were in worse physical condition and required more support than those who were living with the control girls. Last, treated girls are significantly less likely to live in female headed households which raises the concern that elderly individuals move to male headed households as their health worsens. To take this potential source of bias into account, I verify that my main results are robust to restricting the sample to children who resided in male headed households at baseline (see appendix Table A4). I also include the sex of the household head at baseline as a control variable in most of my estimations. This ensures that the estimates of the impact of the death shock aren't confounded by baseline differences in the distribution of the sex of the household head.

Triple differences – To account for potential sources of bias due to unobserved time-varying variables affecting treated and control girls in different ways, I follow Jayachandran and Lleras-Muney (2009) and Muralidharan and Prakash (2017). I add a third difference to the comparison and construct triple difference (DDD) estimates of the impact of the death shocks on the outcomes of interest across time and gender[7]. This allows me to remove bias from non-sex specific unobserved time-varying variables which would be correlated with the death shocks and the outcomes of interest. Consequently, the identifying assumption in what follows is that there is no unobserved sex-specific time-varying variable that is correlated with elderly deaths on one side and changes in educational or caring outcomes on the other. Provided that this assumption is satisfied, the analysis identifies the causal effect of the death shocks on the outcomes of interest.

The data comprise 2,128 observations corresponding to the 1,064 children included in the sample. My main econometric specification uses linear regression with child fixed-effects so that comparisons are within child-year cells. The child fixed-effects are particularly useful in ensuring that the estimations aren't confounded by unobserved differences in innate abilities

[7] Appendix Table A2 provides a test of parallel trends between treated and control male children. It shows that these two groups followed very similar trends in terms of school enrolment, educational attainment and supply of informal care during the study period.

between treated and control children. I use a linear probability model instead of a standard ordinary least squares model where relevant. The triple difference is estimated by:

$$Y_{i,t} = \alpha + \beta_1 T_{i,t} + \beta_2 Female_i x\, \theta_t + \beta_3 Female_i x\, T_{i,t} + \theta_t + \delta_i + \epsilon_{i,t} \quad (1)$$

Where $Y_{i,t}$ is the outcome of interest for child *i* in wave *t*, $T_{i,t}$ is a treatment dummy, $Female_i$ is a dummy equal to one if individual i is a girl, θ_t is a time fixed-effect, δ_i is a child fixed effect and $\epsilon_{i,t}$ is an idiosyncratic error term. $T_{i,t}$ is equal to one in wave 2 if the observed child's baseline household hosted an elderly adult who died between the two survey waves, to zero in wave 2 if all the elderly adults who belonged to the baseline household are still alive at the end of the study period, and to zero in wave 1 for all observations. β_3 is the coefficient of interest which I expect to be positive for schooling outcomes if elderly adult deaths have an impact on girls' education by lowering the burden of care work for treated girls.

B. Results

Schooling outcomes - Table 3 reports results from triple difference (DDD) estimations for the schooling outcomes of interest. The first and second columns show the results for school enrollment. The coefficient on death shock x female in column 1 is positive as expected but statistically insignificant. Column 2 controls for potential sources of bias by adding to the model a set of baseline covariates interacted with the time variable. This specification is adapted from De Vreyer and Nilsson (2019) and controls for time trends by level of the selected observable baseline characteristics. In doing so, I check that the results aren't confounded by time trends along observable variables which would have sex-specific effects on school enrollment. The selection of control variables is based on the baseline differences observed in Table 2. The coefficient on the interaction between death shock and female remains insignificant with these additional controls.

In column 3, I turn to the effect of treatment on female children's educational attainment. The coefficient of interest is positive and statistically significant. The estimate implies that treated girls benefit from approximately 0.5 years of extra education at the end of the study period. To provide an indication of the relative magnitude of this effect, I compute the change in

educational attainment for control girls by adding the coefficient on the time variable and the coefficient on the interaction between time and gender and see that the average educational attainment of this group increased by 2.78 years between the two waves of PSF. I proceed similarly with the relevant coefficients for treated girls. The change in educational attainment is 3.42 years in this case. The effect of the treatment therefore represents 23% of additional human capital accumulation for the girls who lost an elderly co-residing relative compared to control girls. This result is robust to controlling for additional time trends and the magnitude of the effect is nearly unchanged (column 4).

Table 3: Triple difference (DDD) estimates of the impact of the death shock on girls' schooling outcomes - Child fixed effects

	Currently in school		Years of education	
	(1)	(2)	(3)	(4)
Death shock x female	**0.0721**	**0.0736**	**0.552****	**0.550*****
	(0.0613)	**(0.0596)**	**(0.217)**	**(0.208)**
Death shock	0.00147	0.0111	0.0833	0.113
	(0.0465)	(0.0481)	(0.157)	(0.158)
Female x 2nd wave	0.0104	-0.0117	-0.0661	-0.0925
	(0.0303)	(0.0292)	(0.104)	(0.102)
2nd wave	-0.212***	-0.00868	2.851***	3.074***
	(0.0209)	(0.0497)	(0.0794)	(0.210)
Constant	1***	1***	3.051***	3.070***
	(0.00706)	(0.00683)	(0.0292)	(0.0289)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES
Observations	2,104	2,080	1,874	1,854
R-squared	0.203	0.252	0.803	0.811
Number of individuals	1,052	1,040	937	927

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 1 and 2). Standard errors allowing for clustering at the household level between parentheses. Columns 2 and 4 include controls for baseline covariates interacted with time. Baseline covariates include: child age, a dummy for children conducting market work, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households.*** p<0.01, ** p<0.05, * p<0.1

Mechanism - To confirm that a reduction in caring responsibilities is indeed the channel through which elderly death shocks affect educational attainment, I next analyse the time use data collected in both waves of PSF. In Table 4, I present results from running triple difference (DDD) estimations of the impact of the death shocks on care work outcomes. Column 1 shows DDD results for the number of weekly care work hours reported by the respondents. The

coefficient of interest is negative and statistically significant at the 10 percent level. The results are robust to controlling for additional time trends (column 2). Summing the relevant coefficients in column 1 suggests that the female children who were exposed to the death of an elderly adult saw the time they dedicate to caring for relatives decrease by 0.7 hours between PSF wave 1 and wave 2 on average. On the contrary, control girls experienced an increase of 0.5 hours in their supply of informal care work during the same period. These results confirm that the loss of an elderly household member is associated with marked changes in the demand for informal care within the household.

Columns 3 to 10 of Table 4 break down the analysis by interval of the distribution of care work hours. They report linear probability estimates of the relationship between elderly adult death shocks and the probability of falling into each interval. Columns 3 and 4 report coefficients for the probability of not having cared for anyone in the previous month. They inform us on the effect of the death shock on the extensive margin of caring. The positive signs on the coefficients for death shock x female are consistent with a negative relationship between the death of an elderly household member and the probability of caring. However, the estimates are imprecise. At the other end of the distribution, there is a negative effect of the death shocks on the probability that female children dedicate more than 15 hours per week to providing informal care to their relatives. This result is statistically significant at the 5 percent level. Considering that the coefficients corresponding to a moderate burden of caring are statistically insignificant and relatively small (columns 5 to 8), it appears that the negative effect of elderly adult deaths on weekly care work hours is entirely driven by a decrease in the proportion of girls who dedicate very large amounts of time to caring for their relatives.

Heterogeneity of impacts by age of the child - Disaggregating the results by age group provides a more refined understanding of the treatment effects on schooling and care work outcomes. In Table 5, I consider the effects of death shocks on younger and older children separately. The coefficients of interest are statistically insignificant for all outcomes irrespective of the specification when looking at girls aged 6 to 11 at baseline. On the other hand, the analysis points to a significant positive effect of the death shocks on the extensive and intensive margins of schooling when considering female teenagers. These results are matched by large and significant coefficients on death shock x female for the care work outcomes.

Table 4: Triple difference estimates (DDD) of the impact of the death shock on girls' caring responsibilities - Child fixed effects

			Distribution of treatment effects on hours of informal care							
	Impact on hours of informal care per week		0 hours/week [YES=1]		1-5 hours/week [YES=1]		6-15 hours/week [YES=1]		More than 15 hours/week [YES=1]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Death shock x female	**-1.055***	**-1.237***	**0.0790**	**0.0982**	**-0.0487**	**-0.0471**	**0.00871**	**-0.00311**	**-0.0405****	**-0.0460****
	(0.611)	**(0.634)**	**(0.0689)**	**(0.0715)**	**(0.0569)**	**(0.0584)**	**(0.0420)**	**(0.0406)**	**(0.0196)**	**(0.0200)**
Death shock	-0.217	-0.215	0.0555	0.0546	-0.0469	-0.0468	-0.00621	-0.00588	0	0.00139
	(0.184)	(0.209)	(0.0493)	(0.0497)	(0.0393)	(0.0402)	(0.0127)	(0.0130)	(0.00333)	(0.00441)
Female x 2nd wave	0.623*	0.605*	-0.0908***	-0.0800**	0.0675**	0.0594**	0.00691	0.00826	0.0125	0.0111
	(0.325)	(0.339)	(0.0341)	(0.0340)	(0.0262)	(0.0255)	(0.0158)	(0.0170)	(0.0114)	(0.0121)
2nd wave	-0.0800	-0.239	-0.0165	-0.0840*	-0	0.0590	-0.00941	-0.0198	-0	0.00945
	(0.0904)	(0.466)	(0.0187)	(0.0508)	(0.0129)	(0.0391)	(0.00664)	(0.0287)	(0.00333)	(0.0149)
Constant	0.616***	0.622***	0.890***	0.891***	0.0623***	0.0620***	0.0321***	0.0324***	0.00849***	0.00858***
	(0.0681)	(0.0678)	(0.00893)	(0.00889)	(0.00654)	(0.00654)	(0.00375)	(0.00368)	(0.00230)	(0.00230)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Observations	2,120	2,098	2,128	2,104	2,120	2,098	2,120	2,098	2,120	2,098
R-squared	0.011	0.020	0.025	0.030	0.017	0.020	0.001	0.005	0.007	0.015
Number of individuals	1,060	1,049	1,064	1,052	1,060	1,049	1,060	1,049	1,060	1,049

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 3-10). Standard errors allowing for clustering at the household level between parentheses. Even columns include controls for baseline covariates interacted with time. Baseline covariates include: child age, a dummy for children conducting market work, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households.*** p<0.01, ** p<0.05, * p<0.1

Based on the specifications which control for baseline covariates (columns 2 and 4), the probability to be enrolled in school decreases by 45 percentage points between the two survey waves in the group of control girls aged 12 to 17. The decrease is 25% smaller in the treatment group where the probability to be enrolled in school or in a higher education institution falls by 33 percentage points. In the same age group, treated girls have completed an extra 0.6 years of education compared to the girls who haven't been exposed to the death shock. The results for the intensive and extensive margins of informal care are strikingly symmetric. Columns 6 of Table 5 shows that informal care work hours increase significantly between waves in the control group of teenage girls (+3.6 hours per week) while they remain stable in the treatment group. Accordingly, the probability of not providing informal care to relatives decreases markedly in the comparison group but remains stable for treated teenage girls (column 8).

The fact that the positive impact of elderly death shocks on schooling outcomes is paralleled by a negative effect on care work and that these effects are concentrated in the same age group strongly supports this paper's core hypothesis: namely, that elderly deaths have a positive impact on girls' schooling because they result in a negative shock of demand for care work. Interestingly, the effects are observed among the girls who were already teenagers at the time of the first survey, suggesting that female teenagers and young adults play a specific role in terms of informal care provision in Senegalese households. This is in line with the available qualitative literature on this topic (Evans et al. 2016).

Heterogeneity of impacts by productivity of the deceased – To address any remaining omitted variables concern, I also investigate the relationship between the effect of the death shock and the level of dependency of the deceased person at baseline. Unfortunately, the PSF questionnaire does not include a direct measure of a respondent's functional autonomy. As a proxy, I compute the total productivity of each respondent by summing their reported market and domestic work hours. I then assign elderly respondents to a '*highly productive*' group and a'*less productive*' group based on their total productive hours using mean productive hours in the group of respondents aged 60 or more at baseline as the cut-off point between the two groups. While the validity of such a proxy would be questionable in a country where a majority of workers are covered by a retirement pension scheme, leisure time is less likely to increase after retirement age in Senegal where pension coverage is very low. As a result, decreases in productivity at old age are more likely to be involuntary and to correspond to a decline in functional autonomy.

Table 5: Triple difference (DDD) estimates of the impact of the death shock on girls' schooling and care work - By age group, child fixed-effects

	Currently in school		Years of education		Hours of informal care per week		No informal care [hrs of informal care=0]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Children aged 6-11 in Wave 1								
Death shock x female	**-0.0104**	**0.00721**	**0.289**	**0.386**	**0.283**	**0.0768**	**-0.0488**	**-0.0465**
	(0.0633)	**(0.0628)**	**(0.276)**	**(0.276)**	**(0.526)**	**(0.525)**	**(0.0869)**	**(0.0882)**
Female x 2nd wave	0.0127	-0.00760	-0.0447	-0.0804	-0.0189	-0.0346	-0.0661*	-0.0556
	(0.0358)	(0.0343)	(0.134)	(0.133)	(0.233)	(0.234)	(0.0378)	(0.0363)
Death shock	0.0622	0.0453	0.342*	0.286	-0.343	-0.403	0.101*	0.115*
	(0.0457)	(0.0469)	(0.189)	(0.187)	(0.287)	(0.296)	(0.0599)	(0.0606)
2nd wave	-0.152***	0.0958	2.952***	2.532***	-0.0855	0.744	-0.0299	-0.0915
	(0.0244)	(0.0811)	(0.101)	(0.378)	(0.0769)	(0.709)	(0.0254)	(0.0878)
Constant	1***	1***	1.532***	1.547***	0.487***	0.492***	0.908***	0.910***
	(0.00795)	(0.00774)	(0.0369)	(0.0359)	(0.0545)	(0.0544)	(0.0103)	(0.0103)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES	NO	YES	NO	YES
Observations	1,202	1,184	1,082	1,068	1,212	1,196	1,218	1,200
R-squared	0.137	0.179	0.811	0.819	0.004	0.019	0.028	0.036
Number of individuals	601	592	541	534	606	598	609	600
Panel B. Children aged 12-17 in Wave 1								
Death shock x female	**0.123**	**0.175***	**0.662****	**0.712****	**-3.163*****	**-3.474*****	**0.258****	**0.305*****
	(0.103)	**(0.0967)**	**(0.333)**	**(0.325)**	**(1.210)**	**(1.267)**	**(0.108)**	**(0.108)**
Female x 2nd wave	-0.0174	-0.0127	-0.134	-0.119	1.683**	1.584**	-0.126**	-0.117**
	(0.0521)	(0.0525)	(0.158)	(0.163)	(0.715)	(0.720)	(0.0583)	(0.0586)
Death shock	-0.0183	-0.0392	-0.0456	-0.0250	-0.121	0.100	0.0139	-0.00144
	(0.0703)	(0.0705)	(0.210)	(0.214)	(0.253)	(0.294)	(0.0514)	(0.0532)
2nd wave	-0.287***	-0.451**	2.717***	2.699***	-0.0733	2.003	0	-0.169
	(0.0340)	(0.184)	(0.113)	(0.606)	(0.178)	(2.522)	(0.0223)	(0.183)
Constant	1***	1***	5.126***	5.140***	0.789***	0.794***	0.866***	0.865***
	(0.0116)	(0.0111)	(0.0381)	(0.0379)	(0.130)	(0.129)	(0.0116)	(0.0115)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES	NO	YES	NO	YES
Observations	902	896	792	786	908	902	910	904
R-squared	0.291	0.318	0.796	0.802	0.038	0.047	0.033	0.043
Number of individuals	451	448	396	393	454	451	455	452

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 1-2 and 7-8). Standard errors allowing for clustering at the household level between parentheses. Even columns include controls for baseline covariates interacted with time. Baseline covariates include: child age, a dummy for children conducting market work, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households. *** p<0.01, ** p<0.05, * p<0.1

In Table 6, I replicate my analysis with separate treatment variables for the death of an elderly individual who was highly productive at baseline and for the death of a person whose productive time was below the mean of 20 hours per week. I find that the effects of the treatments are concentrated among the girls who were exposed to the death of a less productive elderly adult. The coefficients on death shock (low productivity) x female are significant for educational attainment and care work hours. The signs and magnitudes of the effects are very similar to what was found in the main analysis. None of the coefficients on death shock (high productivity) x female are significant. This is an important result because it provides more direct evidence that changes in demand for informal care are behind the observed impacts of elderly death shocks on the outcomes of interest.

Table 6: Triple difference (DDD) estimates of the impact of the death shock on girls' schooling and care work - By level of productivity of the deceased, child fixed-effects

	Currently in school		Years of education		Hours of informal care per week		No informal care [hrs of informal	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Death shock (low productivity) x female	**0.0932**	**0.0944**	**0.579****	**0.581*****	**-1.099***	**-1.335****	**0.0965**	**0.123**
	(0.0669)	**(0.0655)**	**(0.235)**	**(0.224)**	**(0.605)**	**(0.624)**	**(0.0771)**	**(0.0812)**
Death shock (high productivity) x female	-0.0363	-0.00211	0.229	0.274	-0.677	-0.651	0.00339	-0.0107
	(0.0978)	(0.0933)	(0.424)	(0.401)	(1.452)	(1.453)	(0.0883)	(0.0853)
Female x 2nd wave	0.0110	-0.0125	-0.0595	-0.0890	0.617*	0.599*	-0.0910***	-0.0797**
	(0.0302)	(0.0291)	(0.104)	(0.101)	(0.324)	(0.340)	(0.0340)	(0.0339)
Death shock (low productivity)	-0.0157	-0.0205	0.0321	0.0201	-0.248	-0.191	0.0414	0.0372
	(0.0516)	(0.0531)	(0.175)	(0.173)	(0.210)	(0.244)	(0.0552)	(0.0570)
Death shock (high productivity)	0.0953	0.134**	0.320*	0.452**	-0.00791	-0.214	0.0907	0.106
	(0.0632)	(0.0628)	(0.188)	(0.183)	(0.148)	(0.187)	(0.0803)	(0.0817)
2nd wave	-0.213***	-0.0113	2.849***	3.073***	-0.0824	-0.248	-0.0156	-0.0850*
	(0.0208)	(0.0502)	(0.0789)	(0.210)	(0.0900)	(0.467)	(0.0186)	(0.0511)
Constant	1***	1***	3.051***	3.070***	0.616***	0.622***	0.890***	0.891***
	(0.00704)	(0.00679)	(0.0292)	(0.0288)	(0.0680)	(0.0677)	(0.00893)	(0.00890)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES	NO	YES	NO	YES
Observations	2,104	2,080	1,874	1,854	2,120	2,098	2,128	2,104
R-squared	0.204	0.255	0.803	0.811	0.011	0.020	0.025	0.031
Number of individuals	1,052	1,040	937	927	1,060	1,049	1,064	1,052

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 1-2 and 7-8). Standard errors allowing for clustering at the household level between parentheses. Even columns include controls for baseline covariates interacted with time. Baseline covariates include: child age, a dummy for children conducting market work, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households. *** p<0.01, ** p<0.05, * p<0.1

Other outcomes - I move on to testing a range of potential alternative mechanisms which could also explain the effect of elderly adult death shocks on treated girls' schooling outcomes and thus confound my analysis. In columns 1 to 4 of Table A3, I investigate the effect of the treatment on two other dimensions of children's time use, domestic work and market work, using the same triple difference (DDD) specification as before. I find no treatment effect on domestic work other than care work. The coefficient of interest for domestic work hours is quite large but insignificant (Table A3, column 2). Turning to market work, I find evidence that the probability of conducting this type of work increased more sharply for the girls who were exposed to the death of an elderly household member between the two rounds of PSF. This suggests that treated girls catch-up on the comparison group after the death of their relative. Treated girls are 6 percentage points more likely to be participating in the labor market at endline than they were at baseline (Table A3, column 3). The probability of participating in the labor market decreases by 4 percentage points between waves for non-treated girls. The coefficient of interest is also large and positive for weekly hours of market work in column 4, although not significant.

Could this increase in labor market participation explain the effect of elderly deaths on educational attainment? Dumas (2016) finds that past years of work have a positive impact on children's learning in Senegal. However, the bulk of the child labor literature points to a small but negative effect of economic activities on school enrolment, educational attainment and learning due to reduced time for school attendance and studying at home (Akabayashi and Psacharopoulos 1999, Beegle et al. 2009, Gunnarsson et al. 2006, Ravallion and Wodon 2000). What seems likely in the case of elderly adult deaths is that some of the girls who are exposed to this shock increase their hours of work while others spend more time in school. Of course, we can't completely exclude that economic activities contribute to children's cognitive development and as a result to the effect of the death shocks on educational attainment.

In columns 5 to 9 of Table A3, I estimate the impact of the death of an elderly household member on a range of other outcomes including household size, total per capita expenditure and schooling expenditure in the household of residence, as well as whether the household of residence is female headed and whether the respondent reports being a foster child. The treatment effect on household size is of interest because if elderly adults tend to be negative net contributors to the budget of their household of residence, their death could result in a positive consumption shock for the remaining household members which could also positively affect

children's ability to attend school and to accumulate human capital. I could thus be mistaking the effect of a negative shock of demand for informal care for that of a consumption shock. In this case, I would expect the coefficient of interest to be negative and significant in column 5 which reports estimates of the treatment effect on household size and positive and significant in column 6 which shows results for the impact on household per capita consumption. The results suggest that there is no statistically significant effect of elderly adult deaths on either household size or per capita consumption. Tests of joint significance for the coefficients on death shock and death shock x female in these two specifications also reject this hypothesis. Column 7 looks at the effect of the death on the allocation of resources within the household and in particular on per capita schooling expenditure. The coefficient of interest is once again insignificant as is the test of joint significance for this outcome, suggesting that we can rule out direct investments in human capital as a potential channel for the effect of elderly death shocks on educational attainment.

Table A3 column 8 presents regression results where the dependent variable is an indicator variable equal to one if the child resides in a household which is headed by a woman. The coefficient on death shock x female is small and insignificant. However, the coefficient on death shock alone equals 0.295 and has a p-value of less than 0.01. This coefficient indicates that there is a positive impact of the death shock on the probability of living in a female headed household for girls and boys alike. This result shows that the difference in the probability of having a woman as one's head of household which was observed at baseline between treated and control children is entirely offset by the treatment effect so that treated children are actually far more likely to be living in female headed households than control children at endline. This is a concern for my identification strategy if female household heads happen to be more prone to investing in their children's education than their male counterparts. To assess the extent of the problem, I re-estimate the regressions from Table 3 after restricting my sample to the children who live in a male headed household in both waves of PSF. The results are displayed in Table A4. The effects observed in the main sample of interest are robust to this test and, if anything, statistically more significant. This rules out the possibility that the effect of elderly death shocks on girls' schooling are entirely driven by children who end up living in a female headed household after the death of an elderly relative.

Finally, Table A3 column 9 shows that exposure to the shock associated with the death of an old age household member doesn't increase the probability that a child has been fostered to a

different household. A statistically significant effect of the treatment on this outcome would have been a concern for my identification strategy because previous research has shown that changes in household structure, and in particular child fostering, could be associated with improvements in school enrollment and educational attainment (Akresh 2004).

IV. Robustness

A. Missing data

As previously mentioned, attrition isn't a concern in the sample of interest. However, one limitation of my analysis is that educational attainment data are missing in at least one of the two time periods for 12% of the sub-sample of interest. This could bias my results for this outcome if missing educational attainment data aren't random and happen to be correlated with unobserved predictors of education and with the death shocks.

To assess the extent of this issue, I estimate a Heckman selection model which corrects for the potential bias from non-random missing values (Heckman 1979). In the first step, I estimate the probability of having missing education data in any of the two survey waves using a probit. This probit model uses two sets of excluded variables. First, PSF data collection took place over relatively long time periods and data quality likely varied from month to month during each survey wave. Seasonal factors such as rainy seasons or summer vacation periods could have affected the data collection process for instance. So, I use a series of dummies for the month in which the household was interviewed in each wave of the PSF study as excluded variables. Second, I follow De Vreyer and Nilsson (2019) and also include a series of dummies indicating the identity of the supervisor in charge of the team which interviewed the household in each wave. This second set of excluded variables exploits idiosyncratic differences in skills between supervisors to account for missing values. Overall, both sets of excluded variables are likely to be good predictors of missing data while being uncorrelated with unobserved predictors of the outcome of interest.

The first stage results (not shown) suggest that the sets of excluded variables predict missing education information relatively well (χ^2=67.61, p=0.002). The second step of the model is

estimated in first differences to remove the fixed effects as suggested in Wooldrige (2010). The second step results are presented in Table 7 column 2. The coefficient on the inverse Mills ratio (not shown in the table) is negative and statistically significant at the 10% level, suggesting that missing values are indeed non-random (λ=-0.667, p=0.062). The corrected coefficient on death shock x female is slightly larger, but nevertheless fairy close to the uncorrected first-difference estimate presented in column 1 (which is identical to the main result in Table 3). Correcting for non-random missing data therefore leaves the initial findings essentially unchanged regarding the impact of elderly death shocks on girls' educational attainment.

Table 7: Triple difference (DDD) estimates of the impacts of the death shock on girls' years of education - Heckman selection correction

	Uncorrected (1st differences)	Heckman correction
	(1)	(2)
Death shock x female	0.552**	0.593***
	(0.217)	(0.228)
Female	-0.0661	-0.0619
	(0.104)	(0.110)
Death shock	0.0833	0.00584
	(0.157)	(0.160)
Constant	2.851***	2.995***
	(0.0794)	(0.111)
Observations	937	1058
Selected Observations		931
R-squared	0.017	
ρ		-0.451

Source: PSF Survey, waves 1 and 2. Sample: children aged 6-17 in wave 1. Notes: Column 1 presents results from an OLS regression estimated in first differences with robust standard errors between parentheses. Column 2 displays results from Heckman's two-step selection consistent estimator (Heckman 1979) implemented in Stata 16 (StataCorp. 2019) with the heckman command. Regressors in the regression equation include indicator variables for the month in which data was collected in each survey wave, as well as indicator variables for the identity of the surveyor team head in each wave, indicators for female children and children exposed to the death shock, and the interaction between these last two variables. *** p<0.01, ** p<0.05, * p<0.1

B. Alternative treatment definitions

The somewhat arbitrary age limit used to define the "elderly" population category is another area of potential concern. Note that modifying this definition affects both the boundaries of the sub-sample of interest and the treatment itself. To assess the robustness of the results to alternative definitions of the elderly age group, I replicate my analysis with two different age limits. Panel A of appendix Table A5 presents the results from estimating my main model for the sample of children who resided with an adult aged 58 or more at baseline. The definition of the death shock is also modified to include all deaths of household members aged 58 or more between PSF wave 1 and PSF wave 2. This change of definition increases the number of individuals in the sample by 6.6% and the number of treated children by 3%. In panel B of Table A5, the sample is restricted to the children who resided with an adult aged 62 or more at baseline and the definition of the treatment is modified accordingly. This reduces the sample size by 12.9% and the number of treated children by 6.3%. The results remain very similar to the main findings presented in tables 3 and 4.

C. Spillovers

Intra-household spillovers are a well-known threat to identification in the case of approaches which compare female and male children within the same households. In the present situation, the estimated coefficients for the impact of elderly deaths on girls' education could be biased upwards if the fact that girls tend to attend school more regularly leads boys to reduce their own school hours. Put differently, the parallel trends between treated and control boys displayed in Table A2 could be misleading if they don't reflect what would have happened to treated boys in the absence of treatment. Unfortunately, it is impossible to test this directly without a third wave of PSF data. From a theoretical perspective however, there are few reasons to think that such spillovers are at play. First, human capital investment theory suggests that parents will tend to invest more in the education of the children with the highest returns to education in a context of resource and credit constraints. This is the "sibling rivalry" theory which predicts that male children's education tends to get priority when there is pro-male bias in returns as is most likely the case in Senegal (Garg and Morduch 1998). It therefore seems unlikely that treated households would keep their daughters in school at the expense of their sons' education. Second, considering that girls tend to specialize in domestic work, negative spillover effects on boys would most likely occur if the treatment led female children to reduce their domestic work hours in order to attend school. As mentioned before, the results presented in Table A3 for

domestic work ouctomes don't point to a clear negative effect of elderly adult deaths on these outcomes among treated girls. This questions the plausibility of a negative spillover effect through that channel. Finally, the existing empirical literature in the economics of education tends to point towards positive rather than negative spillovers on boys from interventions aimed at increasing girls' school attendance (Kazianga et al. 2012, Kazianga et al. 2013, Kim et al. 1999). If such positive spillovers were at play in the case of elderly death shocks, the above analysis would be underestimating the positive impact of the shocks on girls' school enrollment and educational attainment.

V. Conclusions

In this article, I document the involvement of children, and especially girls, in the provision of informal care to their relatives in the context of Senegal. I also evaluate the effect of caring responsibilities on the educational attainment of female children. I find that more than one in five girls in the age range 6-17 had some caring responsibilities in 2006-2007. This burden didn't account for a very large share of their time: young female caregivers dedicated 8 hours per week to this task on average. However, my results suggest that conducting care work affected the educational outcomes of these young caregivers.

To identify this impact, I focus on the specific effect of attending to the needs of elderly relatives and find that the schoolgirls who were affected by the death of an elderly household member between 2007 and 2010 completed approximately 0.5 years of additional education compared to schoolgirls who still resided with an elderly adult at the end of this period. I also find a direct effect of elderly death shocks on the intensive margin of caring: bereaved schoolgirls experienced a decrease in care work of 0.7 hours per week between waves while weekly care work increased by half an hour among schoolgirls in the comparison group. I provide evidence that changes in demand for care work are one of the mechanisms through which elderly adult deaths impact education. In particular, I show that deaths of less productive - and therefore most likely less autonomous - individuals account for most of the effects on both educational attainment and informal care hours.

The findings of this paper suggest that informal care displaces schooling for the most intensive caregivers and causes them to drop out of school or to attend school less frequently than they

would have done in the absence of caring duties. Among teenagers in particular, elderly death shocks had an effect on both the extensive and the intensive margin of schooling, suggesting that some female teenagers leave school because of their caring responsibilities. Do the few months of education lost by the girls who resided with an elderly adult throughout the study period make a difference in terms of actual skill retention in early adulthood? To provide suggestive evidence on this matter, I estimate the marginal effect of an extra year of education at the PSF wave 2 sample mean[8] on reading skills, newspaper reading habits, internet usage and mobile money usage among female respondents aged 18 to 30 in the Senegal DHS 2019. The comparison uses entropy balancing to address potential bias from self-selection into longer school curriculums (Hainmueller and Xu 2013). The procedure balances the two groups on the first, second, and third moments of the following covariates: age, ethnicity dummies, urban area of residence, region of residence dummies, and the DHS wealth index. The comparison shows that respondents who have completed 7 years of education instead of 6 are 34 percentage points more likely to be able to read full sentences and 10 percentage points more likely to occasionally read the newspapers (appendix Figure B1). The coefficients aren't significant for internet usage and mobile money usage although the coefficients are also positive. Thus, it seems that relatively small marginal increases in educational attainment have non-trivial implications in terms of retained skills in early adulthood in the Senegalese context[9]. In other words, sacrificing a few months of schooling to attend to the needs of a sick or elderly relative also means sacrificing part of one's future capabilities as an adult.

These results call for an increased attention of policy makers to gender inequalities in child labor. In Senegal, and probably in many other sub-Saharan African countries, female children work significantly more than their male counterparts when all forms of labor are taken into account, including domestic chores and informal care. It will be hard to close the gender gap in education if this imbalance isn't addressed. It appears in particular that the lack of formal care services in many sub-Saharan African countries, weighs on the demand for female child labor and leads many girls to leave school earlier than they could have. Investing in public and private forms of formal care could reduce that burden, and, in doing so, would improve the long-term welfare of African populations.

[8] Female respondents in the subsample of interest of the study had 6 years of education on average when interviewed for PSF 2.

[9] Assuming a linear relationship between educational attainment and literacy, the 0.5 years of extra education completed by bereaved schoolgirls in my sample of interest would increase the probability of being a fluent reader at adult age by 17 percentage points.

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APPENDICES

Appendix A. Additional descriptive statistics and robustness checks for the main analysis

Figure A1: Age distribution of the baseline sample (PSF Wave 1)

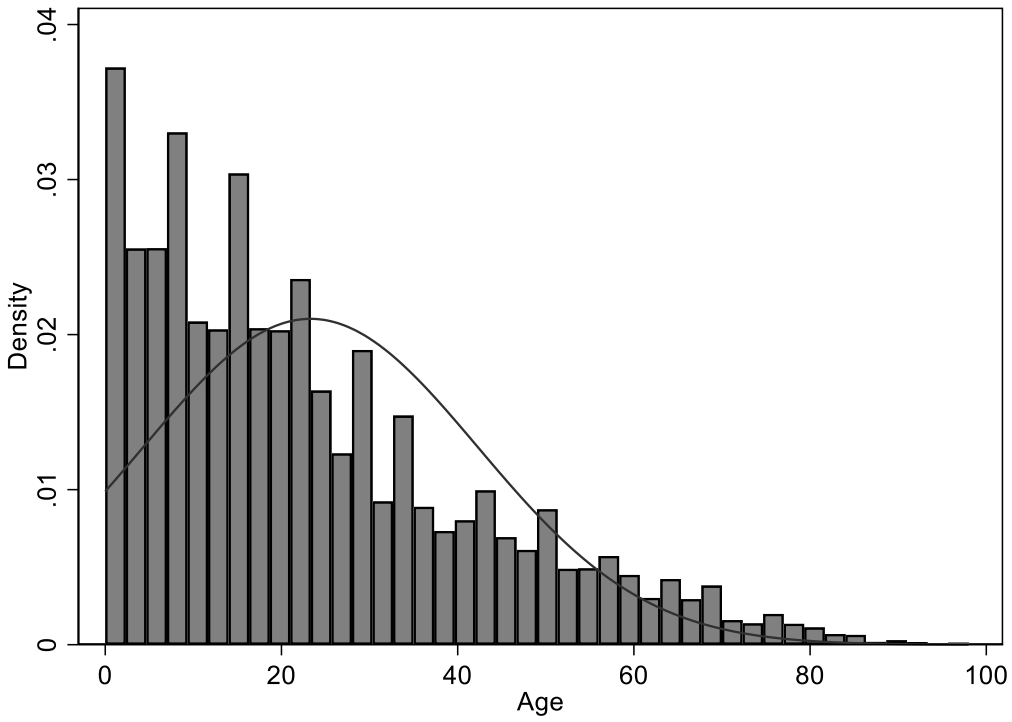
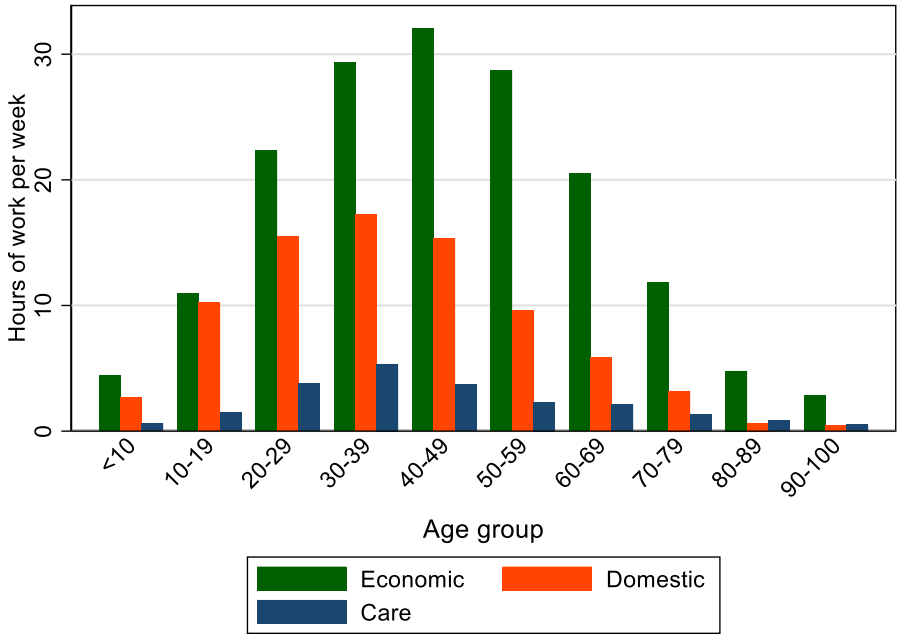
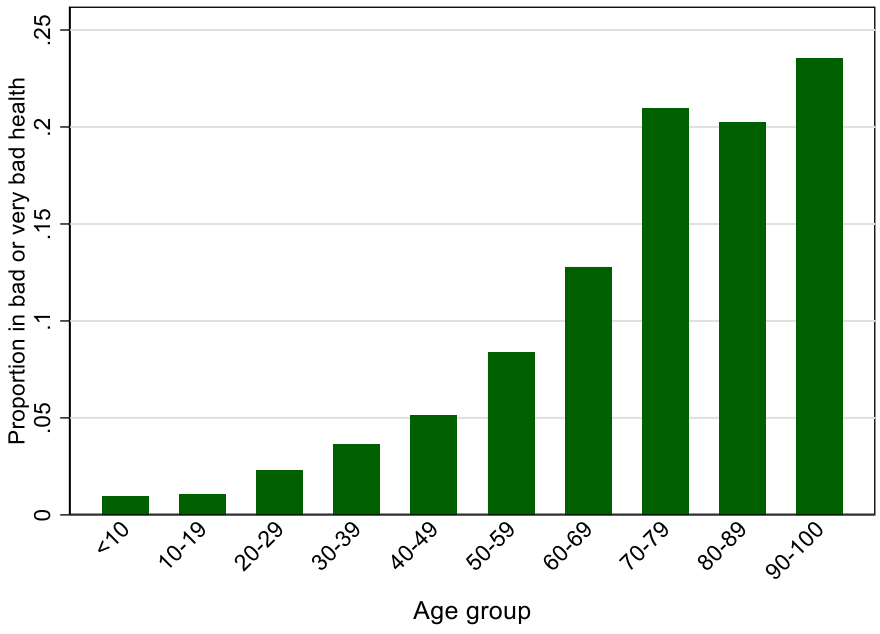


Figure A2: Labor supply and self-reported health among wave 1 respondents

Panel A – Weekly working time by age group and by type of work:



Panel B - Self-assessed health condition by age group:



Source: PSF Survey, wave 1. Sample: All wave 1 observations (panel and attrited).

Table A1: Descriptive statistics (children aged 6-17 in wave 1, panel observations)

	Wave 1 (2006-7)		Wave 2 (2010-12)	
	Mean	*SD*	Mean	*SD*
Panel A. Girls				
Age	11.1	*3.5*	15.4	*3.6*
Schooling Outcomes				
Ever went to school	0.64	*0.48*	0.76	*0.43*
Currently in school	0.56	*0.50*	0.55	*0.50*
Years of education completed	1.9	*2.4*	3.9	*3.3*
Completed primary school	0.10	*0.29*	0.31	*0.46*
Child Labor				
Ever worked (market work)	0.22	*0.42*	0.41	*0.49*
Currently working (market work)	0.18	*0.38*	0.26	*0.44*
Doing domestic work	0.66	*0.48*	0.82	*0.38*
Doing care work	0.22	*0.42*	0.28	*0.45*
Hours of economic work per week	5.4	*14.9*	8.8	*16.7*
Hours of domestic work per week	9.6	*14.5*	13.3	*14.9*
Hours of care work per week	1.7	*4.5*	2.6	*7.5*
Observations	1998			
Panel B. Boys				
Age	11.2	*3.4*	15.4	*3.5*
Schooling Outcomes				
Ever went to school	0.68	*0.47*	0.80	*0.40*
Currently in school	0.62	*0.49*	0.59	*0.49*
Years of education completed	2.1	*2.5*	4.4	*3.4*
Completed primary school	0.12	*0.32*	0.36	*0.48*
Child Labor				
Ever worked (market work)	0.37	*0.48*	0.59	*0.49*
Currently working (market work)	0.31	*0.46*	0.46	*0.50*
Doing domestic work	0.41	*0.49*	0.45	*0.50*
Doing care work	0.07	*0.25*	0.05	*0.21*
Hours of economic work per week	9.5	*20.2*	19.8	*26.2*
Hours of domestic work per week	4.2	*10.0*	4.1	*10.2*
Hours of care work per week	0.3	*1.7*	0.2	*1.8*
Observations	1921			

Source: PSF Survey, waves 1 and 2. Sample : Children aged 6-17 in wave 1. Author's calculations.

Table A2: Test of parallel trends in male subsample - Child fixed effects

	Currently in school	Years of education	Hours of informal care per week	No informal care [hrs of informal care=0]
	(1)	(2)	(3)	(4)
Death shock	0.00147	0.0833	-0.217	0.0555
	(0.0465)	(0.157)	(0.184)	(0.0493)
2nd wave	-0.212***	2.851***	-0.0800	-0.0165
	(0.0209)	(0.0794)	(0.0905)	(0.0187)
Constant	1***	3.174***	0.231***	0.948***
	(0.00936)	(0.0343)	(0.0394)	(0.00892)
Observations	1,094	978	1,106	1,106
R-squared	0.212	0.814	0.008	0.005
Number of individuals	547	489	553	553

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 1 and 4). Standard errors allowing for clustering at the household level between parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A3: Triple differences (DDD) in other outcomes by treatment status - Child fixed effects

	Currently doing domestic work (1)	Hours of domestic work per week (2)	Currently doing market work (3)	Hours of market work per week (4)	Household size (5)	Log(expenditure per HH member) (6)	Log(school exp. per HH member) (7)	Female household head (8)	Child is fostered (9)
Death shock x female	**-0.0650**	**3.515**	**0.189****	**2.981**	**0.756**	**0.0696**	**0.0737**	**0.00466**	**-0.0179**
	(0.0979)	**(2.167)**	**(0.0880)**	**(3.227)**	**(1.139)**	**(0.136)**	**(0.516)**	**(0.0719)**	**(0.0497)**
Death shock	-0.0881	0.574	-0.0836	0.639	-1.426	-0.0813	0.152	0.295***	-0.00238
	(0.0888)	(0.933)	(0.0676)	(2.704)	(1.225)	(0.129)	(0.497)	(0.0665)	(0.0274)
Female x 2nd wave	0.0811*	2.458**	-0.0909**	-5.428***	-0.260	0.0225	0.117	0.0328	-0.0358
	(0.0491)	(0.993)	(0.0401)	(1.566)	(0.456)	(0.0536)	(0.230)	(0.0255)	(0.0221)
2nd wave	0.476***	4.028**	0.0449	2.425	0.896	0.0509	1.428***	-0.000672	0.0579
	(0.0906)	(1.719)	(0.0751)	(3.147)	(0.893)	(0.101)	(0.470)	(0.0493)	(0.0371)
Constant	0.464***	4.375***	0.141***	2.734***	14.79***	12.21***	7.494***	0.202***	0.0913***
	(0.0134)	(0.221)	(0.0115)	(0.467)	(0.180)	(0.0195)	(0.0816)	(0.00883)	(0.00615)
Controls (baseline covariates*2nd wave)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2,046	2,008	2,058	2,058	2,104	1,868	1,896	2,104	2,104
R-squared	0.119	0.112	0.100	0.184	0.012	0.062	0.055	0.131	0.008
Number of individuals	1,023	1,004	1,029	1,029	1,052	934	948	1,052	1,052

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 1, 3, 8 and 9). Standard errors allowing for clustering at the household level between parentheses. In columns 1-2, 5-7 and 9 baseline covariates include: child age, a dummy for children conducting market work, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households. In columns 3-4 baseline covariates include: child age, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households. In column 8 baseline covariates include: child age, a dummy for children conducting market work, and the maximum number of years of education completed by an adult member of the household.*** p<0.01, ** p<0.05, * p<0.1

Table A4: Triple difference (DDD) estimates of the impact of the death shock on girls' schooling outcomes - Child fixed effects, restricted sample

	Currently in school (1)	Years of education (2)
Death shock x female	**0.157***	**0.789*****
	(0.0809)	**(0.268)**
Death shock	-0.00288	0.0735
	(0.0629)	(0.202)
Female x 2nd wave	-0.000735	-0.166
	(0.0399)	(0.122)
2nd wave	-0.233***	2.750***
	(0.0259)	(0.0904)
Constant	1***	3.011***
	(0.00896)	(0.0336)
Observations	1,426	1,258
R-squared	0.229	0.806
Number of individuals	713	629

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for column 1). Sample restricted to children living in male headed households in both survey waves. Standard errors allowing for clustering at the household level between parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A5: Triple difference (DDD) estimates of the impact of the death shock on girls' schooling and care work - Alternative treatment definitions, child fixed-effects

	Currently in school		Years of education		Hours of informal care per week		Informal care work >15h/week	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Children co-residing with an adult aged > 57 at baseline								
Death shock x female	**0.0811**	**0.0777**	**0.627*** **	**0.626*** **	**-1.083***	**-1.238****	**-0.0407****	**-0.0451****
	(0.0596)	**(0.0578)**	**(0.212)**	**(0.203)**	**(0.592)**	**(0.616)**	**(0.0190)**	**(0.0194)**
Female x 2nd wave	0.000560	0.0127	0.0113	0.0453	-0.176	-0.179	0.00219	0.00323
	(0.0454)	(0.0470)	(0.156)	(0.155)	(0.184)	(0.207)	(0.00380)	(0.00458)
Death shock	0.00112	-0.0186	-0.0991	-0.120	0.670**	0.654**	0.0136	0.0126
	(0.0291)	(0.0280)	(0.0996)	(0.0973)	(0.319)	(0.331)	(0.0111)	(0.0118)
2nd wave	-0.207***	0.00830	2.884***	3.075***	-0.114	-0.449	-0.00219	-0.00155
	(0.0200)	(0.0474)	(0.0760)	(0.201)	(0.0967)	(0.455)	(0.00380)	(0.0155)
Constant	1***	1***	3.140***	3.159***	0.622***	0.627***	0.00969***	0.00979***
	(0.00675)	(0.00654)	(0.0279)	(0.0276)	(0.0677)	(0.0673)	(0.00229)	(0.00229)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES	NO	YES	NO	YES
Observations	2,254	2,230	2,010	1,990	2,270	2,248	2,270	2,248
R-squared	0.201	0.252	0.804	0.812	0.010	0.020	0.006	0.013
Number of individuals	1,127	1,115	1,005	995	1,135	1,124	1,135	1,124
Panel A. Children co-residing with an adult aged > 61 at baseline								
Death shock x female	**0.0561**	**0.0565**	**0.470****	**0.455****	**-1.023***	**-1.187***	**-0.0340***	**-0.0390****
	(0.0655)	**(0.0637)**	**(0.230)**	**(0.220)**	**(0.615)**	**(0.640)**	**(0.0185)**	**(0.0187)**
Female x 2nd wave	0.0154	0.0325	0.168	0.233	-0.111	-0.133	-0	0.000845
	(0.0494)	(0.0515)	(0.171)	(0.168)	(0.178)	(0.204)	(0.00389)	(0.00502)
Death shock	0.0338	0.0128	0.0191	-0.00422	0.657*	0.629*	0.0146	0.0129
	(0.0336)	(0.0323)	(0.114)	(0.111)	(0.354)	(0.369)	(0.0126)	(0.0134)
2nd wave	-0.229***	-0.0149	2.786***	2.986***	-0.0852	-0.334	0	0.00499
	(0.0230)	(0.0539)	(0.0901)	(0.223)	(0.105)	(0.510)	(0.00389)	(0.0158)
Constant	1***	1***	2.938***	2.959***	0.589***	0.595***	0.00755***	0.00764***
	(0.00753)	(0.00733)	(0.0315)	(0.0310)	(0.0724)	(0.0722)	(0.00246)	(0.00246)
Controls (baseline covariates*2nd wave)	NO	YES	NO	YES	NO	YES	NO	YES
Observations	1,836	1,812	1,618	1,598	1,854	1,832	1,854	1,832
R-squared	0.208	0.259	0.802	0.810	0.010	0.019	0.007	0.015
Number of individuals	918	906	809	799	927	916	927	916

Source: PSF Survey, waves 1 and 2. Notes: Results from OLS regressions with individual fixed-effects (linear probability model for columns 1-2 and 7-8). Standard errors allowing for clustering at the household level between parentheses. Even columns include controls for baseline covariates interacted with time. Baseline covariates include: child age, a dummy for children conducting market work, the maximum number of years of education completed by an adult member of the household, and a dummy for female headed households. *** p<0.01, ** p<0.05, * p<0.1

Appendix B. Entropy balanced comparison of reading skills, newspaper reading habits, internet usage and mobile money usage among female respondents aged 18 to 30 in the Senegal DHS 2019

This section presents estimates of the marginal effect of an extra year of education at the PSF wave 2 sample mean (6 years of education) on reading skills, newspaper reading habits, internet usage and mobile money usage among Senegalese women aged 18 to 30. The estimation is based on Hainmueller and Xu's (2013) multivariate reweighting method also known as "entropy balancing". The estimation uses the main sample of women from Senegal's 2019 DHS. However, I restrict the sample to women aged 18 to 30 which approximately corresponds to the age range of the PSF sample used in this paper at the time when the DHS data were collected (2019). I further restrict the DHS sample to individuals who report having completed 6 or 7 years of education because I am interested in the marginal effect of an extra year of education conditional on having completed 6 years. The procedure balances the two groups on the first, second, and third moments of the following covariates: age, ethnicity dummies, urban area of residence, region of residence dummies, and the DHS wealth index. Pre and post reweighting balance checks are presented in Table B1.

Estimates from unweighted and weighted probit models are presented in Figure B1. The models regress the four outcomes of interest on a "treatement" indicator variable equal to 1 if the individual has completed 7 years of education and to 0 otherwise. The unweighted models also control for age, wealth, and indicators for urban respondents, for the region of residence, and for ethnicity. Figure B1 graphs the coefficients on the treatment variable with 95% confidence intervals. Standard errors are clustered at the primary sampling unit level in the unweighted models.

Table B1: Covariates balance by sub-sample

	Raw means				Entropy-balanced means			
	(1) Education: 6 yrs	(2) Education: 7 yrs	(3) Diff. (1)- (2))	(4) SE	(5) Education: 6 yrs	(6) Education: 7 yrs	(7) Diff. (5)- (6))	(8) SE
Age	25.395	20.447	4.948***	(0.624)	20.446	20.447	-0.001	(0.524)
Wealth index	8794.656	10172.463	-1377.807	(6868.037)	10172.629	10172.463	0.166	(8206.483)
Urban	0.413	0.392	0.021	(0.037)	0.392	0.392	0.000	(0.044)
Region: Dakar	0.071	0.045	0.026	(0.018)	0.044	0.045	-0.001	(0.015)
Region: Ziguinchor	0.153	0.125	0.028	(0.026)	0.126	0.125	0.000	(0.028)
Region: Diourbel	0.082	0.032	0.049***	(0.017)	0.032	0.032	0.000	(0.012)
Region: Saint-Louis	0.020	0.045	-0.025*	(0.014)	0.045	0.045	0.000	(0.022)
Region: Tambacounda	0.051	0.051	-0.000	(0.017)	0.051	0.051	0.000	(0.018)
Region: Kaolack	0.120	0.071	0.049**	(0.022)	0.071	0.071	0.000	(0.021)
Region: Thies	0.054	0.109	-0.056***	(0.021)	0.109	0.109	0.000	(0.031)
Region: Louga	0.056	0.048	0.008	(0.017)	0.048	0.048	0.000	(0.017)
Region: Fatick	0.036	0.058	-0.022	(0.016)	0.058	0.058	0.000	(0.023)
Region: Kolda	0.110	0.113	-0.003	(0.024)	0.113	0.113	0.000	(0.028)
Region: Matam	0.051	0.064	-0.013	(0.018)	0.064	0.064	0.000	(0.021)
Region: Kaffrine	0.048	0.035	0.013	(0.015)	0.035	0.035	0.000	(0.014)
Region: Kedougou	0.043	0.103	-0.060***	(0.020)	0.103	0.103	0.000	(0.032)
Region: Sedhiou	0.105	0.100	0.005	(0.023)	0.100	0.100	0.000	(0.025)
Ethnicity: Wolof	0.270	0.190	0.081**	(0.032)	0.189	0.190	-0.001	(0.032)
Ethnicity: Poular	0.296	0.341	-0.045	(0.035)	0.341	0.341	0.000	(0.043)
Ethnicity: Serer	0.125	0.145	-0.020	(0.026)	0.145	0.145	0.000	(0.033)
Ethnicity: Mandingue/ Socé	0.099	0.125	-0.026	(0.024)	0.126	0.125	0.000	(0.030)
Ethnicity: Diola	0.089	0.093	-0.004	(0.022)	0.093	0.093	0.000	(0.026)
Ethnicity: Soninké	0.036	0.035	0.000	(0.014)	0.035	0.035	0.000	(0.016)
Ethnicity: Other Senegalese	0.061	0.051	0.010	(0.017)	0.051	0.051	0.000	(0.018)
Ethnicity: Not Senegalese	0.023	0.019	0.004	(0.011)	0.019	0.019	0.000	(0.011)
Observations	392	311	703		392	311	703	

Source: Author's calculations from Senegal DHS 2019. Sample: Women aged 18 to 30 who have completed between 6 and 7 years of education. Notes: Heteroskedasticity robust standard errors between parentheses. Standard errors and differences obtained from univariate OLS regressions of a dummy variable equal to one if an individual has completed 7 years of education on the covariate of interest. *** p<0.01, ** p<0.05, * < p<0.01.

Figure B1 - Impact of 1 extra year of education conditional on having completed 5 years