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The Long-Term Impacts of Violent Conflicts on Human Capital: U.S. Bombing and, Education, Earnings, Health, Fertility and Marriage in Cambodia

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Abstract

We combined household surveys and the intensity of bombing to investigate the long-term impact of U.S. bombing during the 1969-1973 period on education, earnings, health, fertility and marriage in Cambodia. The novelty of this paper consists of the use of the quantity of bombs dropped in each geographic district, which allows the estimation of the effects of the intensity of bombing. Taking into account this intensive margin adds significant insights to using a binary exposure to bombing that has been reported in previous research. We find that one standard deviation increase in the intensity of bombing during 1969-1973 reduced years of schooling by about 0.11-0.23. The effects for men are larger than those for women. Fertility (total births) increased by 0.20 and age at first marriage for girls declined by 0.32 year. The reduction in years of education completed do not seem to have affected earnings, however. Similarly, we did not detect any significant effect on health.

Keywords: U.S. Bombing, Education, Fertility, Marriage, Mortality, Cambodia
JEL Codes: O15, I28

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1 Introduction

Armed conflicts whether within or between countries bring about immediate and long-term consequences. Immediate negative effects are apparent ranging from destruction of capital and infrastructure, displacement of population, loss of social network, separation among family members, disruption of schooling and other economic activities, food shortage and health crises, delay in reproduction and marriage, and death of civilians and army. By contrast, long-term impacts are less apparent and the evidence from existing studies is mixed.

Recent literature documents two lines of conflicting evidence. Studies that look at the aggregate effects measured by macroeconomic indicators, such as Davis and Weinstein (2002), Brakman et al. (2004), Chen et al. (2008) and Miguel and Roland (2011), show that the negative consequences of armed conflicts do not persist decades later. In contrast, other studies that investigate the long-term consequences of armed conflicts at the micro level such as Ichino and Winter-Ebmer (2004), Akresh and de Walque (2008), Shemyakina (2011), Merrouche (2011), León (2012), Akbulut-Yuksel (2014) and Islam et al. (2015a, 2015b), find long-lasting effects on the outcomes of individuals several decades later.

This study adds to a growing body of literature on the long-term impacts of armed conflicts. First, unlike recent studies on armed conflicts in Cambodia, particularly by Islam et al. (2015a), who use years of exposure to conflicts by regions during the 1970-1979 period as a measure of atrocities inflicted by conflicts, and Merrouche (2011), who uses landmine contamination during the 1970-1998 period, this study in turn uses intensity of U.S. bombs dropped in Cambodia as a measure of destruction caused by armed conflicts during 1969-1973. No other study has used bomb intensity as the measure of the destruction of conflicts to examine the impacts at the micro level of the households. Second, it contributes to the limited number of studies on the long-term effects of armed conflicts on earnings and marriage.

We use nationally representative surveys that we can have access to, such as Cambodia Socio-Economic Surveys (CSES) 2004, 2008, 2009 and 2010, Cambodia Demographic and

Health Surveys (CDHS) 2000, 2005 and 2010, and data of the U.S. bomb sites and apply difference-in-differences (DID) approach to investigate the long-term impacts of the U.S. bombing during the 1969-1973 period. First, we find that one standard deviation increase in bombs during the 1969-1973 period reduced years of schooling by 0.11-0.23. The effects for men are larger than those for women. Second, we do not find any effect on earnings and employment for both men and women. Third, a one-standard deviation increase in bombing intensity caused an increase in fertility by 0.20 birth. Exposure to bombing also lowered the age at first marriage of girls (0.32 year by one standard deviation increase in bombing intensity), which may explain the increase in fertility. Hence, even if earnings are not impacted, the findings suggest that the bombing affected the non-monetary returns to education, i.e. fertility and age at first marriage. Finally, we do not find any effect on women's height (used as a proxy for the overall health status). It is plausible that amongst those exposed to the bombing as children, healthier individuals would have been more likely to survive till adulthood, hence biasing the estimate on health downward (e.g. Deaton, 2007). We provide some evidence of selective survival by showing that the bombing campaign reduced the probability of survival among children aged under five.

The rest of the paper is structured as follows. The second section reviews the existing evidence of the long-term impacts of armed conflicts. Section 3 documents the background of the U.S. bombing in Cambodia during the 1965-1973 period. We describe the data and report the descriptive statistics in Section 4. We discuss the conceptual framework and identification strategy in section 5. We present our results in section 6 and conclude in section 7.

2 Literature

This section reviews existing evidence of the impacts of armed conflicts on education, earnings, fertility, health, and marriage. Islam et al. (2015a) examine the long-term consequence

of civil war during the 1970-1979 period in Cambodia and find that individuals exposed to the war during their primary school age accumulated between 2.5 and 3.5 months fewer schooling. Merrouche (2011) uses data on landmine contamination during the 1970-1998 period in Cambodia and finds that armed conflicts reduced years of schooling of individuals, who were too young to be enrolled in school before the war, by 0.5. Likewise, using data of the aggregate residential rubble per m^3 per capita in Germany as a measure of the intensity of World War II (WWII) destruction, Akbulut-Yuksel (2014) shows that 40 years later, war-exposed children received on average 0.3 fewer years of schooling in their adulthood. Using data on regional political violence in Perú, León (2012) also finds that individual exposed to political violence acquired about 0.31 fewer years of schooling.

There is also a growing evidence of the effects of armed conflicts on earnings. Islam et al. (2015a) find that armed conflicts affected earning through the reduction in education, where one year exposure to conflicts reduced average earnings for men between 6.6 and 8.6 percent. Similarly, Akbulut-Yuksel (2014) finds that WWII destruction in Germany reduced male earnings through education about 9 percent. Ichono and Winter-Ebmer (2004) find that individuals who were ten years old during conflicts in Austria and Germany suffered from both educational loss and substantial reduction in earnings during their adulthood compared with the individuals of other cohorts. On the contrary, Merrouche (2011) investigates the long-term impacts of armed conflicts on earnings in Cambodia, and unlike Islam et al. (2015a) she uses a different measure of atrocities and covers longer period of conflicts. She finds no effect of the conflicts on earnings.

Studies on the effects of armed conflicts on fertility tend to focus on the short-term impacts of economic shocks and conflicts, and have produced conflicted findings. Linsdrom and Berhanu (1999) and Agadjanian and Prata (2002) document the decline in fertility due to famine, and political violence in Ethiopia and Angola, respectively. Verwimp and Van Bavel (2005) find an increase in fertility among Rwandese female refugees, which they attribute to the conflicts.

Research on the long-term effects on fertility has attempted to identify the channel through which conflicts and economic shocks affect fertility. Islam et al. (2015a) attribute the increase of fertility in Cambodia to the decline of female education attainment. Recent studies that find negative effects of armed conflicts on the probability of having ever been married among women include Kesternich et al. (2014), Shemyakina (2013) and Schindler and Verpoorten (2013). By contrast, Valente (2011) finds that Nepalese women who were at school age during the conflict period are more likely to be married than the comparison group, but there is no effect on women, who were at marriageable age during the conflicts.

Another line of research documents the adverse effects of in-utero or early childhood exposure to conflicts on health outcomes during adulthood[1]. Islam et al. (2015b) use sex ratio and mortality rate as the measures of the intensity of the genocide in Cambodia (1975-1979) and find a negative effect of the genocide on the height-for-age z-score of children born to parents, who were at their prime-marriage age (14-29) during the genocide. Akbulut-Yuksel (2014) finds that children exposed to the average destruction of WWII in Germany are about 6 inches shorter during their adulthood than others not exposed to the war.

3 U.S. Bombing in Cambodia (1965-1973)

The U.S. bombing started in 1965 and lasted until August 1973. The original aim of the operation was to bomb the Ho Chi Minh Trail, which passed through Laos and Cambodia. The magnitude of the bombs dropped during the period was around 2,756,941 tons, higher than the 2 million tons of bombs dropped by the Allies during World War II (Owen and Kiernan 2006). Since the population of Cambodia in the 1960s was about 7 million at the time, the U.S. bombing translates into hundreds of kilograms of bombs per capita. The bombing during the 1965-1968 period was much smaller in scale than that during the 1969-1973 period, as indicated in Figures 1a & 1b. The most intensive bombing operation was

[1]See Islam et al. (2015b), Akbulut-Yuksel (2014), Akresh et al. (2012), and Minoiu and Shemyakina (2012, 2014), among others. See Almond and Currie (2011) for a review of the long-term effect of fetal (in-utero) and childhood shocks, particularly the "fetal origins" hypothesis.

between March and August 1973. By total weight of bombs during the 1965-1973 period, the general-purpose bomb was about 84.6 percent of all purposes, while the cluster and incendiary bombs were around 6.2 percent and 5 percent, respectively. Interestingly, the bombing operation with confirmed enemy location was only 33.8 percent of the total bomb sites during the period, while the rest of the targets consisted of a long list of locations and facilities. Additionally, by total weight of the bombs, only 26.4 percent were dispatched to the confirmed enemy locations.

Figure 2a shows that more than half of the country's land mass was covered by the U.S. bomb sites, which were concentrated in areas going through the Cambodia-Vietnam border to the center of the country. Provinces located along the border such as Kampong Cham, which was the sole province that grew rubber trees and generated substantial revenue to the national economy, received the most bombs, that is approximately 20% of the total bomb weight. In contrast, provinces located in the west of the country, such as Banteay Mean Chey and Pailin, were not under any ariel strike (Figure 2b)[2].

Arguably, the bombing campaign of such magnitude and intensity could have long-term effects on individuals, especially those whose human capital accumulation was vulnerable to social and economic shocks. Young children, who were still growing, and school-age children are usually among the groups most affected in the long-term. For instance, the bombing could disrupt schooling through the destruction of school buildings and/or the displacement of population and teachers. This type of disruption, when it reduces education attainment, can affect individual lifetime earnings (Islam et al. 2015a). It is also plausible that exposure to negative shocks either in utero or in early childhood affects other health negatively and reduces learning capacity, and thus reduces education attainment and earnings in adulthood (Barker 1995). In the case of Cambodia, the massive destruction of paddy fields and its corollary of plummeting rice production would have induced severe food shortage, especially for young children and those in utero at that time.

[2]It should be noted that province is Cambodia's first-level administrative unit above district.

Additionally, fertility may be affected by conflicts. Change in the fertility can operate through multiple channels, including age at marriage, separation of couples due to male conscription and reduced fecundity due to psychological stress (Linstrom and Berhanu 1999). Moreover, risk-sharing and/or old-age security motives could lead to increase fertility following the conflicts if families seek to replace their children or relatives who perished during the conflicts (Verwimp and Van Bavel 2005). It is also plausible that reduced education attainment (especially for girls) translates to earlier marriage and increased fertility (Schultz 1994).

4 Data

The data come from three sources, including the Cambodia Socio-Economic Survey (CSES), the Cambodia Demographic and Health Survey (CDHS) and the administrative records of the U.S. bombs dropped in Cambodia between 1969 and 1973. Each of the two household surveys has its specific strengths and disadvantages. The CSES contains detailed information. The CSES is a nationally representative survey, which is carried out by the National Institute of Statistics under the Ministry of Planning of the Royal Government of Cambodia. Sampling design of the survey follows three-stage sampling process, starting from villages to enumeration areas, and households. The survey collects information related to household demography, housing, agriculture, education, income and liability, and consumption. We use all survey rounds of the years 2004, 2008, 2009 and 2010, which are all the rounds we have access to.

The CDHS is a USAID-funded project, which aims to collect detailed and reliable information on fertility history, family planning, maternal and child health, and mortality. It collects household information based on household questionnaire and identifies eligible males and females aged between 15 and 49 from the household for separate interviews. We use eligible women sample to look at the impacts on health, fertility and marriage. The

first CDHS round was fielded in 1998, with subsequent rounds in 2000, 2005, 2010 and 2014. Only the 2000 and subsequent survey include geographic information. Furthermore, the 2014 round of the survey is not distributed publicly yet. Hence, we pool the 2000, 2005 and 2010 rounds and merge these datasets with the district-level map of the bombing sites.

The data of the U.S. bomb sites during the 1969-1973 period are from the Cambodian Genocide Program at Yale University library, and are publicly distributed[3]. The data contain geographic coordinates for each bomb site, weight of bomb, bomb damage assessment, type of ordnance and target. We construct spatial intensity of the U.S. bombing at the district level. First, the U.S. bomb data are merged with the district map (177 districts), and bomb weights are summed for each district. Then, the combined district bomb data are merged with each CSES round by using the district names. The resulting dataset is used to examine the impacts on education, earnings and employment. Similarly, to obtain data for the analysis of fertility, health and marriage, we first merge the geo-coded CDHS data with the district map that contains the information on bombing. The resulting dataset is used to look at the impacts on fertility, health, marriage and mortality. Table 1 provides summary statistics of outcomes of interest and other explanatory variables.

5 Conceptual Framework and Identification strategy

5.1 Conceptual Framework

There are multiple channels through which the bombing campaign could have disrupted the accumulation of human capital. In this section we propose a simple economic framework to describe how the effects of conflict on human capital. Conceptually, the bombing campaign could have affected education through either the demand side or supply side factors, and more likely via both ways. These effects can be easily pictured using simple demand and

[3]http://gsp.yale.edu/case-studies/cambodian-genocide-program/cambodian-genocide-databases-cgdb/geographic-database-cgeo

supply curves, and treating education as a normal good. We illustrate using education, but the framework can be amended easily to explain the demand and supply of other public services as well. Figure 3 provides an illustration of the framework.

First, destruction of school building combined with displacement of teachers would shift the supply curve to the left, all else being equal. Substantive school destruction during the bombing campaign has been reported by Can (1991) for example, although he did not provide any number. It is also documented that teachers sought refuge in nearby cities or fled to France (Ayres 2000:80). On the other hand, several studies (e.g. Kazianga et al 2013, 2016) document the positive effects of school infrastructures on educational outcomes in the developing world. The findings from these studies imply that the destruction of education infrastructures would affect education attainment. These changes are reflected by the shift from S_1 to S_2 in Figure 3.

Second, fewer children would demand to attend school during or immediately after a conflict for several reasons, holding the supply side constant. Population displacement and safety[4] concerns would make parents reluctant to send their children to school. There are accounts that the two-month ground invasion by the South Vietnamese Army (SVA) in 1970 generated about 130,000 refugees, sixty percent of whom were displaced, while there were incidents that villages were completely levelled and subsequently abandoned during the last six months of the bombing (Kiernan 1989). By the end of 1971, about one third of Cambodia's seven million population were displaced (Shawcross 1987:222). By these accounts, the demand curve would have shifted down, holding the supply constant. These changes are reflected by the shift from D_1 to D_2 in Figure 3.

Overall, the bombing campaign would have resulted in a new equilibrium (Q_{E_2}) where education attainment is lower than the equilibrium (Q_{E_1}) before the conflicts. This description also clarifies the interpretation of our DID estimates, that the bombing campaign caused education attainment of the young cohort (the new equilibrium) to be lower than that of the

[4]For example, during the last week of the bombing campaign, Ecole Wat Phnom, a private primary school in the center of Phnom Penh, was hit by the bomb when classes were in progress (Ayres 2000:67).

old cohort (the old equilibrium). Specifically, the DID estimates indicate the change from Q_{E_1} to Q_{E_2} in Figure 3.

5.2 Identification strategy

Figures 4a & 4b plot the average years of schooling of individuals by year of birth. Figure 4a shows that the average years of schooling of the individuals born about a decade before 1969 is lower than that of those born earlier. The pattern is similar for the individuals born in either the high or low bomb intensity districts, as shown in Figure 4b. The graph in Figure 4a indicates that the individuals born about a decade before the U.S. bombing (1969-1973) or the Lon Nol regime (1970-1975) gained the average years of schooling lower than those born earlier. This is qualitatively justifiable as children normally start school between 7 and 12 years of age. Hence, the bombing might have some effects on the years of schooling of the individuals, who were at the primary school age at the start of the bombing or were already enrolled in the primary school during the bombing.

The identification exploits the exogenous variation in the intensity of the U.S. bombing, as well as the timing of exposure of individuals to the bombing to estimate the effect of the bombing on the outcomes of interest. As the magnitude of the bombing during the 1965-1968 period was too small to have any effect[5], we use the 1969-1973 only as the bombing period. An individual's year of birth determines timing of exposure. Currently, children in Cambodia normally start school when they are 6 years old. To account for late starts that were common in the 1950s and 1960s, we use age 7-12 as the primary school age. Thus, the "after" group comprises individuals who were between 7 and 12 year old in 1969 or born between 1957 and 1962, while the "after" group comprises those who were older than 12 or born during the 1950-1955 period (refer to Table 1 in the Appendix). The treated group consists of individuals from the "after" group who were exposed to the bombing. We

[5]We also compare the individuals, who were at their primary school age during the 1965-1968 period, with the control group, who were born during the 1945-1951 period, but the effect from DID estimate is extremely small at 0.00027 per standard deviation of the bomb.

use these distinct groups and apply DID approach, which is similar to the method in Duflo (2001), by estimating the following equation:

$$y_{ijkr} = \alpha + \beta(bomb_j * young_{ik}) + \mu_j + \delta_k + \lambda_r + \rho \mathbf{X}_{ijk} + \sum_{p=1}^{4} \theta_p (zone_p * trend) + \varepsilon_{ijk} \quad (1)$$

where y_{ijkr} is either years of schooling completed, log monthly earning, fertility, age at first marriage or height of an individual i, born in district j at year k and survey year r. And, $bomb_j$ is the level of regional bomb intensity measured in thousand metric tons in district j, while $young_{ik}$ is a dummy variable indicating that individual i was at primary-school age (7-12) during the bombing period. μ_j is the district specific fixed effects, which controls for the fact that districts may differ systematically from each other, and δ_k is the year of birth or cohort fixed effects. λ_r is the survey round dummy. Moreover, $\mathbf{X}_{ijk}$ is a vector of additional controls including sex and ethnic Khmer dummy. ε_{ijk} is an error term.

For robustness check, we also control for zone trends ($zone_p * trend$), which are the interactions between zone dummies and year of birth dummies to account for the differential trends of outcomes across the five zones, which are geographic units above province and district. Standard errors are clustered at district level to account for intra-regional correlation of outcomes of individual in the same district. We also apply White's standard error correction to obtain the valid test statistic for our estimates. In this specification, β measures the effect of the U.S. bombing during the 1969-1973 period. Interpretation of this estimate relies on the assumption that the education and earnings of household in the affected and non-affected districts do not differ systematically in the absence of the bombing. In other words, β would have been zero in the absence of the bombing campaign.

6 Results

6.1 Education

The results in Table 2 indicate that the U.S. bombing campaign during the 1969-1973 period produced a negative long-term effect on education. This result is consistent with findings by Islam et al. (2015a) and Merrouche (2011). The DID estimates from all samples are statistically significant at the 5 percent level. The estimate from the CSES full sample, as indicated in column (1), shows that conditional on the DID assumption, a standard deviation increase in the U.S. bombs reduced education attainment by approximately 0.11 years[6]. If we restrict the sample to the working age population and with observations on wages (column 3), we find that education attainment decreases by 0.23 year for one standard deviation increase in quantity of bombs dropped. If we measure at the average number of years of exposure (3 years) and the average amount of ordnance dropped (15.798), for the earning sample on average the U.S. bombing reduced years of schooling by about 0.44 years (0.0092*15.798*3), lower than the average loss of 0.7 or 1 years of schooling in Islam et al. (2015a), which use years of exposure as a measure of the intensity of the conflicts and covers the period of 1970-1979. Finally, we show the DID estimates using the CDHS data in column 5. The point estimate implies that education attainment drops by about 0.14 year per standard deviation increase in the quantity of bombs. Overall, it is comforting that the point estimates are quite stable across different subsamples and surveys. Moreover, in Table 3 in the appendix, we demonstrate that our results are robust to controlling for zone trends.

6.2 Heterogeneity of impact on education by gender

We now investigate whether the effects of bombing on education differed between men and women. We use the same specification as above (equation 1) and interact a gender dummy (for men) with the treatment interaction terms[7]. The DID estimates are shown in columns

[6]We obtain 0.11 by multiplying the point estimate with one standard deviation of the quantity of bombs dropped, i.e. (0.0045*25.369).

[7]The interaction term is augmented as follows: $bomb_j * young_{ik} * male_{ik}$.

(2), (4) and (6) in Table 2. The estimates from both CSES samples are negative and similar in size, suggesting that the U.S. bombing affected schooling for men more than that for women. Conditional on the DID assumption, a standard deviation increase in the bombs reduced years of schooling for men about 0.19 (0.0075*25.369), which is about twice as much as that for women. The DID estimate from the CDHS sample, shown in column (6), is also negative and marginally higher than those from the CSES samples. The effect is about 0.25 years per standard deviation increase in the bombs. All DID estimates in this section are also robust to adding zone trends (Table 3 in the Appendix).

The low enrollment rate among women relative to that of men during the 1950s and early 1960s might be the one reason underlying the difference in the impact. The number of women, who were at the primary school age and never attended school during the periods, were about 3 to 4 times as low as that of men according to census 2008, suggesting that there was more room to reduce boys enrollment than that of girls. Moreover, child soldiers aged between 10 to 15 during the 1970-1975 period could be another factor, but this explanation should be taken with caution owing to the absence of data. Seaman (1999) claims based on the reports from various journalists that there was the use of child soldiers by the Lon Nol's regime and the Khmer Rouge army during the 1970-1975 period, but provides no concrete accounts and statistics of its extent and scope. It is also worth noting that young boys were more preferred by the Khmer Rouge to young girls as they were more ready to help during the combat and easy to be indoctrinated. Thus, young boys from peasant families would have been more likely to be abducted than girls by the Khmer Rouge during their ambushes of the villages.

6.3 Earnings

Table 3 presents the results of the effect of the U.S. bombing on earnings and employment for both men and women. Although the results in the preceding sections show that the effect on education for men is larger than that for women, the results in Table 3 do not

reveal any effect of the bombing on earnings and employment for both groups. The DID estimates of the log monthly earnings for both men and women are negative, but statistically insignificant, as indicated in columns (1), (2) and (3) in panel A. The effect on employment, as shown in the same columns in panel B, are also negative, but statistically insignificant.

These results are consistent with those in Merrouche (2011), who finds that land mine contamination over the 1970-1998 period in Cambodia did not have any effect on earnings. Islam et al. (2015a) find no effects on women earnings either, but their estimates indicate that the bombing affected men's earnings. We estimate that an additional year of schooling increases earnings for men about 7.5% and for women about 7.1% for the sample households (Table 2 in the Appendix). Thus, the reduction in the years of schooling by between 0.11 and 0.23 years due to the U.S. bombing may not be large enough to generate any detectable effect on earnings.

It is also conceivable that the effects of the U.S. bombing on earnings may work through the supply of labor. There could be positive wage gain due to the decline in labor supply as there was a spike in the number of deaths of siblings during the early 1970s, the period of the bombing, as shown in Figure 4. Additionally, column (1) in Table 4 in the Appendix shows that the U.S. bombing reduced the survival probability of the siblings. Thus, this may offset the effect due to the reduction in the years of schooling. On the other hand, although the bombing does not have any effect on the monetary returns to schooling, we argue that it in turn has an effect on the non-monetary returns to schooling provided that it increased fertility. For instance, the positive effect of the bombing on fertility, as shown in column (1) in Table 5, provides an explanation to this argument because women's education has a negative effect on fertility (Schultz 1994). Islam et al. (2015a) also find that armed conflicts in Cambodia during the 1970-1979 period increased fertility through the reduction in years of schooling.

6.4 Fertility and marriage

This section looks at the impacts of the U.S. bombing on fertility and marriage, which are shown in columns (1) and (2) in Table 4. The DID estimate for fertility is positive and statistically significant at the 5 percent level, while the estimate for age at first marriage is negative and statistically significant at the 10 percent level. Additionally, conditional on the DID assumption, a standard deviation increase in the U.S. bombing led to about 0.20 increase in the total number of births and 0.32 decline in the age at first marriage. A rise in fertility may have resulted also from the decline in girls' education attainment as documented above.

The observed increased fertility may also be a result of the high mortality due to the bombing campaign. This so-called replacement theory suggests that high child mortality due to shocks puts pressure on household to replace the lost ones. Vierwimp and Van Bavel (2005) test this old-age security approach in the context of Rwanda and find that fertility of the women refugees rose in response to the conflicts. We provide some descriptive[8] support for a replacement theory in Cambodia in Figure 5 and in Table 4 in the appendix. From the figure, it is apparent that sibling deaths spiked in the early 1970s. Moreover, column (1) in Table 4 in the appendix shows that the U.S. bombing reduced the probability of survival among siblings, while column (4) in the same Table also shows that the bombing reduced the probability of survival among children aged under 5. Therefore, households residing in the districts that were more severely bombed were more likely to die and lose their children. As our results also show that the U.S. bombing increased fertility, it is likely that households, who lost their children or siblings due to bombing, were more likely to replace their lost ones.

[8]The DHS data relies on female family members aged between 15 and 49 to report the number of their siblings and their survival, including dates of death when relevant. This way of recording deaths underestimates mortality for three reasons: 1) sibling deaths of women outside this age range are not recorded, 2) deaths are not reported if only male siblings survived, and 3) deaths are not reported if all siblings died.

6.5 Health

As we are interested in the impacts of the U.S. bombing on the individuals, who were either in-utero or younger than 5 years of age during the bombing, our treatment group are individuals, born between 1965 and 1969, while our control group are those, who were born between 1960 and 1964. We run OLS on specification equation (1) to obtain estimate of the impact, which is shown in column (3) in Table 4. The DID estimate is negative, but small and statistically insignificant, which suggests that there is no evidence of the impact of the U.S. bombing on health among the female individuals.

However, the situation of malnutrition was widespread during the bombing period provided that by the end of 1971 more than 2 million of the Cambodia's population of 7 million were displaced and about 20 percent of the country's property were destroyed (Shawcross 1987:222). Moreover, by around August 1971, the North Vietnamese Army (NVA) had occupied more than half of the country's territory (Becker 1998:130). There was also substantial reduction in paddy rice production as large paddy rice fields were either destroyed or under the control of the NVA. In addition, disease such as gastric disorder, which could have been cured if there had been sufficient medical supplies, was very common among children (Shawcross 1987:223). Therefore, the absence of the effect might be because individuals selected into the sample are the fittest survivors meaning that we are likely to compare outcomes of the bombing-exposed individuals, who were fittest, with those of the non-exposed individuals.

To investigate whether there is evidence of the survival of the fittest, we run OLS on specification equation (1), where dependent variables are the probabilities of being alive of the siblings, children under five and the adults aged above 17. The results are in Table 4 in the Appendix. Column (1) shows that the U.S. bombing reduced survival probability of siblings, while column (2) shows no effect of the U.S. bombing. This suggests that individuals, exposed to the bombing at younger age, were not affected and were more likely to be fittest children to survive through the bombing period. Column (4) provides additional support

to this because the U.S. bombing reduced the probability of survival among children aged under five, which suggests that child mortality during the bombing was probably high. Furthermore, the results in columns (5) and (6) show no effects of the U.S. bombing on survival probability of adults. Thus, we can qualitatively argue that the absence of the effect is attributed to selection of the fittest survivors into the sample. Our results are also in line with the study by Deaton (2007), who shows that mortality selection, rather than scarring[9], was the underlying reason behind the positive association between high childhood mortality and taller adults in Africa.

7 Conclusion

Armed conflicts cause both immediate and long-term consequences, the evidence of its long-term impact of which has been documented at both macro and micro levels. The U.S. bombing in Cambodia during the 1965-1973 period was the sideshow of the Vietnam war, and it was so massive that about a third of its total population were displaced and a large number of schools, massive paddy rice fields and infrastructures were destroyed, which suggests its long-term impact on households, who resided in the districts with high bomb intensity. This study uses two sources of variation, namely bomb intensity at the district level and the birth cohorts, exposed to the bombing, by applying the DID approach to identify the impact of the U.S. bombing campaign on education and earnings. We find that conditional on the DID assumption, one standard deviation increase in the U.S. bombs during the 1969-1973 period reduced years of schooling between 0.11 and 0.23. The effects on years of schooling for men are higher than those for women.

We do not find any effect on earnings and employment for both men and women. Nonetheless, we find that the U.S. bombing increased the total number of births by about

[9]Deaton (2007) postulates that disease and nutritional environment in childhood is likely to have two effects, namely selection and scarring, on adult height. The first effect arises when there is a positive association between high childhood mortality due to high-disease and low-nutritional environment and taller adults. The later, which is the negative association between high childhood mortality and adult height, occurs when disease and nutritional environment during childhood was severe.

0.20 per standard deviation increase in the bombs, which suggests that the U.S. bombing reduced non-monetary returns to schooling. We also find that the U.S. bombing increased age at first marriage among young female Cambodians, which is a factor contributing to the rise in fertility. However, we do not find any effect on women's height, but predict that the negligible effect could be due to comparing outcomes of the bombing-exposed individuals, who were the fittest during their childhood, with the non-exposed individuals because there was a marked increase in the number of deaths of siblings during the early 1970s and our results also show that the U.S. bombing reduced the probability of survival among siblings, as well as children aged under five.

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Figure 1a: US ordance in metric ton dropped in Cambodia 1965–1969

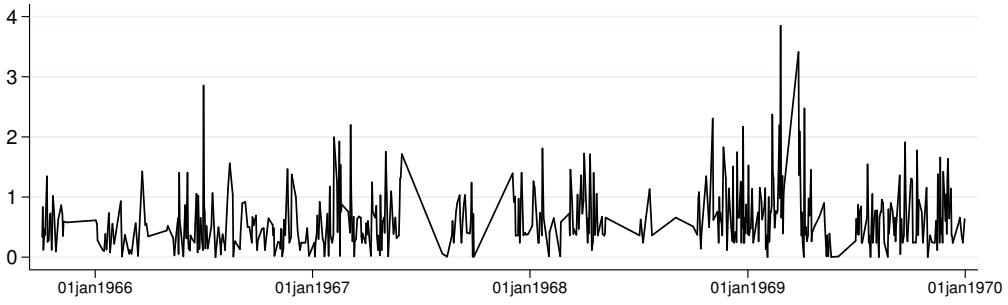


Figure 1b: US ordance in metric ton dropped in Cambodia 1970–1973

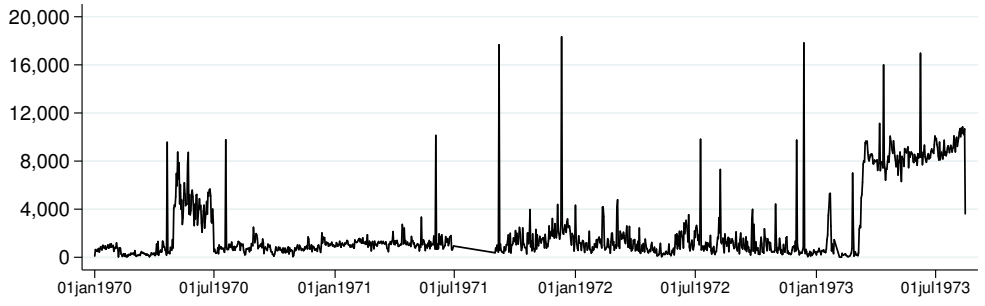


Figure 2a: US bombing sites 1965-1973

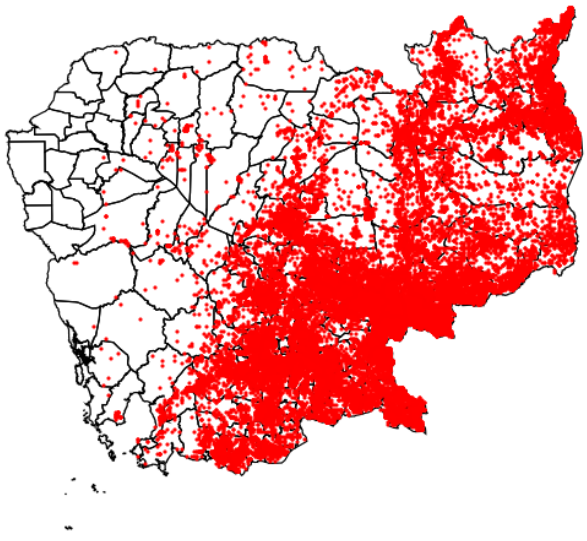


Figure 2b: US ordnance dropped on districts of Cambodia 1965-1973

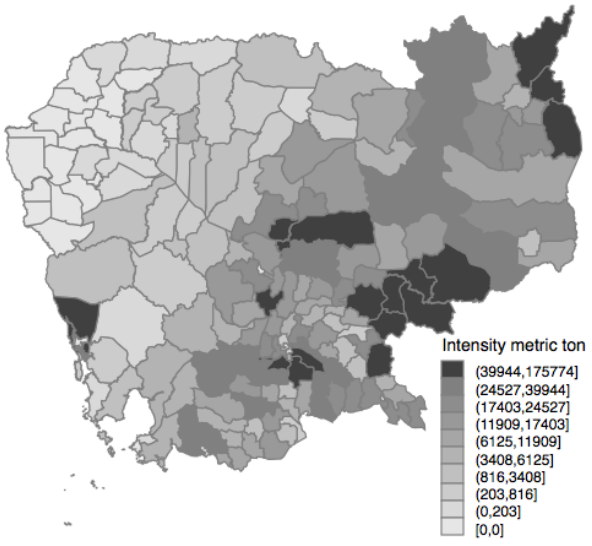
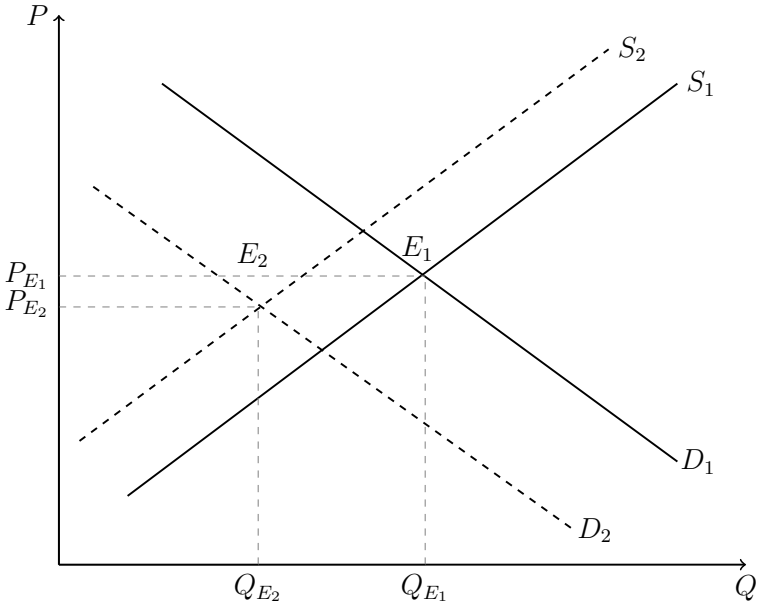


Figure 3: Market for educational services



Note: Figure 3 depicts the market for educational services in Cambodia, where P and Q are price and quantity of educational services, respectively. We treat education as a normal good. Prior to the U.S. bombing, quantity demanded of education is (Q_{E_1}), for a given cohort this would be years of education completed. The bombing campaign is an exogenous shock that affects the equilibrium E_1 in two ways. First, supply of the eduction services shifts from S_1 to S_2, because of (let say) the destruction of school buildings across the country and displacement of teachers. Second, demand for education services shifts from D_1 to D_2. This shift is driven, for example, by population displacement, concerns for children's safety and the negative income shocks. At the new equilibrium (E_2), quantity of education demanded, Q_{E_2}, is smaller.

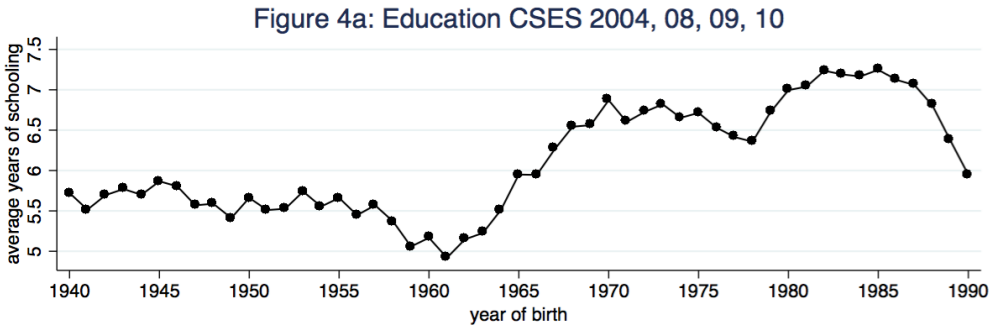


Figure 4a: Education CSES 2004, 08, 09, 10
average years of schooling
5
5.5
6
6.5
7
7.5
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
year of birth

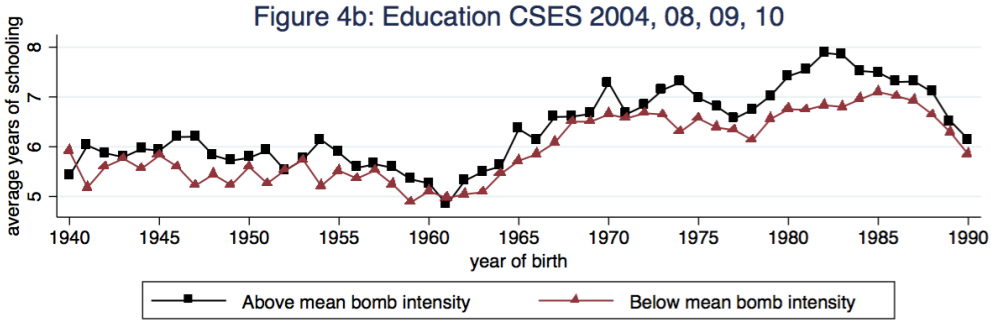


Figure 4b: Education CSES 2004, 08, 09, 10
average years of schooling
5
6
7
8
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
year of birth
Above mean bomb intensity
Below mean bomb intensity

Figure 5: Mortality of siblings of women aged 15-49 (CDHS 2000, 2005, 2010)

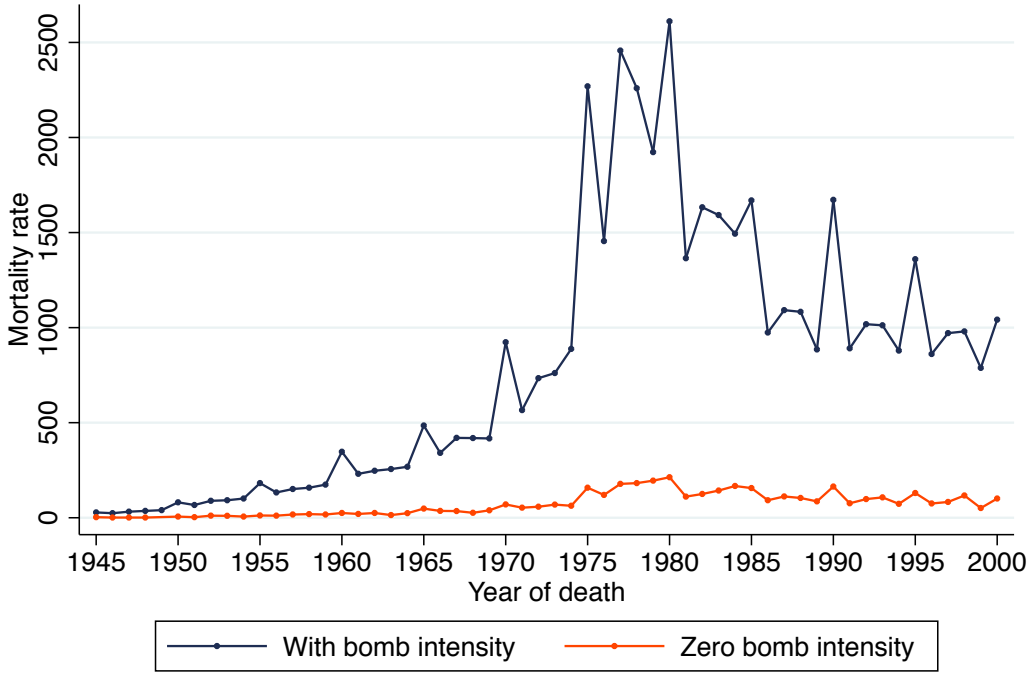


Table 1: Summary statistics of the main variables in the analyses

	Mean	S.D	N
Panel A: CSES (2004, 2008, 2009, 2010)			
Full sample			
Years of schooling completed	3..76	3.67	16,424
Age	49.55	4.63	16,511
Sex (male=1)	0.43	0.49	16,511
Marital status (single=1)	0.03	0.17	16,509
Ethnic dummy (Khmer=1)	0.96	0.19	16,504
Urban	0.25	0.43	16,511
Earning sample			
Years of schooling completed	4.55	4.18	6,599
Monthly earnings in Riels	149,173.60	364,371.40	6,599
Log monthly earnings	10.80	1.57	6,599
Age	47.75	4.12	6,599
Sex (male=1)	0.59	0.49	6,599
Marital status (single=1)	0.02	0.15	6,598
Ethnic dummy (Khmer=1)	0.96	0.19	6,599
Urban	0.29	0.45	6,599
Panel B: DHS household sample (2000, 2005, 2010)			
Years of schooling in single year	3.22	3.17	21,834
Age	48.25	5.67	21,980
Sex (male=1)	0.42	0.49	21,980
Urban	0.17	0.38	21,980
Panel C: DHS women sample (2000)			
Height (centimeters)	152.57	9.09	2,008
Number of children ever born	5.48	2.64	3,768
Age at first marriage	19.98	4.34	3,768
Urban	0.16	0.36	3,768
Panel D: U.S. bomb intensity			
District level			
Bomb '000 metric ton 1965-1973	15.799	25.370	177
Bomb '000 metric ton 1965-1968	0.001	0.004	177
Bomb '000 metric ton 1969-1973	15.798	25.369	177

Table 2: Impact of U.S. bombing on years of schooling

	CSES Full sample		CSES Earning Sample		DHS household sample (2000, 2005, 2010)	
Dependent variable: Education	(1)	(2)	(3)	(4)	(5)	(6)
Bomb*born 1957-1962	-0.0045**	-0.0014	-0.0092**	-0.0036	-0.0054**	-0.0001
	(0.0021)	(0.0019)	(0.0036)	(0.0047)	(0.0026)	(0.0026)
Bomb*born 1957-1962*sex		-0.0075***		-0.0076*		-0.0100***
		(0.0024)		(0.0042)		(0.0026)
Sex (male=1)		2.0660***		2.0095***		1.9954***
		(0.0655)		(0.0986)		(0.0832)
Ethnic Khmer (Khmer=1)		1.6057***		1.6037***		
		(0.1914)		(0.3097)		
Constant	3.8792***	1.5545***	6.1955***	3.5611***	3.5425***	2.7362***
	(0.1218)	(0.2191)	(0.4292)	(0.5445)	(0.0608)	(0.0553)
Observations	15,473	15,466	6,210	6,210	21,363	21,363
R-squared	0.1093	0.1908	0.1796	0.2365	0.1580	0.2454
District fixed effects	yes	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes

Notes: Standard errors are clustered at district level. Comparison group are individuals born between 1950 and 1955. Earning sample include both waged workers and self-employed workers aged between 17 and 57. *** Significant at 1%; ** significant at 5%; * significant at 10%.

Table 3: Impact of U.S. bombing on earning and employment for both men and women

	Both	Male	Female
CSES (2004, 2008, 2009, 2010)	(1)	(2)	(3)
Panel A: Log monthly earning			
Bomb*born 1957-1962	-0.0011	-0.0015	-0.0008
	(0.0013)	(0.0017)	(0.0017)
Observations	6,210	3,650	2,560
R-squared	0.3489	0.3967	0.3483
Panel B: Employment			
Bomb*born 1957-1962	-0.0001	-0.0001	-0.00004
	(0.0001)	(0.0001)	(0.0001)
Observations	6,210	3,650	2,560
R-squared	0.0462	0.0735	0.1295
District fixed effects	yes	yes	yes
Cohort fixed effects	yes	yes	yes

Notes: Standard errors are clustered at district level. Comparison group are individuals born between 1950 and 1955. Sample is restricted to those aged between 17 and 57. *** Significant at 1%; ** significant at 5%; * significant at 10%.

Table 4: Impact of U.S. bombing on fertility, marriage and health

	Fertility	Age first marriage	Height
DHS women sample (2000)	(1)	(2)	(3)
Bomb*born 1957-1962	0.0079**	-0.0125*	
	(0.0037)	(0.0074)	
Bomb*born 1965-1969			-0.0012
			(0.0242)
Observations	3,734	3,734	1,984
R-squared	0.1305	0.0606	0.0866
District fixed effects	yes	yes	yes
Cohort fixed effects	yes	yes	yes

Notes: Standard errors are clustered at district level. Comparison group are individuals born between 1950 and 1955 for fertility and age at first marriage, while comparison group for height are individuals born between 1960 and 1964. *** Significant at 1%; ** significant at 5%; * significant at 10%.

Appendix

Table 1: Years of birth exposed to US bombing during primary school age

Year of Birth	Age in 1969	Age in 1973	Age in 1975	Age in 1979	Treat=1	
1950	19	23	25	29	0	
1951	18	22	24	28	0	
1952	17	21	23	27	0	
1953	16	20	22	26	0	Not exposed
1954	15	19	21	25	0	
1955	14	18	20	24	0	
1956	13	17	19	23	0	
1957	12	16	18	22	1	
1958	11	15	17	21	1	
1959	10	14	16	20	1	U.S. Bombing
1960	9	13	15	19	1	
1961	8	12	14	18	1	
1962	7	11	13	17	1	
1963	6	10	12	16	1	
1964	5	9	11	15	1	Bombing & genocide
1965	4	8	10	14	1	
1966	3	7	9	13	1	
1967	2	6	8	12	1	
1968	1	5	7	11	1	
1969	0	4	6	10	1	
1970	-	3	5	9	1	Genocide only
1971	-	2	4	8	1	
1972	-	1	3	7	1	

Table 2: Returns to years of education (CSES 2004, 2008, 2009, 2010)

	Both sexes	Male	Female
Log monthly earnings	(1)	(2)	(3)
Education	0.0731***	0.0748***	0.0714***
	(0.0052)	(0.0065)	(0.0078)
Age	0.0516	0.1641	-0.0976
	(0.0958)	(0.1196)	(0.1449)
Age squared	-0.0006	-0.0018	0.0010
	(0.0010)	(0.0012)	(0.0015)
Sex (male=1)	0.1507***		
	(0.0368)		
	(0.0071)	(0.0084)	(0.0068)
Year 2004	-2.0962***	-2.2275***	-1.8930***
	(0.0907)	(0.1071)	(0.1301)
Year 2008	-0.3906***	-0.4615***	-0.1633
	(0.1336)	(0.1442)	(0.1624)
Year 2009	-0.3512***	-0.3836***	-0.3334***
	(0.0810)	(0.0888)	(0.1420)
Observations	6,210	3,650	2,560
R-squared	0.3840	0.4242	0.3732

Note: Standard errors are clustered at district level. Each model includes district fixed effects and sample is restricted to individuals aged between 17 and 57. *** Significant at 1%; ** significant at 5%; * significant at 10%

Table 3: Impact of U.S. bombing on years of schooling, fertility and age at first marriage

	CSES Full sample		CSES Earning Sample		DHS sample (2000, 2005, 2010)		DHS sample (2000)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Education	Education	Education	Education	Education	Education	Fertility	Age at first marriage
Bomb*born 1957-1962	-0.0046**	-0.0015	-0.0088**	-0.0032	-0.0054**	-0.0001	0.0098**	-0.0124
	(0.0022)	(0.0020)	(0.0037)	(0.0047)	(0.0026)	(0.0026)	(0.0041)	(0.0079)
Bomb*born 1957-1962*sex		-0.0074***		-0.0077*		-0.0100***		
		(0.0024)		(0.0040)		(0.0026)		
Sex (male=1)		2.0673***		1.9988***		1.9952***		
		(0.0656)		(0.0983)		(0.0832)		
Ethnic Khmer (Khmer=1)		1.5368***		1.5458***				
		(0.1860)		(0.3005)				
Constant	3.0864***	0.8641***	4.9427***	2.3530***	3.2741***	2.4473***	143.9811**	-3.4826
	(0.2799)	(0.3080)	(0.5313)	(0.6138)	(0.3822)	(0.3777)	(62.3280)	(64.9849)
Observations	15,473	15,466	6,210	6,210	21,363	21,363	3,734	3,734
R-squared	0.1184	0.1994	0.1923	0.2482	0.1583	0.2457	0.1330	0.0619
Add zone trend	yes	yes	yes	yes	yes	yes	yes	yes

Notes: Standard errors are clustered at district level. Earning sample includes both waged workers and self-employed workers aged between 17 and 57. Comparison group are individuals born between 1950 and 1955. *** Significant at 1%; ** significant at 5%; * significant at 10%.

Table 4: Impact of U.S. bombing on probability of survival of siblings

Dummy variables	Sibling survival		Child survival (Age < 5)		Adult survival (Age >17)	
	(1)	(2)	(3)	(4)	(5)	(6)
Born1957-1962	0.1113***		0.0054		0.1548***	
	(0.0086)		(0.0049)		(0.0092)	
Bomb*Born1957-1962	-0.0007**		0.0001		-0.0004	
	(0.0004)		(0.0002)		(0.0003)	
Born1965-1969		0.0264***		-0.0056		0.0239***
		(0.0062)		(0.0039)		(0.0038)
Bomb*Born1965-1969		0.0000		-0.0003***		0.0001
		(0.0002)		(0.0001)		(0.0002)
Sex (female=1)	0.1766***	0.0786***	0.0103***	0.0093***	0.1194***	0.0405***
	(0.0068)	(0.0056)	(0.0037)	(0.0033)	(0.0052)	(0.0036)
Year 2005	-0.0553***	-0.0478***	-0.0143***	-0.0180***	-0.0394***	-0.0291***
	(0.0118)	(0.0096)	(0.0053)	(0.0053)	(0.0074)	(0.0033)
Year 2010	-0.0553***	-0.0478***	-0.0143***	-0.0180***	-0.0394***	-0.0291***
	(0.0118)	(0.0096)	(0.0053)	(0.0053)	(0.0074)	(0.0033)
Constant	0.5657***	0.7485***	0.9417***	0.9449***	0.6928***	0.9152***
	(0.0093)	(0.0065)	(0.0040)	(0.0035)	(0.0072)	(0.0032)
Observations	37,002	50,312	37,002	50,312	37,002	50,312
R-squared	0.0661	0.0286	0.0216	0.0178	0.0746	0.0206
District fixed effect	yes	yes	yes	yes	yes	yes

Notes: Standard errors are clustered at district level. Comparison group for individuals born during 1957-1962 are those born between 1950 and 1955, while comparison group for individuals born during 1965-1969 are those born during 1960-1964. *** Significant at 1%; ** significant at 5%; * significant at 10%.