Aerial Bombardment and Educational Attainment

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Abstract

This paper provides evidence that the Allied bombing of Vietnam, the longest and heaviest aerial bombardment in history, imposed detrimental ramifications on educational attainment and future labor market outcomes of school-age individuals. By exploiting the plausibly exogenous district-by-cohort variation in bomb destruction under a difference-in-differences framework, we find that an increase in bomb intensity leads to significantly fewer educational years completed and lower future earnings for school-age children exposed to the bombardment. We further show that both the supply-side factors (inadequate school security and the lack of teachers) and the demand-side factors (residential casualties, restricted access to healthcare, damaged properties, and increased reliance on welfare assistance) could be potential mechanisms driving the long-term consequences of aerial bombardment. Our findings underline the importance of conflict prevention and post-conflict reconstruction in promoting sustainable development.

JEL codes: I20, I21, J24, O15.
Keywords: Vietnam War, aerial bombardment, human capital

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1 Introduction

The dread of war and its disruptive consequences, ranging from the destruction of capital and infrastructure to health and environment disasters, are widely known. From a macro perspective, armed conflicts can hinder long-term economic development by inducing poverty traps (Azariadis and Drazen, 1990; Sachs, 2008) or discouraging capital accumulation (Guidolin and La Ferrara, 2007). From a micro viewpoint, wars could potentially lead to severe disruptions to people's lives such as worsened health conditions, shortened schooling accumulation and distorted labor market outcomes (Bundervoet et al., 2009; Akbulut-Yuksel, 2014; Bruck et al., 2019). Other dreadful consequences of armed conflicts include diverting resources from production, direct destruction of infrastructure, and increased mortality rates (Collier, 2009).

This paper makes three contributions to the branch of research on the relationship between conflict and development. First, we focus on the less discernible but persistent cost of conflict while the majority of attention has been paid to the immediate consequences on individuals with urgent humanitarian needs (Bruck et al., 2017). Specifically, we examine the long-term consequences of aerial bombardment on educational accumulation and future earnings of school-aged children. Our context of study is the bombing of Vietnam, which is by far the longest and heaviest aerial bombardment in history.[1] Moreover, Vietnam was very poor at the time of the bombardment period, making Vietnamese school-aged children especially vulnerable to the shocks arising from such large-scale destruction.

Second, we rigorously analyze the potential pathways to the adverse ramifications of aerial bombardment by evaluating both the supply-side factors and the demand-side factors of education. Finally, we introduce a more precise measure of aerial bombardment. Unlike previous studies which either have limited or no information on the intensity of armed conflicts (Ichino and Winter-Ebmer, 2004; Bundervoet et al., 2009), or rely on unadjusted measures of destruction such as the quantity of bombs (Miguel and Roland, 2011), our measure of bombing devastation is the bomb density - defined as the total weight of all weapons (in tons)

[1] Throughout the Vietnam War, over 7.5 million tons of explosives were dropped by the U.S. and its allies. The total weight of bombs delivered was three times as much as that dropped during the European and Pacific Theater in World War II.

dropped onto a district, divided by its area (in square kilometer).[2 3] As pointed by Mueller (2016), measurement issues can bias the estimating results. The incorporation of per-area weapon weight, which adjusts for the destructive power of different classes of weapons, can provide a more accurate measure for the bombardment havoc.

We utilize the data from the Theater History of Operation and the Vietnam Household Living Standard Survey. The newly released Theater History of Operation offers rich information on the bomb intensity. The Vietnam Household Living Standard Survey provides us with rich individual-level information such as demographics, education, and income, among others. In terms of identification strategy, we employ the difference-in-differences (DiD) model to examine the impacts of wartime bombardment on educational accumulation and future labor market outcomes. Within the DiD framework, we exploit the district-by-cohort variation in bombing devastation.

Our study reaches the following findings. First, a 10% increase in bomb density leads school-age individuals exposed to the aerial bombardment for at least five years to complete 0.01 fewer years of education. To put these numbers to perspective, the gap in educational attainment between an individual in an average bombed district and an individual in the most heavily bombed district is about 0.3 years. Second, we explore the non-linear effects of aerial bombardment. Third, differential impacts of bomb destruction across gender are detected with larger repercussions on females. Fourth, aerial bombardment leaves a long-lasting adverse impact on future labor market outcomes, mostly on female earnings. Fifth, we detect differential effects by bomb missions and targets. Finally, we show that both the supply-side factors (inadequate school security and the lack of teachers) and the demand-side factors (residential casualties, restricted access to healthcare, damaged properties, and increased reliance on welfare assistance) could be potential mechanisms driving the long-term consequences of aerial bombardment.

Our findings offer meaningful policy implications. By showing the adverse ramifications of aerial bombardment on human capital, this paper sheds additional light on the persistent cost of violent conflict that has been insufficiently considered. Individuals exposed to aerial

[2] Ichino and Winter-Ebmer (2004) uses "being born in Austria and Germany" and "being born between 1930-1939" as an exposure to World War II. Bundervoet et al. (2009) rely on the timing and location of the civil war.

[3] Weapons include different classes of bombs, missiles, rockets, and ammunition. See Section 3.1 for details.

bombardment during school age accumulated fewer years of education and had worse labor market outcome in the future. Given the possibility of intergenerational transmissions, these burdens of conflict could be passed on to the future generation. Our results suggest that the prevention and reduction of conflict should be put as one of the global priorities, in order to promote peaceful societies for sustainable development (SDG-16). Our findings further imply that post-conflict reconstruction initiatives are important when conflicts already occurred. Government interventions aiming to improve the abilities/skills of affected individuals could help lessen the cost of conflict.

The paper proceeds as follows. Section 2 presents the literature review and theoretical discussion. Section 3 describes the data and our analysis sample. Section 4 presents the empirical methodology. Section 5 provides the estimation results, falsification test, and robustness check. Section 6 explores potential mechanisms. Section 7 concludes our paper.

2 Literature Review and Theoretical Discussion

2.1 Literature Review

This paper is related to the literature on the costs of conflict. At the aggregate level, conflict destroys production capacity and induces GDP loss (Guidolin and La Ferrara, 2007; Sachs, 2008; Dunne et al., 2013). At the micro-level, conflict can impose immediately apparent cost such as the loss of lives (Blomberg et al., 2004; Anderton and Carter, 2009). Furthermore, violent conflict also leaves potentially immense costs which are less visible and inadequately measured namely increased health risks, disruption of the education process, and distorted labor market outcome (Bruck et al., 2012; Dunne et al., 2013; Bruck et al., 2019).

It is documented that conflict imposes detrimental consequences on health outcomes. The health costs are acutely borne by women evident by higher risk of physical and mental trauma since women tend to be targeted in times of violence (Usta et al., 2008; Shemyakina, 2011; Justino, 2012). In addition to these relatively immediate impacts, conflict can have long lasting ramifications on health. Specifically, children exposed to conflict tend to be shorter in height and are more likely suffer from post-traumatic stress disorders in adulthood than those unaffected (Catani et al., 2008; Bundervoet et al., 2009; Akresh et al., 2012).

Prior studies also show that conflict can adversely affect the accumulation of education and labor market outcome. Affected children not only have lower academic achievement and have their schooling disrupted (Bruck et al., 2019), but they also attain fewer years of education (Shemyakina, 2011; Chamarbagwala and Moran, 2011; Leon, 2012). Violent conflict can perpetuate inequality as children from disadvantaged background exposed to conflict will continue to lag behind in terms of education, thus reinforcing the socio-economic advantages over time (Chamarbagwala and Moran, 2011; Bruck et al., 2017). Given the detrimental effects on education, exposure to conflict during school ages also leads to declining labor earnings in adulthood (Ichino and Winter-Ebmer, 2004; Akbulut-Yuksel, 2014).

By investigating the impacts of violent conflict on educational attainment and labor market outcome, this paper makes three contributions to the branch of research on the relationship between conflict and development. First, we estimate the less discernible but persistent cost of conflict, while the majority of attention has been paid to the immediate consequences on individuals with urgent humanitarian needs (Bruck et al., 2017). Second, we rigorously analyze the potential pathways to the adverse ramifications of aerial bombardment by evaluating both the supply-side factors and the demand-side factors of education. Finally, we introduce a more accurate measure of aerial destruction compared to prior studies, the total weight of all weapons dropped onto a district per km^2 area. The study context is the bombing of Vietnam, which is of interest because of two reasons. The country was very poor at the time, making Vietnamese school-aged children especially vulnerable to the shocks arising from such large-scale destruction. Besides, the bombing of Vietnam is the longest and heaviest aerial bombardment in history where over 7.5 million tons of explosives were dropped by the U.S. and its allies (three times the amount in the European and Pacific Theater in World War II).

2.2 Theoretical Discussion

To guide our empirical study, we provide a simple model where bombing distorts the efficiency in accumulating human capital, thus, discouraging educational attainment. Suppose that individuals are expected to live for $T > 0$ years (excluding retiring and pre-schooling years). At year $\tau \leq T$, individuals face two options: (1) leaving school to join the labor market, or (2) staying in school to accumulate human capital. For the sake of simplicity, we assume that individuals cannot go back to school after joining the labor market. Let us denote by $s \geq 0$ the "*additional years of schooling*" expected to attain by an individual at year τ. Her human capital after s additional years of schooling is given by,

$$h_{\tau+s} = h_\tau \exp\left[s\ \Theta(x)\right] \tag{1}$$

where $h_\tau = h_0 \exp\big[\tau\ \Theta(x)\big]$ is the level of human capital at year τ, with τ years of schooling and h_0 innate human capital. The value of $\Theta(\cdot)$ represents the local level of efficiency affecting human capital production, and x is the degree of destruction caused by the aerial bombing. We assume that $\partial\Theta(x)/\partial x < 0$, such that the efficiency level is negatively correlated with bombing destruction. Thus, after s years of additional schooling, human capital increases by an amount of $\Delta h_\tau = h_{\tau+s} - h_\tau$, given by,

$$\Delta h_\tau = h_\tau \exp\big[s\ \Theta(x)\big] - h_\tau \tag{2}$$

By staying in school to gain Δh_τ unit of human capital, she produces zero unit of output for s years. However, if she chooses to quit school and go to work, her production function exhibits constant returns to scale technology taking a form of:

$$y_\tau = h_\tau \tag{3}$$

where y_τ is the amount of output produced, and h_τ is the level of human capital accumulated up to year τ. Normalizing output price to one, zero-profit condition implies that individual earning is also her human capital $w_\tau = h_\tau$. The discounted value of lifetime gain from s additional years of schooling ($\Delta\Omega_\tau$) can be expressed as follows,

$$\Delta\Omega_\tau = \int_{\tau+s}^{T} h_{\tau+s} e^{-\rho t}\mathrm{d}t - \int_{\tau}^{T} h_\tau e^{-\rho t}\mathrm{d}t \tag{4}$$

where ρ is the discount factor. Thus, the marginal return of the additional years of schooling evaluated at year τ is given by,

$$\frac{\partial\Delta\Omega_\tau}{\partial s} \triangleq \frac{\Theta(x) - \rho}{e^{\rho(\tau+s)}} - \frac{\Theta(x)}{e^{\rho T}} \tag{5}$$

The symbol $\triangleq$ indicates that common terms are suppressed for simplicity. The first order condition, i.e. setting $\partial\Delta\Omega_\tau/\partial s = 0$, yields the optimal years of schooling,

$$\tau + s = \begin{cases} \tau\ ,\ \text{if } x > \breve{x} \\ T + \dfrac{1}{\rho}\ln\left[\dfrac{\Theta(x) - \rho}{\Theta(x)}\right] > \tau\ ,\ \text{if } x \leq \breve{x} \end{cases} \tag{6}$$

Here, the value of the threshold $\breve{x}$ can be obtained from inverting the equality $\Theta(x) = \rho/1 - e^{-T\rho}$. Put it differently, $\breve{x} = \Theta^{-1}\left(\rho/1 - e^{-T\rho}\right)$. The model generates two important predictions regarding the relationship between bombing destruction x and individuals' educational attainment $\tau + s$.

First, the probability of staying in school $P(\tau + s > \tau)$ is directly linked to the degree of destruction x according to the equality $P(\tau + s > \tau) = P(x \leq \breve{x})$. Therefore, the theory suggests that across geographic units and individuals identical in all respects except for the degree of bombing destruction, the higher the degree of destruction x, the lower the probability of staying in school $P(\tau + s > \tau)$. In other words, when the degree of bombing destruction exceeds a certain threshold $\breve{x}$, individuals will drop out of school. We refer to this relationship as the impact of bombing on education at the extensive margin.

Second, individual's additional years of schooling s, conditional on staying in school $s > 0$, is a decreasing function of bombing destruction x. To see this, we differentiate the second case of equation (6) with respect to the degree of destruction x to obtain the following,

$$\text{sign}\left[\frac{\partial s_i(x|x < \breve{x})}{\partial x}\right] = \text{sign}\left[\frac{\partial \Theta(x)}{\partial x}\right] < 0 \tag{7}$$

Thus, the theory also suggests that an increase in the degree of bombing destruction generates a reduction in individuals' years of schooling, conditional on staying in school. We refer to this relationship as the impact of bombing on education at the intensive margin.

Overall, the model shows that the aerial bombardment decreases educational attainment of school-age individuals during the wartime. At the extensive margin, the devastation forces them to drop out of school. At the intensive margin, aerial bombardment shortens the additional years of education for those not dropping out.

3 Data and Analysis Sample

3.1 Data Overview

The data for this study is drawn from two sources: the Theater History of Operations (THOR) and the Vietnam Household Living Standards Survey 2010-2014 (VHLSS).

Theater History of Operations (THOR) – We first use the THOR database released by the U.S. Department of Defense in late 2016 to measure bombing intensity at the district level.[4] The raw data were recorded at the flight-mission level drawn from the Combat Activities File 1965-1970 (CACTA), the Southeast Asia Aerial Bombing Database 1970-1975 (SEADAB), and the Strategic Air Command's Combat Activities 1965-1973 (SACCOACT). The publicly available information includes a description of each mission (e.g. mission code, date, operation supported, source of mission logs), a description of aircrafts carrying out the mission (e.g. Air Force Groups, type and quantity of aircrafts, takeoff location, fly hours, time on target), a description of weapons delivered (e.g. ordnance type, quantity, weight, purpose category, and time off target), and a description of mission targets (e.g. latitude-longitude coordinates of targets, target description, weather condition, and bomb damage assessment).

The richness of the THOR database enables us to construct our explanatory variable of interest, the measure of bomb destruction. There are approximately 4.84 million flight missions carried out by 104 types of aircraft during the period of 1965 - 1975. The mainly used type of aircraft is the fighter-bomber McDonnell Douglas F-4 Phantom II, carrying out approximately 957,427 missions. There are 239 main classes of weapons delivered during the Vietnam War including 173 classes of bombs, 25 classes of missiles, 28 classes of rockets, and 13 classes of ammunition.

To capture the district-level intensity of bombs delivered from 1965 to 1975, we construct the bomb density measure (in tons per square-kilometer, t/km^2), by dividing the total weight of all weapons (in *tons*) dropped within a district boundary by its area (in km^2). Weapon weight is a more precise measure of bomb destruction than bomb quantity utilized in prior studies. For example, a heavy bomb-type ammunition is much more destructive than a light shot-type ammunition. Besides adopting the weapon weight, our measure of bomb intensity is further accurately captured by incorporating the destruction site area. The per-area weapon weight adjusts for the devastating nature of different classes of weapons.

Vietnam Household Living Standards Survey (VHLSS) – By special permission, we obtain access to three waves (2010, 2012, and 2014) of the VHLSS from the General Statistics Office (GSO) of Vietnam.[5] [6] The VHLSS is a nationally representative household survey conducted by GSO with technical support from the World Bank. This dataset provides rich

[4] The THOR dataset can be accessed at the website of the Air Force Research Institute (www.au.af.mil).

[5] The VHLSS can be obtained from the official website of GSO (www.gso.gov.vn).

[6] According to the Law on Statistics of Vietnam, statistical information circulated by the GSO has the highest legal effect.

information at the individual level including demographics, education and income.

Our dependent variables of interest are individual education and annual earnings. In terms of education, each household member is asked to specify the grade he/she has completed in school and the educational level (college, university, master, or PhD). Our main explanatory variable of interest is the number of school grade completed. We also construct an additional measure accounting for the educational level. Particularly, individuals with college, university, master, and Ph.D. degrees are assigned with 14, 16, 18, and 20 years of education, respectively.

As for incomes, the income modules are consistently conducted over time. Income refers to earnings from different sources in the last 12 months. Recall that we focus on the earnings of individuals. In each household, a member working as paid employee in the past 12 months provides information on his/her main job in terms of the total main salary received and other incomes related to that salaried job (such as bonuses, social subsidy, etc.). If the person has a second/third job, the same income information is collected. Our measure of individual earning is the total amount (main salary and other incomes for main jobs as well as for other jobs) each person receives during the past 12 months. In this paper, we focus on individuals with salaried jobs. Because it is not feasible to obtain individual incomes for those working in family farms and family businesses.

3.2 Analysis Sample

We examine the long-run consequences of aerial bombardment in a DiD framework, which requires one affected (treated) group and one unaffected (control) group.[7] In our main setup, we choose the 1953-1963 cohorts as the affected group and the 1985-1996 cohorts as the unaffected group. Specifically, war (affected) cohorts are defined as individuals who spent at least five years of schooling during the bombing period of 1965-1975. We believe that the five years of exposure is long enough for the effects of bombing to be realized. We then proceed to drop the 1948-1952 and 1964-1969 cohorts because they were exposed to bombing for fewer than five school years.[8] Table A1 in the Appendix presents the number of school years subject to aerial bombardment. We exclude individuals born between 1970 and 1984 since this group attended school during the Reconstruction period and thus might partially

[7] Details of this method are provided in Section 4.

[8] We do, however, include these individuals in the affected (war) cohorts in a robustness check. Categorizing them into the war cohorts does not substantially change our result.

suffer from adverse effects of the large-scale bombing destruction.

Individuals born during 1985-1996 constitute the non-war (unaffected) cohorts since they attained their education after the *"Doi Moi"*, marking an end to the postwar reconstruction period. We further restrict our sample to those at least 18 years old, i.e. those supposed to finish high school when being surveyed. Moreover, macro-level studies suggest that economies quickly return to their steady state within 20 years after wars, (Davis and Weinstein, 2002, Brakman et al., 2004, and Miguel and Roland, 2011), lending additional support to our choice of the 1985-1996 cohorts as the unaffected group. Although the main analysis sample only comprises the 1953-1963 war cohorts and the 1985-1996 non-war cohorts, the estimation using different categorizations of the affected-unaffected groups is reported in various robustness checks.

Summary statistics for individual-level and district-level variables are respectively presented in Panel A and B of Table A2. An issue with the VHLSS is that they only provide the number of school grades completed. In other words, the number of years of education is top-coded at 12. Therefore, we adopt this raw top-coded measure of education as our primary outcome. We also attempt to deal with this issue by imputing the total number of educational years based on the reported grade completed and the educational level in a different specification. Particularly, individuals with college, university, master, and Ph.D. degrees are assigned with 14, 16, 18, and 20 educational years respectively.

As shown in Panel A of Table A2, the war cohorts completed 7.5 years of schooling on average while the non-war cohorts finished 9.75 years. Our measure of labor market outcomes is individual annual earnings. The mean annual earning among the war cohorts is roughly 35 million VND (around 1,500 USD) whereas on average, the non-war cohorts earn approximately 29 million VND (1,300 USD) per year.[9] Turing to district-level variables, as visible from Panel B, the average bomb dropped onto a district is 11.42 tons per km^2 and the maximum bomb density is 279.38 tons per km^2. In the final sample, there are approximately 32,000 individuals across 625 districts of 63 provinces.

4 Empirical Methodology

To evaluate the effects of aerial bombardment on schooling accumulation and labor market outcomes, we rely on the exogenous district-by-cohort variation in bomb destruction intensity,

[9] All monetary values in the paper are in 2010 constant price.

and employ a DiD framework given in the following equation,

$$Y_{idt} = \beta_0 + \beta_1 WarCohort_{ic} \times BombIntensity_d + X'_{idc}\gamma + \delta_d + \lambda_t + \epsilon_{idt} \tag{8}$$

where Y_{idt} is the outcomes of interest for individual i residing in district d and born in year t, including the number of educational years and the log of annual earnings. The $WarCohort_c$ term is a dummy variable taking a value of one if an individual belongs to the affected group, where the subscript c refers to the cohort group (either affected or unaffected), and zero otherwise. Particularly, the affected group comprises individuals exposed to the Allied bombing for at least five schooling years (born between 1953 and 1963).[10] [11] The $BombIntensity_d$ term is the log of bomb density measure where bomb density is defined as the total weight of all weapons (in tons) dropped onto district d divided by the district area (in square kilometers).

The vector X'_{idc} includes: (i) individual observable characteristics (e.g. gender, mother education, indicator for living in the north) and survey year fixed effects, (ii) a set of interactions between the observables and birth year dummies to account for differential return of these demographic characteristics by cohorts (Acemoglu et al., 2004), and (iii) another set of interactions between district-level geographic controls and birth year indicators to account for the factors determining local economic conditions and strategic bombing decisions during wartime. Geographic variables proxying for local development include districts' centroid longitude, latitude, distance to coast, average precipitation, temperature, terrain ruggedness, land suitability, and the share of arable land (excluding water, snow, and ice surface, as well as barren or sparsely vegetated surface) in district total areas. Other geographic factors potentially affecting military strategy during the Vietnam War are also controlled for, such as district average altitude and district centroid distance to Ho Chi Minh Trail (Miguel and Roland, 2011).[12]

We denote by δ_d and λ_t district and birth year fixed effects, respectively. Finally, ϵ_{idc} stands for the error term. We also control for the province-specific time trend and cluster standard

[10] Ideally, we should use the individual's district of birth instead of the district of residence. However, the VHLSS does not provide this information. We address the potential issue of migration in Section 5.1.2.

[11] As a robustness check, we also consider those ever exposed to the bombardment during their schooling time as the war cohorts.

[12] For example, Ho Chi Minh trail was the main route through which the Communists supplied their backed insurgents fighting in the South, therefore, was bombed heavily.

errors at the district-by-birth-year level. Coefficient of interest β_1 captures the effects of aerial bombardment on educational attainment and labor market outcomes for the war cohorts.

5 Estimation Results

5.1 Results on Educational Attainment

5.1.1 Main Results and Heterogeneity

We report our baseline results on educational attainment from equation (8) in Table 1. Each cell is the DiD estimate from a regression that controls for district and birth year fixed effects, survey year fixed effects, and several sets of interactions as discussed in Section 4. As evident from Column 1, the estimated effect for the full sample is negative (-0.098) and statistically significant at 1%. This implies a 10% increase in bomb density leads to a reduction of approximately 0.01 years of education for individuals who spent at least five years of their schooling during the bombardment time.[13] To get a better understanding of the magnitude of the impact, we compare the educational attainment of an individual in a heavily bombed district, say, Gio Linh (Quang Tri Province) where the bomb density was 279.38 ton/km^2 (the maximal bomb density, Table A2), and an individual in a district with an average bomb density (11.42 ton/km^2, Table A2). Individuals of school age during the bombing period in Gio Linh completed 0.3 years of education than those in a district with an average destruction level. This impact is consonant with the effect of violent conflicts on educational attainment documented in Akbulut-Yuksel (2014) and Leon (2012).

We present the heterogeneous impacts of aerial bombardment along the lines of gender and mother's education in Column 2 through 5 of Table 1. A female who spent at least five school years during the bombardment finished 0.012 fewer educational years in response to a 10% increase in bomb density (Column 3) while the reduction for a male counterpart is roughly 0.008 year (Column 2). This finding is consistent with Shemyakina (2011) where a larger impact of armed conflicts on females is documented. As evident from Column 4 and 5, individuals with higher-educated mothers (mothers' education is higher than primary level)

[13] Because *BombIntensity* is the log of bomb density, the linear-log specification (8) where the outcome is the number of educational years omits the six districts which were not bombed at all. To this respect, we re-estimate equation (8) where *BombIntensity* is $log(1 + bombdensity)$. The point estimate is still negative and significant, implying the gap of 0.5 years of education between affected individuals in the most heavily bombed district and affected individuals in the district with an average destruction level (Column 1 of Table A3).

were hardly affected by the bomb destruction while individuals with a more disadvantaged background (mother with lower educational attainment, primary education or less) bore larger consequences. Having said that, due to a large number of missing values for mother's education, we urge some caution in interpreting the heterogeneous effects of aerial bombardment in this respect.

Taken together, we detect negative consequences of aerial bombardment on educational attainment. The educational gap between an individual of school age during the bombing period in the most heavily destroyed district and the one in the average bombed district is 0.3 years. The magnitude is comparable to the one in previous studies (Leon, 2012; Akbulut-Yuksel, 2014). The estimates underline the dreadful cost of violent conflict to human capital accumulation. Our results are consistent with prior literature on the micro-level effects of conflict on school attainment (Shemyakina, 2011; Chamarbagwala and Moran, 2011; Leon, 2012). Our findings also supplement Bruck et al. (2019) which reveals that exposure to conflict decreases the probability of passing the final exam, test score, and the probability of entry into higher education.

5.1.2 Mobility, Falsification, and Nonlinearity

Endogenous Mobility - It should be noted that in equation (8) we measure the bomb density at the district of residence (not the district of birth) level. Endogenous mobility could potentially contaminate our coefficient estimates since people might have reallocated from heavily bombed districts to less destroyed ones for better living conditions or the heavily destroyed districts might have been better in attracting labor and talent during the reconstruction era. We test for this potential contamination by creating a migration indicator (Migration) that takes the value of one if the individual lacks permanent registration in his/her residential district.[14] Demombynes and Vu (2016) documented that very few people moved without the sanction before 1990 and those who did move struggled to survive without a local *"ho khau"* (permanent registration). Using Household Registration data of Vietnam, Demombynes and Vu (2016) further shows that the population without permanent registration has demographics characteristics that are typical of migrant populations. Therefore, the probability of not holding *"ho khau"* is a good proxy for the probability of migration.

[14] This permanent registration system known as *"ho khau"*, which is similar to the *"hukou"* in China, *"hoju"* in Korea and *"koseki"* in Japan. The *"ho khau"* is a remnant of the centrally planned economy that was employed by the States for public security and control of migration. Those moving from one district to another must meet certain requirements in order to transfer their *"ho khau"*.

We proceed to test for endogenous mobility. First, we estimate equation (8) using the Migration indicator as the outcome variable. Evident from Column 1 of Table 2, aerial bombardment does not appear to be correlated with the probability of migration. Second, we estimate the educational effect of aerial bombardment on the non-migrant population and compare it with the impact on the full sample. The results are reported in Table A4. Non-migrants are defined as those having permanent registration in their residential districts. The proportion of non-migrants in our data is approximately 98.77%. The percentages of non-migrants in the war and non-war cohorts are 99.19% and 98.38%, respectively. Evident from Column 2, bombing has negative consequences on the education of non-migrants. Specifically, a 10% increase in bomb density is associated with the decrease in educational attainment by approximately 0.01 years. The effect is statistically significant and close in magnitude to the effect on the full sample (Column 1).[15] The results lend suggestive evidence against selective migration.

Falsification Test - To lend additional support to the causal interpretation of the estimated effect of bomb destruction on educational accumulation in Table 1, we conduct a falsification test. Particularly, we run equation (8) with the war cohorts being those born between 1909 and 1940 (who should have completed their education before the bombardment started). The 1985-1996 cohorts still serve as a comparison unaffected group. If aerial bombardment indeed reduces educational attainment, we expect to find no impact on individuals who finished schooling prior to the onset of the Vietnam bombing. The result is reported in Column 2 of Table 2. The point estimate is both economically and statistically indistinguishable from zero, suggesting no spurious relationship between bombing destruction and schooling accumulation.

Nonlinear Effects - To explore the possible nonlinear effects of aerial bombardment, we replace the single $BombIntensity_d$ measure in equation (8) with three indicators, each of which takes the value of one if the bomb density in the district lies in the top, middle, and bottom third of the bomb density distribution (with the bottom third dummy being omitted). The results are reported in Column 3 of Table 2. The adverse effects are both economically and statistically significant for individuals in districts in the top third of the bomb destruction distribution. However, the point estimate falls short of statistical significance for individuals

[15] We are unable to estimate the impact of aerial bombardment on the migrant population due to the small sample size.

in districts in the middle third of the bomb distribution.[16]

Robustness Checks - We examine the educational impacts of aerial bombardment using equation (8) with different classifications of the war and non-war cohorts. Results are reported in Table 3. In Column 1 and 2, the 1909-1935 and the 1935-1947 cohorts (who completed schooling prior to the onset of the Allied bombing) are respectively defined as the non-war cohorts, with the war cohorts being the 1953-1963 group. Point estimates are negative, significant, and close in magnitude to the estimate in Table 1. In other words, our results are robust to the choice of the older cohorts as the unaffected group.

In Column 3, all cohorts other than the main war cohorts (1953-1963) form the unaffected group. We still find that a 10% increase in bomb density leads to a reduction of 0.01 years of education. Recall that in Table 1, our main affected cohorts consist of individuals who spent at least five years of schooling during the bombing period. Now, we include a wider range of cohorts as the affected cohorts. Specifically, in Column 4, individuals who ever spent any time of their schooling years in the bombardment period, i.e. those born between 1948 and 1968, constitute our affected group. The educational effects of bombing are still negative and significant, although the point estimate is smaller than the one in Table 1. In Column 5, individuals exposed to the aerial bombardment for at least eight school years are categorized as the war cohorts. The estimated impact is similar to the effect in the main specification. Particularly, a 10% increase in bomb density is associated with a decline of 0.01 years of schooling.[17] The results in Table 3 show that different categorizations of the affected and unaffected groups leave our results essentially unchanged.[18]

5.1.3 Heterogeneity in Bombing Tactics

In this section, we attempt to explore the heterogeneous impacts of different bombing tactics on educational attainment. It is possible that bombs the mission of which was to destroy

[16] Sample size is larger than that in Column 1 of Table 1 because here we take into account six districts with zero bomb destruction. These districts belong to the omitted bottom third category.

[17] In a different specification, we impute the total number of educational years based on the reported grades completed and educational level, and re-estimate our main specification (1) using the imputed total years of education as the dependent variable. Particularly, individuals with college, university, master, and Ph.D. degrees are assigned with 14, 16, 18, and 20 years of education, respectively. The result is similar to the baseline estimate and is provided in Column 2 of Table A3.

[18] In the main results, standard errors are clustered at the district-by-birth year level. In Panel A of Table A5, we replicate the specifications in Table 1 but change the cluster level to the district. Our results remain the same.

physical capital would leave more severe impacts than bombs without such destruction missions. It could also be expected that the effects of military strikes are larger than those of general raids. It is because military strikes tend to involve more precise and intentional attacks as well as more powerful classes of weapons.[19] Therefore, we re-estimate equation (8) with different measures of bomb density. Specifically, we focus on bombs with destruction and non-destruction missions (Column 2 and 3), bombs used in military strikes as opposed to general raids (Column 4 and 5). The estimating results are reported in Table 4.

In Column 1, we replicate the main result in Table 1 (Column 1) where we consider the weight of all weapons regardless of missions or targets. When we restrict the measure bomb density to bombs with the missions of destroying physical capital, we detect negative and significant impacts on educational accumulation. Column 2 suggests that the educational gap between a school-age individual during the bombardment period in the districts with maximal bomb density and the one in the average bombed district is 0.3 years. This magnitude is similar to the main result. Moving to Column 3, as we consider bombs with non-destruction missions, the estimated effect of aerial bombardment, although negative, is much smaller in magnitude and is statistically indistinguishable from zero. As expected, bombing intended for destruction missions imposes more severe consequences on educational attainment than bombing with non-destruction missions.

We proceed to estimate the impacts of aerial bombardment by target types, including: (i) targets subject to military strikes, and (ii) targets subject to general raids. Evident from Column 4 and 5, bombs used in both military strikes and general raids adversely affect educational attainment. The estimates are both economically and statistically significant for both scenarios. In addition, we find that the magnitude is slightly larger for bombs used in military strikes.

5.2 Results on Labor Market Outcomes

In this subsection, we explore the effects of aerial bombardment on future labor market outcomes. The dependent variable is the log of individual annual earnings. Because the unaffected group comprises individuals born in 1985-1996 and the information on earnings is taken from the 2010-2014 data wave, there could be a problem with right-censoring of the outcome variables. Therefore, the analyses in this section are further limited to individuals

[19] We thank an anonymous reviewer for raising this interesting point.

aged 23-60, those supposed to be on the labor market with a college degree. In addition to previously discussed controls in Section 4, the earning regressions are conditioned on age and the square of age to account for working experiences. The main DiD estimate in Column 1 of Table 5 is negative and significant. Specifically, a 10% increase in bomb density leads to a 1.1% decrease in annual earnings for individuals exposed to aerial bombardment for at least five school years. Put it differently, the annual earnings of an individual in the most heavily bombed district is around 70% of the yearly income of an individual in a district with an average destruction level.

The results from the heterogeneity analyses by gender and mother's education are presented in Column 2 through 5. Aerial bombardment worsens future market outcomes of females and left males' future earnings intact, as evident in Column 2 and 3. The estimated effect on male earnings is small and statistically indistinguishable from zero while the effect on female earnings is negative and statistically significant. This is consistent with results on educational attainment presented in Section 5.1 where bomb destruction leads to larger reductions in completed grades for females than males. The finding is consonant with Shemyakina (2010). In exploring the heterogeneity along the line of maternal education, the impact on individuals with higher-educated mothers is small and insignificant (Column 4). As shown in Column 5, the effect of bombing devastation on the earnings of individuals from a disadvantaged background (mother's educational level is primary or less) is negative and larger in magnitude, despite the lack of statistical evidence. Due to a high number of missing values in maternal education, a level of caution should be exercised in interpreting estimates in Column 4-5.[20]

Collectively, we uncover adverse long-term ramifications of aerial bombardment on individual earnings. Particularly, a 10% increase in bomb density is associated with a 1.1% decline in annual earnings for individuals exposed to aerial bombardment for at least five school years. To put the numbers into perspectives, the annual earning gap between an individual in the district with maximal bomb density and the one in an average bombed district is 30%. Consistent with the results on educational attainment, violent conflict disrupts the education process, thus reducing productivity reflected in lower future earnings. Our findings highlight the detrimental cost of violent conflict to human capital, thus corroborating prior studies on the burden of conflict in terms of future labor market outcome (Ichino and Winter-Ebmer,

[20] In Panel B of Table A5, we replicate the specifications in Table 5 but change the cluster level to the district. Our results remain the same.

2004; Akbulut-Yuksel, 2014).

6 Possible Mechanisms

In this section, we explore the potential channels that drive the long-term impacts of aerial bombardment on educational attainment and consequently, labor market outcomes. Prior studies show that the detrimental consequences of aerial bombardment on schooling accumulation among the war cohorts could potentially be transmitted through both the supply side and the demand side of the education production function. Specifically, Glewwe and Jacoby (1994) and Akbulut-Yuksel (2014) point out that through the supply side, aerial bombardment could destroy schools, and increase the absence of teachers. Further more, through the demand side, adverse income shocks to households (Jacoby and Skoufias, 1997, Thomas et al., 2004), sizable damages to both mental and physical health (Hoeffler and Reynal-Querol, 2003, Ghobarah et al., 2003, Annan et al., 2006, Evans and Miguel, 2007) could possibly shrink the number of students.

To explore the potential mechanisms, we employ the Hamlet Evaluation System (HES) conducted by the US and the South Vietnam during 1969-1973. HES is a quarterly dataset that offers a wide range of information on economic, social, and security conditions in all hamlets (clusters of habitats within a village) in the South Vietnam. The time of the survey overlaps with the bombing period, making it ideal for our study. One disadvantage is that HES does not cover the North Vietnam. Original responses in categorical form are turned into binary indicators. These indicators are averaged to the district level across the sample period (Dell et al., 2018).

Following prior studies, we categorize the mechanisms into two groups: supply-side factors and demand-side factors of the education production function. Particularly, to capture the supply-side channels, we make use of three measures, namely, (i) the percentage of residential clusters within district (hamlets) where school attendance was restricted due to security concerns (Lack School Security), (ii) the fraction of hamlets where school attendance was restricted due to the lack of teachers (Lack Teachers), and (iii) the proportion of hamlets where school attendance was restricted due to the lack of school facilities (Lack Facilities).

We proceed to the demand side of the education production function. Demand-side channels are first represented by factors that could affect individual health (Hoeffler and Reynal-Querol, 2003, Ghobarah et al., 2003, Annan et al., 2006, Evans and Miguel, 2007). Since aerial bombardment could engender serious impairments to individual health by inflicting casualties and destroying hospitals, thus restricting access to healthcare service, we utilize (i) the proportion of hamlets where the military activities were the direct cause of casualties among residents (Residential Casualties) and (ii) the fraction of hamlets with accessible medical services to residents (Healthcare Access). Second, aerial bombardment could leave negative repercussions on educational attainment through adverse income shocks to households (Jacoby and Skoufias, 1997, Thomas et al., 2004). To proxy for income shocks, we look at (iii) the percentage of hamlets where the military activities were the direct cause of physical damage to residential properties (Damaged Properties), (iv) the proportion of hamlets with households requiring welfare assistance to maintain the subsistence level (Assistance to Survive), and (v) the faction of hamlets with needy households receiving assistance from the government in the past quarter (Past Quarter Assistance).

To examine whether the educational repercussions of bombing could be explained by the above-mentioned demand-side and supply-side factors, we estimate the following equation,

$$M_d = \alpha_0 + \alpha_1 BombIntensity + \Gamma_d' \psi + \upsilon_d \tag{9}$$

where M_d is the potential mechanism. Subscript d stands for district. $BombIntensity$ is the log of bomb density. Γ_d' is a set of district-level geographic controls including districts' centroid longitude, latitude, distance to coast, average precipitation, temperature, terrain ruggedness, land suitability, the share of arable land (excluding water, snow, and ice surface, as well as barren or sparsely vegetated surface) in district total areas, average altitude and district centroid distance to Ho Chi Minh Trail. The coefficient α_1 represents the estimated effect of aerial bombardment on the supply side and demand-side factors.

We provide district-level regression results in Table 6. Looking at the supply side in Panel A, bombing devastation increases the percentage of hamlets where school attendance was restricted due to security concerns and due to the lack of teachers (Column 1 and 2). Specifically, a 10% increase in bomb density is associated with the increase in the fraction of hamlets with security concerns and the fraction of hamlets lacking teachers by 0.24 and 0.25 percentage points, respectively. We do not have enough statistical evidence for the impacts of bombing on the fraction of hamlets lacking school facilities (Column 3). It is possible that the supply-side factors, proxied by the worsening school security and the lack of teachers, could be one pathway to the educational consequences of aerial bombardment.

Moving to the demand side in Panel B, it is likely that bombing devastation increases the proportion of hamlets where the military activities were the direct cause of resident casualties and physical damages to residential properties (Column 1 and 3). In addition, there is suggestive evidence that aerial bombardment could have restricted residential access to medical services (Column 2) and raised the percentage of hamlets where households needed welfare assistance to maintain the subsistence level (Column 4). Aerial bombardment, however, is not associated with the receipt of government assistance in the past quarter among needy households (Column 5). Taken together, demand-side factors, captured by residential casualties, restricted access to healthcare, damaged properties, and increased reliance on welfare assistance, could be potential mechanisms driving the detrimental impacts of bombing.

7 Conclusion

This paper contributes to the literature by providing causal evidence on the ramifications of large-scale physical destruction during the Allied bombing of Vietnam. Notably, we exploit the district-by-cohort variation in bomb intensity in a DiD framework to quantify the effects of interest. The paper also utilizes the newly released dataset (THOR) to construct a more accurate measure of aerial destruction, the total weight of all weapons dropped onto a district per km^2 area. Not only do we estimate the long-term effects of aerial bombardment on educational attainment and labor market outcomes but we also uncover potential channels driving these effects.

The negative repercussions on schooling accumulation detected in this paper highlight the long-term consequences of aerial bombardment. Specifically, we find that a 10% increase in bomb density leads to a reduction of 0.01 educational years for individuals who spent at least five schooling years during the bombing of Vietnam. To put these numbers into perspective, a school-aged individual in the most destroyed district completed 0.3 fewer years of education than his/her peer in the district with an average bomb density level. Furthermore, we find that bombing devastation also worsens future earnings. Particularly, the annual earnings of an individual in the most heavily bombed district are approximately 70% of the yearly income of an individual in a district with an average destruction level.

We attribute these detrimental consequences to both the supply-side and the demand-side factors of education. Specifically, the supply-side factors, proxied by inadequate school security and the lack of teachers, could be one pathway to the educational consequences of aerial bombardment. Furthermore, the demand-side factors, captured by residential casualties, restricted access to healthcare, damaged properties, and increased reliance on welfare assistance could also be the channels through which aerial bombardment depresses educational attainment, and thus future earnings.

Our findings offer meaningful implications for policymakers. By showing the adverse ramifications of aerial bombardment on human capital, this paper sheds additional light on the persistent cost of violent conflict that has been insufficiently considered. Exposure to conflict during school age decreases educational accumulation and worsens future labor market outcome. Since the returns to education go beyond personal earnings, the decline in educational attainment among the war cohorts could have affected other aspects of their lives such as health (Silles, 2009; Conti et al., 2010; Kemptner et al., 2011), and the outcomes of their offspring (Currie and Moretti, 2003; McCrary and Royer, 2011; Lundborg et al., 2014). Affected individuals could transmit these socioeconomic disadvantages to the future generation, aggravating social inequality and hindering economic development. Our results suggest that the prevention and reduction of conflict should be put as one of the global priorities, in order to promote peaceful societies for sustainable development (SDG-16). Our findings further imply that post-conflict reconstruction initiatives are important when conflicts already occurred. Government interventions aiming to improve the abilities/skills of affected individuals could help lessen the cost of conflict.

Declaration of Interest Statement: The authors have no conflict of interest.

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Appendix - Generalized DiD

In the main DiD specification, we exploit the exogenous district-by-cohort variation in the devastation of aerial bombing where treatment is the interaction between $WarCohort_{ic}$ dummy and $BombIntensity_d$ (the natural log of bomb density in a given district). For the β_1 coefficient on this interaction to have a causal interpretation, the fundamental identifying assumption, which is, had the aerial bombardment not occurred, the difference in schooling accumulation between the unaffected and affected (war) cohorts would have been the same across districts with varying bomb intensity levels, must be satisfied. To assess this assumption, we specify the generalized version of equation (8) by estimating the cohort-specific impacts of aerial bombardment:

$$Y_{idt} = \beta_0 + \sum_{g=1}^{11}(Cohort_{ig} \times BombIntensity_d)\beta_{1g} + X'_{idc}\gamma + \delta_d + \lambda_t + \epsilon_{idc} \tag{10}$$

where Y_{idt} is the outcome for individual i residing in district d and born in year t. $Cohort_{ig}$ is an indicator taking the value of 1 if an individual i was born in cohort g. Birth cohorts are grouped into 11 years of birth categories, and the cohorts 1985-1996 constitute the comparison group and are omitted from the regression. Each coefficient β_{1g} represents the effects of bombing destruction on a given cohort group. If the "parallel trend" is satisfied then the impact of aerial bombardment should be indistinguishable from zero for cohorts that completed their education before the start of the Allied bombing (cohorts born prior to 1948), or for any cohorts who did not spend their schooling years during the devastation time.

We provide the estimates for the cohort-specific effects of aerial bombardment on educational attainment using equation (10) in Table A6.[21] For cohorts of 1948-1952, 1953-1957, 1958-1960, and 1961-1964 the estimated effects are negative and significant while for other cohorts (who finished schooling prior to the bombardment period, e.g. the 1937-1941 cohort, or attained education after the end of the bombing destruction, e.g. the 1975-1984 cohort), point estimates are statistically indistinguishable from zero. Individuals born in 1953-1957 and 1961-1964 respectively completed 0.014 and 0.011 fewer years of education in response to a 10% increase in bomb density. In other words, individuals born in 1953-1957 in a district with maximal bomb destruction completed 0.45 fewer educational years than those in a

[21] In the generalized DiD framework, we include all cohorts (1909-1996) and group them into different categories. There are 11 groups and cohorts 1985-1996 are omitted from the regression.

district with an average destruction level. The reduction in years of education for cohorts 1948-1952 and 1958-1960 is around 0.008 to 0.009, respectively, following a 10% bomb density increment.[22] Figure A1 plots the cohort-specific coefficients and the corresponding 90% confidence interval.

[22] Cohorts of 1948-1952 were exposed to the bombardment from 0.5 to 4 school years.

MAIN TABLES

Table 1: Impacts of Bombardment on Educational Attainment

	All Individuals	Male Only	Female Only	Mother with higher than primary education	Mother with primary education or less
	(1)	(2)	(3)	(4)	(5)
$WarCohort \times$ $BombIntensity$	-0.098*** (0.031)	-0.083** (0.042)	-0.120*** (0.041)	-0.040 (0.062)	-0.390*** (0.125)
Sample size	32,440	15,662	16,778	3,233	2,540

NOTE: Each cell reports coefficient β_1 of equation (8). War cohorts consist of individuals born in 1953-1963. The comparison (unaffected) cohorts include individuals born in 1985-1996. Regressions are conditioned on district, birth year, survey year fixed effects, and province-specific time trend. Individual observable characteristics include gender, mother education, an indicator for living in the north, and the interactions of these characteristics with birth year dummies. Additional controls consist of the interactions between district-level geographic characteristics and birth year indicators. See Section 3 for the details on geographic controls. Standard errors are clustered at the district-by-birth year level. ***p<0.01, **p<0.05, *p<0.1.

Table 2: Tests for Endogenous Mobility, Falsification, and Nonlinear Effects

	Migration	Years of Education		Years of Education
	(1)	(2)		(3)
$WarCohort \times$ $BombIntensity$	-0.002 (0.001)	-0.008 (0.044)	$WarCohort \times$ Middle Third Bomb Intensity	-0.034 (0.125)
			$WarCohort \times$ Top Third Bomb Intensity	-0.322** (0.142)
Sample size	32,440	23,452		33,702

NOTE: Column 1 reports the coefficient β_1 in equation (8) but the outcome is the Migration indicator. In Column 1, the war cohorts consist of individuals born in 1953-1963 and the comparison (i.e. unaffected) cohorts include individuals born in 1985-1996. Column 2 presents the result of a falsification test (using specification (1)) where the war cohorts include individuals born prior to 1940 and the unaffected cohorts comprise individuals born in 1985-1996. Column 3 shows the possible nonlinear impacts of bomb destruction where the single *BombIntensity* measure is replaced with indicators which take the value of one if the bomb density in the district lies in the top, middle, and bottom third of the bomb density distribution (with the bottom third dummy being omitted). Standard errors are clustered at the district-by-birth year level. ***p<0.01, **p<0.05, *p<0.1. See the note under Table 1 for details on control variables.

Table 3: Bombardment and Education: Different Unaffected and War Cohorts

	Y = Years of Education				
	(1)	(2)	(3)	(4)	(5)
$WarCohort\times$ $BombIntensity$	-0.149*** (0.056)	-0.125*** (0.047)	-0.116*** (0.024)	-0.056** (0.026)	-0.102** (0.040)
Sample size	18,784	21,431	80,692	44,924	24,477
War Cohorts	1953-1963	1953-1963	1953-1963	1948-1968	1956-1960
Non-war Cohorts	1909-1935	1935-1947	Others	1985-1996	1985-1996

NOTE: Each cell reports coefficient β_1 of equation (8) with different categorizations of the war and non-war cohorts. Standard errors are clustered at district-by-birth year level. ***p<0.01, **p<0.05, *p<0.1. See the note under Table 1 for details on control variables.

Table 4: Bombardment and Education: Heterogeneity in Bombing Tactics

	Y=Years of Education				
	(1)	(2)	(3)	(4)	(5)
$WarCohort\times$ $BombIntensity$	-0.098*** (0.031)	-0.079** (0.031)	-0.025 (0.017)	-0.083*** (0.029)	-0.076** (0.032)
Sample Size	32,440	32,112	26,788	31,906	30,989
Bomb Characteristics	All Bombs	Bombs with destruction missions	Bombs with non-destruction missions	Bombs in military strikes	Bombs in general raid

NOTE: Each cell reports coefficient β_1 of equation (8). In Column 1, *BombIntensity* includes all types of bombing. In Column 2, the measure of bomb density is restricted to bombs the mission of which was to destroy physical capital. Column 3 considers bombs with non-destruction missions. In Column 4, *BombIntensity* only includes bombs used in military strikes. *BombIntensity* in Column 5 is restricted to bombs used in general raids. Standard errors are clustered at district-by-birth year level. ***p<0.01, **p<0.05, *p<0.1. See the note under Table 1 for details on control variables.

Table 5: Impacts of Bombardment on Earnings

	All Individuals	Male Only	Female Only	Mother with higher than primary education	Mother with primary education or less
	(1)	(2)	(3)	(4)	(5)
$WarCohort \times BombIntensity$	-0.109*	0.023	-0.169**	0.050	-0.285
	(0.058)	(0.088)	(0.078)	(0.179)	(0.195)
Sample size	22,535	10,668	11,867	2,289	1,823

NOTE: Each cell reports coefficient β_1 of equation (8). War cohorts consist of individuals born in 1953-1963. The comparison (unaffected) cohorts include individuals born in 1985-1996. Standard errors are clustered at the district-by-birth year level and provided in the parentheses. ***p<0.01, **p<0.05, *p<0.1. See the note under Table 1 for details on control variables.

Table 6: Potential Mechanisms

	(1)	(2)	(3)	(4)	(5)
Panel A: Supply-side Factors					
	Lack School Security	Lack Teachers	Lack Facilities		
$BombIntensity$	0.024***	0.025**	0.011		
	(0.004)	(0.010)	(0.012)		
Sample size	316	316	315		
Panel B: Demand-side Factors					
	Residential Casualties	Healthcare Access	Damaged Properties	Assistance to Survive	Past Quarter Assistance
$BombIntensity$	0.020***	-0.009**	0.015***	0.015*	0.005
	(0.002)	(0.004)	(0.002)	(0.008)	(0.006)
Sample size	317	317	317	329	317

NOTE: Each cell reports the coefficient on the log of bomb density (Bomb Intensity) from the regressions where mechanisms variables are regressed on *BombIntensity* and a set of district-level geographic controls. The geographic controls include districts' centroid longitude, latitude, distance to coast, average precipitation, temperature, terrain ruggedness, land suitability, the share of arable land (excluding water, snow, and ice surface, as well as barren or sparsely vegetated surface) in district total areas, average altitude and district centroid distance to Ho Chi Minh Trail. Standard errors are clustered at the district level and provided in the parentheses. *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX TABLES

Table A1: Number of School Years Affected from Aerial Bombardment

Minimum Exposed Years	Cohorts	Minimum Exposed Years	Cohorts	Minimum Exposed years	Cohorts
1	1949-1967	4	1952-1964	7	1955-1961
2	1950-1966	5	1953-1963	8	1956-1960
3	1951-1965	6	1954-1962	9	1957-1959

Table A2: Summary Statistics

	Affected	Unaffected		All Bombed Districts	
	Mean (1)	Mean (2)		Mean (3)	Max (4)
Panel A: Individual			**Panel B: District**		
Years of Education	7.51	9.75	Bomb Density (t/km^2)	11.42	279.38
	(3.56)	(3.09)		(26.40)	
Annual Earnings	35,614	29,210			
	(41,173)	(24,608)			
Year of Birth	1958	1989	Number of Provinces	63	
	(3.09)	(2.95)			
Sample size	15,113	17,327	Number of Districts	625	

NOTE: Standard deviations are in parentheses. Affected group refer to individuals born in the period of 1953-1963. Unaffected group includes those born in the period of 1985-1996. Monetary values of earnings are in '000 VND, 2010 constant price.

Table A3: Bombardment and Education: Supplementary Specifications

	Years of Education	Imputed Years of Education
	(1)	(2)
$WarCohort$ × Log(1+Bomb Density)	-0.159***	
	(0.049)	
$WarCohort$ × Bomb Intensity		-0.099***
		(0.035)
Sample size	33,702	32,440

NOTE: Each cell reports coefficient β_1 of equation (8). War cohorts consist of individuals born in 1953-1963. The comparison (unaffected) cohorts include individuals born in 1985-1996. In Column 1, $BombIntensity_d$ is defined as the log of (1+Bomb Density) to account for districts with no bombing destruction. In Column 2, $BombIntensity_d$ is still the log of Bomb Density, but dependent variable is the imputed years of education (individuals with college, university, master, and PhD degrees are assigned with 14, 16, 18, and 20 educational years respectively). See the note under Table 1 for details on control variables. Standard errors are clustered at the district-by-birth year level and provided in the parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A4: Additional Testing for Endogenous Mobility

	Y = Years of Education	
	(1)	(2)
$WarCohort \times BombIntensity$	-0.098***	-0.099***
	(0.031)	(0.031)
Sample size	32,440	32,039
Sample	Full	Non-migrants

NOTE: Each cell reports coefficient β_1 of equation (8). War cohorts consist of individuals born in 1953-1963. The comparison (unaffected) cohorts include individuals born in 1985-1996. See the note under Table 1 for details on control variables. Column 1 shows the estimate for the full sample. Column 2 and 3 present the estimates for non-movers and movers, respectively. Migrants are defined as those lacking permanent registration in their district of residence. See Section 5.1.2 for more details. Standard errors are clustered at the district-by-birth year level and provided in the parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Impacts of Bombardment: Different Cluster Level

	All Individuals	Male Only	Female Only	Mother with higher than primary education	Mother with primary education or less
	(1)	(2)	(3)	(4)	(5)
Panel A: Years of Education					
$WarCohort \times$	-0.098**	-0.083*	-0.120**	-0.040	-0.390***
$BombIntensity$	(0.042)	(0.050)	(0.048)	(0.079)	(0.141)
Sample size	32,440	15,662	16,778	3,233	2,540
Panel B: Annual Earnings					
$WarCohort \times$	-0.109*	0.023	-0.169**	0.050	-0.285
$BombIntensity$	(0.060)	(0.091)	(0.084)	(0.179)	(0.215)
Sample size	22,535	10,668	11,867	2,289	1,823

NOTE: Each cell reports coefficient β_1 of equation (8). War cohorts consist of individuals born in 1953-1963. The comparison (unaffected) cohorts include individuals born in 1985-1996. Regressions are conditioned on district, birth year, survey year fixed effects, and province-specific time trend. Individual observable characteristics include gender, mother education, an indicator for living in the north, and the interactions of these characteristics with birth year dummies. Additional controls consist of the interactions between district-level geographic characteristics and birth year indicators. See Section 3 for the details on geographic controls. Standard errors are clustered at the *district* level and provided in the parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table A6: Bombardment and Educational Outcomes by Cohorts

	Years of Education	
	Coefficients	Std. Errors
	(1)	(2)
Born before 1936$\times BombIntensity$	0.013	(0.048)
Born(1937-1941)$\times BombIntensity$	-0.021	(0.062)
Born(1942-1947)$\times BombIntensity$	-0.007	(0.054)
Born(1948-1952)$\times BombIntensity$	-0.074	(0.048)
Born(1953-1957)$\times BombIntensity$	-0.140***	(0.040)
Born(1958-1960)$\times BombIntensity$	-0.086**	(0.043)
Born(1961-1964)$\times BombIntensity$	-0.105***	(0.036)
Born(1965-1968)$\times BombIntensity$	-0.018	(0.038)
Born(1969-1974)$\times BombIntensity$	0.042	(0.033)
Born(1975-1984)$\times BombIntensity$	0.015	(0.027)
Sample size	80,692	

NOTE: Each cell reports coefficient β_{1g} in equation (10). Omitted cohorts are individuals born during 1985-1996. Standard errors are clustered at the district-by-birth year level and provided in the parentheses. ***p<0.01, **p<0.05, *p<0.1. See the note under Table 1 for details on control variables.

Figure A1: Impacts of Bombardment on Years of Education by Cohorts, 90% CI.