

# The Long Run Effects of WWII Destruction on German Households

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## Abstract:

This paper presents causal evidence on the long run consequences of WWII destruction on educational attainment and health status of German households. I combine a unique dataset on WWII bombing intensity in Raumordnungsregionen (Regional Policy Regions) level with the individual survey data, German Socio-Economic Panel (GSOEP) to study the long-lasting effects of WWII devastation. The identification strategy exploits exogenous variation in the intensity of WWII destruction across regions and across birth cohorts. I show that Allied Air Forces bombing during WWII had a detrimental effect on years of schooling and health outcomes such as height and health satisfaction, even 40 years after the war. Additional analysis also suggests that inter-generational transfers are prominent in determining one's education and the negative impact of war destruction is mitigated through parental human capital endowment. These results survive after alternative sample specifications and estimation strategies and are not driven by individual or regional omitted variables. My findings suggest that, consequences of wars along human dimensions could be more substantial and longer lasting than any physical capital impacts.

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## **1. Introduction**

War has devastating consequences for a country, including loss of lives, physical injuries, displacement of people, and destruction of public infrastructure as well as physical capital and cease of economic growth. Civil wars may also retard investment in new physical capital as well as damage the fabric of society – its institutions and organizations, or “social capital” (Collier 1999; Collier, Hoeffler, and Soderbom 2004). However, given the extreme trauma experienced by war victims, it is likely that effects of wars along human dimensions could be more substantial and longer lasting than any physical investment impacts. In fact, wars will inevitably erode education of civilians, cause widespread mental distress, a worsening of existent malnutrition (particularly among children) and outbreaks of communicable diseases. World Bank Report (2003) concludes that the economic and social costs of wars are not only deep but also persistent, even for years after the end of the conflict.

Though the incidence of civil wars peaked in 1990s, WWII still remains as the most costly and widespread global military conflict. It involved the mobilization of over 100 million military personnel, making it the most widespread war in history, and placed the participants in a state of "total war", erasing the distinction between civil and military resources. This resulted in the complete activation of a nation's economic, industrial, and scientific capabilities for the war effort purposes. Over 60 million people, the majority of them civilians, were killed, making it the deadliest conflict in human history. The financial cost of the war is estimated at about a trillion 1944 U.S. dollars worldwide, making it the most costly war in capital as well as lives.

Despite the fact that this global conflict had split the majority of the world's nations into two opposing military alliances: the Allies and the Axis powers<sup>2</sup>; European theatre and in particular, territory of Germany has witnessed the extensive bombing campaign of Allied Air Forces. Throughout the World War II, over one-half million tons of high explosive, incendiaries and fragmentation bombs were dropped in area raids on German cities. The raids left more than 7 million people homeless; approximately 600,000 civilians died and approximately 850,000 civilians were injured. Allied Air Forces raids also destroyed or heavily damaged 3,600,000 dwelling units, approximately 20 percent of the total housing stock in nationwide and 45 percent of the housing stock in the large cities.

This paper first aims to exploit the variation in the intensity of WWII destruction across German Raumordnungsregionen (Regional Policy Regions) and across birth cohorts as an exogenous source of variation and provide evidence on the causal long lasting impacts of wars on German households' human capital. The second question considered is whether war conflict has long run detrimental effects on health status of exposed cohorts including height, health satisfaction and mental health.

I utilize a unique historical data compiled from German Achieves as a measure of war devastation. As a another measure of destruction intensity, I also exploit detailed district-level data on Allied Air Force bombing assembled by Center of Military History of the U.S. Army. I have linked these two measures of war destruction to nationally representative individual survey data, German Socio-Economic Panel (GSOEP), to study the long-lasting effects of WWII destruction.

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<sup>2</sup> Allies Powers of World War II mainly consisted of British Empire, Union of Soviet Socialist Republics and the United States of America. The major Axis Powers were Germany, Italy and Japan.

The contribution of this paper to the existing literature is multifold. First, to the best of our knowledge, there is no other paper studying the impact of war destruction on individuals' educational attainment and health status using a very detailed regional level destruction data. Second, this study exploits across-region variation within Germany to account for the secular trends over time. Individuals residing in less destroyed regions are likely to serve as a better control for individuals residing in highly destroyed regions. Finally, I distinguish between the actual amounts of bombs dropped and the extent of destruction, while the previous studies mainly focus on the amount of bombs dropped. This specification will help us to quantify the realized destruction in the regions, oppose to the intention to destroy measures that the previous papers employ.

To preview of my results, I find that that Allied Air Forces bombing during WWII had a negative effect on years of schooling and height even 40 years after the war. Additional analysis suggests that German households residing in more destroyed areas are more likely to have worries about health and less likely to be satisfied with their current health status.

The remainder of the paper is organized as follows. Section 2 reviews the existing literature. Section 3 provides an overview of the background of Allies Forces bombing of Germany and how the Allied Air Forces bombing strategy gradually shifted towards area raids. Section 4 describes the destruction and individual level data used in the analysis and explains the key variables. Section 5 describes the empirical identification strategy and section 6 presents the main results as well as robustness tests. Section 7 concludes.

## **2. Literature Review**

Extensive literature looks at association between civil and military conflicts and country's socioeconomic performance from a macroeconomic perspective. In different country settings, this strand of the literature mainly finds that war impacts are limited to the destruction of physical capital, in line with the predictions of the neoclassical economic growth model, which suggests rapid catch-up growth postwar. Among others, using the extensive U.S. bombing campaign in Vietnam as a quasi experiment, Miguel and Roland (2005) show that U.S. bombing does not have had long lasting impacts on poverty rates, consumption levels, infrastructure, literacy or population density 25 years after the war in Vietnam. Studies that focus on United States bombing – including in Japan (Davis and Weinstein 2002), Germany (Brakman et al 2004) – also find few if any persistent impacts of the bombing on local population or economic performance. Along these lines, Organski and Kugler (1977, 1980) provide similar evidence on war destruction mainly for European countries suggesting that for both capitalist and socialist economies, the economic effects of the two world wars tended to dissipate after only 15-20 years.

A very few of studies provide microeconomic level evidence on the cost of conflict on human capital and labor market outcomes mainly due to the data limitations. Based on cross-cohort and cross-country comparison, Ichino and Winter-Ebmer (2004) investigate the long run cost of Second World War in Austria and Germany. They show that Austrian and German individuals who were 10 years old during or immediately after the conflict attain less education compared to other cohorts as well as individuals of same cohort born in non-war countries, such as Switzerland and Sweden. They also

demonstrate that the same cohort also suffered from the significant earning loss 40 years after the war. Meng and Gregory (2002, 2007) visit the same question using Chinese Cultural Revolution as a source of exogenous shock to individuals' education attainment. Chinese Cultural Revolution had generated a large scale interruption in many individuals' education, mainly through abolishing recruitment of students to universities and senior high school for entire course of 11 years. They find that Chinese Revolution retard the individuals' educational attainment mainly for individuals at the age of attending a college. However they show that the corresponding loss in individuals' education has not been transmitted to individuals' earnings as in Germany and Austria.

There are few studies also address the long-lasting impacts of conflicts and natural disasters on child's health status. Exploiting the exogenous variation in the war's timing across provinces and across cohorts, Akresh, Bundervoet and Verwimp (2007) find in Burundi that children experienced the war has on average 0.515 standard deviations lower height-for-age z-scores relative to the other children. Maccini and Yang (2006) for Indonesia and Meng and Qian (2006) for China also provide analogous evidence on the detrimental effect of negative rainfall shocks and China's Great Famine. Both studies suggest that unfavorable environmental conditions early in life appear to have long-run detrimental effects on adults' health status and socioeconomic outcomes.

This study also relates to literature investigating the education and labor market outcomes of veterans. However, it is likely that the veterans might experience the different consequences of the war relative to the households who are not involved to the war. For instance, veterans may acquire skills that are transferable to the civilian labor market (Angrist and Krueger, 1994), therefore alter their occupational trajectories and

economic wellbeing (Maas and Settersen (1999)). In addition, U.S. and Canadian governments offered G.I. Bill to veterans as a subsidy for education (Bound and Turner (1999) for the U.S. G.I. Bill, and Lemieux and Card (2001) for the Canadian G.I. Bill). To extent, the veterans are likely to be impacted by the war in different dimensions than the rest of the population.

### **3. Background on Allied Bombing of German Cities during WWII<sup>3</sup>**

Throughout the World War II, Germany cities have experienced the widespread bombardment of Allied Air Forces (AAF)<sup>4</sup>. The raids left more than 7 million people homeless; approximately 600,000 civilians died and approximately 850,000 civilians were injured. AAF raids also destroyed or heavily damaged approximately 20 percent of the total housing stock in nationwide and 45 percent of the housing stock in the large cities. In Wurzburg, for instance, 89% of built-up area was destroyed, while the figure in Remscheid and Bochum was 83%, in Hamburg and Wuppertal 75% (Diefendorf, 1993). Though the largest numbers of destroyed buildings were apartment houses, in every bombed city also schools, hospitals, churches, museums and many other kinds of public buildings had been also destroyed or heavily damaged. The public buildings such as recreational and health facilities that remained in good condition after the air raids, were also been confiscated for their own use by Allied Forces.

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<sup>3</sup> Information presented in this section is mainly gathered from the following historical sources: (i) USSBS (1945). Experts including John Kenneth Galbraith, Paul Baran and Nicolas Kaldor had conducted an extensive survey, the United States Strategic Bombing Survey, in 1945 to examine the effectiveness of U.S. in WWII; (ii) Diefendorf (1993) "In the Wake of War: The Reconstruction of German Cities after World War II; (iii) Grayling (2006) "Among the Dead Cities: Was the Allied Bombing of Civilians in WWII a Necessity or a Crime?"

<sup>4</sup> Allied Air Forces comprised of British and U.S. Army Air Forces.

In fact, the British Royal Air Forces (RAF) started the war with doctrine of “night precision bombing” aiming to attack specific targets. The targets selected by the RAF initially were oil, aluminum, and aero-engine plants. Marshaling yards were treated as secondary targets, to be attacked only when the main target could not be located (USSBS, 1945). However, Bomber Command’s efforts to hurt Germany by disrupting its transportation and industrial capacity were greatly less successful (Grayling, 2006). Attacks on canals (which transported one third of German production) and railway marshalling yards were persistent, costly and mainly ineffective. For instance, the huge marshalling yards at Hamm, the nerve center of the German railway system, were attacked eighty-five times in between June 1940 to June 1941 with scarcely any impact on movement of trains.

With Butt Report, published by British War Cabinet Secretariat in August 1941 and from photographs taken from aircrafts during the attacks, The RAF realized that the idea of “night precision bombing” was not as effective and was much too ambitious. Butt Report demonstrated that many bomber aircraft never found their targets at all. Even in good weather on moonlight nights, only two-fifth of bombers found their targets, but in hazy or rainy weather only one in ten did so. Besides, the percentage of success also varied greatly with the geographical position of the target, and the intensity of aircraft defense which work against the RAF bombers on most occasions. Apart from the problems related to navigation of the targets, the technological limitations also forced the RAF to reconsider the “night precision bombing” strategy. Indeed, RAF bombers were neither heavily armed nor capable of flying at very high attitudes. Since precision bombing of specified industrial targets required daylight, the toll on British planes from



German anti-craft fire and fighters was unacceptably high. Although safer for British fliers, night bombing permitted dropping the payload only on an area like a city, where the resulting fires would show other pilots where to drop their bombs (Diefendorf, 1993).

Due to limitations discussed earlier, in fall of 1941 area bombing came into being not as a method desirable in itself but as an expedient of necessity to be resorted to until the precision of night attacks could be improved. With the appointment of Sir Arthur Harris as Chief of the Bomber Command in early 1942, the picture changed, for he regarded area bombing not as a temporary expedient but as the most promising method of aerial attack. Harris and his staff had a low opinion of economic intelligence and were skeptical of "target systems." Instead of trying to blow up each building with high explosive, which was obviously an impossibly large task, the aim was to start conflagration in the center of each town, which, it might be hoped, would consume the whole. At the same time, they had a strong faith in the morale effects of bombing and thought that Germany's will to fight could be destroyed by the destruction of German cities (USSBS, 1945).

In August 1942, American Air Forces (AAF) also joined air war in the European theater with their campaign of "daylight precision bombing" of industrial targets. Similar to RAF, weather over Germany and German flak and air force often proved to be a problem for U.S. Air Forces attacks even during daylight hours; and it was difficult to achieve great bombing accuracy from high altitudes under fire. As a consequence, at the end of 1943 American pilots were also authorized to undertake radar-guided attacks on cities when visibility precluded precision bombing of the primary designated industrial targets and consequently they joined to their ally, RAF in area raids.

For the greater part of the war starting from 1942, overwhelming majority of the attacks consisted of area bombing at night. Table 1 indicates the shifting emphasize on area bombing with aim of destroying areas rather than points. Allied Air Forces went on to bomb almost every major and minor German city. The targeted cities were not necessarily selected because they were particularly important for the war effort, but also for their visibility from the air, depending for example on weather conditions or visibility of outstanding landmarks such as cathedrals (Friedrich, 2002). In addition, Sir Harris, the Commander Chief of RAF, positively insisted on bombing those cities which remained unbombed; and so his aircraft destroyed cities like Wurzburg and Hildesheim, noted more for their historical beauty than their military importance (Grayling, 2006).

The degree of damage and the amount of resulting rubble depended upon number of factors including the distance of town from England, technological developments at the time and intensity or concentration of the bombing within the city. In general, cities in the northern and western parts of Germany-those most easily reached from the bases in England-suffered the most destruction. As a consequence, Berlin has not been as hard hit till end of 1943 because of its great distance from the bomber airfields of Eastern England-it was nearly twice as far away as the cities in Ruhr Area (Diefendorf, 1993; Grayling, 2006). Along these lines, improvements in aircraft technology and operational techniques early in 1944, such as the development of P-51 long-range fighter and new bomb-aiming techniques as well as the improved quality and increased weight of bombs rendered possible continuous attacks deep in the heart of Germany. Finally, the amount of rubble also depended on the intensity or concentration of the bombing as well as the concentration of population and building area within a city. For example, one of

Munich's eight central districts contained 4.3 times as much as rubble the least damaged of the eight.

All in all, almost every city in Germany got exposed to the Allied Air Forces air raids mainly between 1942 and 1945; though the amount of bombs dropped and the degree of destruction vary substantially across cities (see Figure 1).

#### **4. Data and Descriptive Statistics**

In this paper, I rely on two sources of war destruction to analyze the long run impact of WWII destruction on German households. The primary source for war destruction is assembled from Kästner (1949), who reports the results of a survey undertaken by the German Association of Cities (“Deutscher Städtetag”), which was also published in the 1949 Statistical Yearbook of German Municipalities. Kästner (1949) provides municipality-level information on rubble in  $m^3$  per capita in 1945 and the percentage of the stock of housing unit destroyed in 1946 in the territory of former West Germany. In addition, another measure of war devastation, school destruction, is compiled from chapters on German Education System published in the 1949 and 1939 Statistical Yearbooks of German Municipalities. Using these historical records in the Statistical Yearbook of German Municipalities immediately before and after WWII, I assembled cross-municipality level data on the percentage of schools demolished in 1947 relative to school stock in 1939. The data on rubble per capita and percentage of housing units destroyed in 1945 is available for almost all cities with more than 12.000 inhabitants in 1939; whereas school destruction measure is only available for German municipalities with more than 20.000 people in 1939. Apart from the data on war

destruction, I also compile data from 1939 Statistical Yearbook on prewar characteristics of municipalities including aggregate and average per capita income in German Reichsmarks in 1938<sup>5</sup>, total area in square kilometers in 1939 and percentage of built-up residential area in total area of city in 1938.

As a another measure of destruction intensity, I also exploit detailed district-level information on Allied Air Force bombing assembled by Richard G. Davis, member of the historical staff at the Army's Center of Military History<sup>6</sup>. This database contains detailed information on targeted country and city, exact date of the bombing, tons<sup>7</sup> and type of bombs dropped, the purpose of the bombing, number of attacking and lost aircrafts for virtually every aircraft sortie credited with attacking a strategic target in Europe. The database mainly covers mining, supply missions, and special operations of all two and four-engine bombers of the RAF Bomber Command in Great Britain and the RAF 205 Group in the Mediterranean as well as all four-engine bomber (B-17 and B-24) operations of the US Eighth Air Force in Great Britain and the US Ninth, Twelfth, and Fifteenth Forces in the Mediterranean. Mainly high-explosive, incendiary and fragmentation bombs reported released over the targets<sup>8</sup>.

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<sup>5</sup> The U.S dollar worth 4.02 RM in 1938.

<sup>6</sup> Original achieves supplied all the bombing information gathered for this database. For coverage of Royal Air Force Bomber Command night raids (January 1942 through May 1945), the raw data relies on Bomber Command Night Raid Reports and the Air Ministry War Room monthly operations summaries. For The US Army Air Forces aerial operations, the study utilized the Eighth Air Force monthly operations reports (January 1944 through April 1945), the Eighth Air Force target summary (25 May 1945) and, most importantly, on the individual mission folders (17 August 1942 through 25 April 1945). In addition, Fifteenth U.S. Air Force and heavy bomber units of the Ninth and Twelfth Air Forces daily operations and intelligence summaries were incorporated.

<sup>7</sup> Tonnage of bombs is given in short tons (2000lbs.). British tonnage has been converted from long tons to short tons ( $B * 2.240 / 2.000 : A$ ) where A is a pound (which is approximately 0.453 kg.)

<sup>8</sup> The RAF did not routinely use fragmentation bombs, and when it did it appears to have used weapons supplied by American Air Force.

The data on individual and household characteristics comes from cross-section of 1985 West German, sample A file, in German Socio-Economic Panel (GSOEP). I restrict the empirical analysis to individuals those were born between 1924 and 1961. I consider WWII destruction impacts at both the Regional Policy Regions (*Raumordnungsregionen*, ROR) and Kreise (district) levels. Exploiting different levels of aggregation is likely to enhance our understanding of potential spillovers. U.S. bombing of one district could generate negative externalities for nearby districts. Regional level regressions are one way to partially capture these externalities, although this specification still misses broader cross-regions externalities.

To yield the final data set used in the analysis, raw data on war destruction and bombing intensity are recoded using German region/district boundaries employed by GSOEP in 1985 and then combined with a rich longitudinal individual and household data set, GSOEP. The GSOEP household panel survey is representative for the entire German population residing in private households<sup>9</sup>. GSOEP provides wide range of information on individual characteristics as well as parental background and the childhood environment one grows up. Information at the level of Regional Policy Regions (*Raumordnungsregionen*, ROR)<sup>10</sup> as well as at level of county is available for all waves of SOEP from 1985 onwards. Overall, the number of Regional Policy Regions

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<sup>9</sup> In the GSOEP, interviewers do face-to-face interviews with all members of a given survey household aged 16 years and over. Thus, there are no proxy interviews for adult household members. The reduction in the population size for all individual samples is mainly the result of person-level dropouts, refusals, moving abroad, etc. However, the sample size increases as new persons move into already existing households and as children reach the minimum respondent's age of 16. Also, a person is followed up even after moving out of the household. For further information on the GSOEP see Haisken-DeNew and Frick (2005) and Burkhauser et al. (1997).

<sup>10</sup> The SOEP geocode data module contains the official identification numbers of the regional policy regions (ROR) as defined by Federal Office for Building and Regional Planning (BBR, previously BfLR).

(*Raumordnungsregionen*, ROR)<sup>11</sup> amounts to 75 in West Germany in 1985 while there are 291 counties (Kreise and kreisfreie Städte)(see map in Appendix).

GSOEP also incorporates war-related questions including whether father got involved to war and father's death during the war years. This feature of the data enables us to analyze the some of the potential channels that likely to generate negative impacts on one's education and health status. In addition, GSOEP asks the respondents whether they still live in the city or area where they grew up. It is important to note that Germany has low levels of geographic mobility in comparison to the USA and UK and that mobility is particularly low during childhood and early adulthood (Rainer and Siedler, 2005). Furthermore, mobility rates were low during the period 1950-1970 among native Germans in the Federal Republic of Germany, with an annual migration rate between states of around 0.02, as defined as the ratio of number of migrants to or from a state within one year by the population of that federal state (Hochstadt, 1999)<sup>12</sup>.

All in all, 145 districts contains information on rubble in m<sup>3</sup> per capita, 160 districts on change in housing stock and 290 districts on amount of bombing out of 291 districts in West Germany in 1985. Table 2 presents the descriptive statistics for war destruction measures in district and region level. Table 2 suggests that in general, territory of former West Germany got exposed to the highly intensive bombing in WWII, with an average of 38.7 tons of bombs per km<sup>2</sup>, 8.05 rubble in m<sup>3</sup> per capita and 26% destruction in total housing units though there is a variation across regions/ districts in terms of both bombing and destruction intensity.

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<sup>11</sup> The GSOEP geocode data module contains the official identification numbers of the regional policy regions (ROR) as defined by Federal Office for Building and Regional Planning (BBR, previously BfLR).

<sup>12</sup>In addition, individuals living in West Berlin in 1985 are excluded from the analysis as a robustness to avoid potential problems from East-West migration.

## 5. Estimation Framework

In this section, I quantify the effect of WWII destruction on the German households' human capital accumulation and health status by exploiting the exogenous variation of destruction intensity across regions and birth cohorts. The date of birth and the region of birth jointly determine individual's exposure to WWII shock. In particular, the proposed estimate of the average treatment effect is given by  $\beta$  in the following baseline region and birth cohort fixed effects equation:

$$Y_{irt} = a + \beta (\text{Intensity}_j \times \text{WWII}) + q_r + r_t + p' \mathbf{X}_{irt} + e_{irt} \quad (1)$$

where  $Y_{irt}$  is the outcome of interest for individual  $i$  living in region  $r$  born in year  $t$ . The dependent variable is de-trended by cubic polynomial of age estimated separately for females and males.  $\text{Intensity}_j$  is the destruction and/or bombing intensity in region  $r$ . For schooling outcome,  $\text{WWII}$  is a dummy variable that takes a value of 1 if individual  $i$  was born between 1924 and 1939 and zero otherwise. Individuals born between 1924 and 1939 were still at school continuing their education during WWII and likely to be impacted by WWII destruction. On the other hand, presumably, one may expect that mainly children who were born immediately before or during the war are severely impacted by the malnutrition and deterioration of health status caused by the war. In line with this idea, for height, the treatment group is restricted to individuals who were born between 1930 and 1939. To facilitate the treatment group for health status, dummy variable  $\text{WWII}$  takes a value of 1 if individual  $i$  was born between 1930 and 1939, and zero otherwise.  $q_r$  is region-specific fixed effects, controlling for the fact that regions may be systematically different from each other (most saliently, highly-bombed regions may be systematically different from less-bombed regions).  $r_t$  is the birth cohort-specific fixed

effect, controlling for the likely secular changes over time.  $\mathbf{X}_{ijt}$  is a vector of individual characteristics including gender and rural dummy, and marital status and  $e_{irt}$  is a random, idiosyncratic error term. Higher-intensity region is defined as those regions with more than average rubble per capita while lower-intensity regions are regions with rubble per capita below the mean. In some specifications, I also incorporate WWII-related questions in GSOEP to account for the potential underlying channels that likely to affect individuals' education and health status.

The coefficient  $\beta$  in Equation 1 measures the impact of war conflict on human capital and health status of those who are residing in highly destroyed regions and belong to the birth cohort of 1924-1939 for education, and 1930-1939 for health status. The identification of this equation rests on the assumption that in the absence of the WWII, the change in education attainment over time would have been similar in higher-intensity and lower-intensity regions, That is, coefficient for interaction between birth cohort and region of residence would be zero in the absence of WWII destruction. However, it is possible that higher-intensity regions would have had different trends in educational and health outcomes from lower-intensity regions. To address this potential problem, I restrict the empirical analysis to older cohorts, whose educational and health outcomes have not been directly impacted by the war conflict. This specification should yield a zero coefficient of interaction term to rule out the potential pre-trends between higher-intensity and lower-intensity regions.



## 6. Empirical Results

### 6. 1. Effect of War Destruction on Educational Attainment

Table 3 reports the estimation results for years of schooling. Each column is from a separate regression. The dependent variable is residual from regression of years of schooling on cubic polynomial of age estimated separately by gender. The difference-in-differences estimate,  $\beta$ , is reported in the first row. It is negative and significant at 95% level of confidence in almost every specification. Column 1 has an estimated  $\beta$  of  $-0.017$  for whole population. Column 2 of Table 3 provides results only for individuals who still live in the city or area that they grew up. We see that difference-in-difference coefficient virtually remain unchanged for non-movers suggesting that movers and non-movers are not substantially different in terms of their educational attainment. Columns 3 and 4 present the results for specifications involving family background characteristics, such as father's and mother's years of education which are likely to serve as a proxy for parents' economic status. Though negative, the estimated difference-in-difference coefficient decreases substantially once family background characteristics is taken into account. This suggests that inter-generational transfers are prominent in determining one's education and the negative impact of war destruction is mitigated through parental human capital endowment. On the other hand, Columns 5 and 6 allow the war devastation to differ by both father's and mother's education. Findings in these columns reinforce the results reported in Columns 3 and 4. The difference-in-difference coefficient increases substantially in these specifications. Taken together, findings in Columns 3-6 provide evidence suggesting that the children of less educated families severely suffered from the detrimental effects of war devastation. Specifications in Columns 7 and 8 introduce war-

related controls such as whether father actively fought in war and whether father died in war to account for family's first hand experience with the consequences of the war. Column 7 provides that indeed children of those fought in the war have considerably lower levels of education. On the other hand, from Column 8, it appears that the coefficient of father died in war variable is negative, but not statistically significant. This result is mainly driven by the fact that luckily only very small fraction of father lost their lives because of the war and only half of the sample provides information on when their father died. The last specification allows war shock to differ by gender. We see from Column 9 that the negative impact of war is somewhat more pronounced for females, though not statistically significantly different from baseline specification.

## 6. 2. Effect of War Destruction on Individuals' Height

I then turn to the estimates showing the impact of WWII destruction on individuals' height, presented in Table 4. The previous research has established that height of population reflects both its genetic endowment and its long-run nutritional intake and health status (Fogel, 1994). Similar to education findings, almost all difference-in-difference estimates are significant at 5% significance level. In column 1, the difference-in difference estimate is -0.094 indicating that war devastation also has a detrimental impact on individuals' height. In column 2, I only focus on individuals who continued to live in their childhood city or area. The difference-in-difference coefficient is somewhat higher in magnitude for non-movers; however not statistically significantly different from the baseline specification. Similar to previous section, I introduce family background controls to the baseline specification in Columns 3 and 4. In contrast to education results, it appears however that the negative impact of war conflict has not

been alleviated through favorable family background in height. Columns 5 and 6 allow the war effect to vary by parental education. Parallel to education results, we see that children of disadvantageous families suffered the most from the war shock in terms of nutrition intake and health status as well. The following two columns add war-related variables to the baseline specification. Surprisingly, it seems that neither father's involvement to war nor loss of father due to the war has impacted the German households' height. The final column shows estimates allowing the war impact to differ for females. The difference-in-difference coefficient virtually remains unchanged compared to baseline specification implying that war hurt everyone regardless of gender.

## **7. Conclusion**

This paper presents causal evidence on the long-run socioeconomic consequences of world's most costly and widespread global military conflict, WWII on German households. I combine individual and household survey data, German Socio-Economic Panel (GSOEP), with a unique dataset on WWII bombing intensity in Raumordnungsregionen (Regional Policy Regions) level to study the long-lasting effects of WWII destruction on education and health status. The identification strategy exploits exogenous variation in the intensity of WWII destruction across regions and across-birth cohorts. I find that WWII destruction induce individuals that experienced WWII to attain less education. In addition, I also show that war shock not only has affected the individuals' education but also their nutrition intake and health status has been deteriorated.

Taken together these findings suggest that though severely hit regions rapidly return to their prewar patterns in terms of local population and macroeconomic outcomes, consequences of wars along human dimensions could be more substantial and longer lasting than any physical capital impacts.

## References

- Akresh R., Bundervoet and Verwimp (2007) "Health and Civil War in Rural Burundi", Policy Research Working Paper 4500.
- Angrist, Joshua D., and Alan B. Krueger. (1994). "Why do World War II veterans earn more than nonveterans?" *Journal of Labor Economics* 12, no. 1 (January): 74–97.
- Bound, John, and Sarah Turner. 1999. Going to war and going to college: Did World War II and the G.I. Bill increase educational attainment for returning veterans? Working Paper no. 7452, National Bureau of Economic Research, Cambridge, MA.
- Brakman, Steven, Harry Garretsen and Marc Schramm (2004) "The Strategic Bombing of Cities in Germany in World War II and its Impact on City Growth", *Journal of Economic Geography* 4(1): 1-18.
- Collier, Paul. 1999. "On the Economic Consequences of Civil War," *Oxford Economic Papers*, 51, 168-83.
- Collier, P. and Hoeffler, A., 2000. "Greed and Grievance in Civil War," *World Bank Policy Research Paper* 2355.
- Collier, P., Hoeffler, A. and Soderbom, M., (2004). "On the Duration of Civil War," *Journal of Peace Research* 41(3): 253-273.
- Davis, Donald, and David Weinstein (2002) "Bones, Bombs, and Break Points: The Geography of Economic Activity", *American Economic Review*, 92(5), 1269-1289.
- Diefendorf, J.M. (1993), *In the wake of the war. The reconstruction of German cities after World War II*, Oxford University Press, New York.
- Fogel, Robert (1992), "Second Thoughts on the European Escape from Hunger: Famines, Chronic Malnutrition and Mortality Rates," in S. R. Osmani, ed., *Nutrition and Poverty*. Oxford: Clarendon, 1992, pp. 243-86.
- Grayling (2006) "Among the Dead Cities: Was the Allied Bombing of Civilians in WWII a Necessity or a Crime?"
- Hochstadt, S. (1999), *Mobility and modernity: Migration in Germany 1820-1989*. Ann Arbor: University of Michigan Press.
- Ichino, A. and Winter-Ebmer, R., 2004, "The long-run educational cost of World War II", *Journal of Labor Economics*, 22(1), pp.57-86.
- Kästner, Friedrich. 1949. "Kriegsschäden: Trümmernengen, Wohnungsverluste, Grundsteuerausfall und Vermögensteuerausfall." *Statistisches Jahrbuch Deutscher Gemeinden*, 37: 361—91.
- Lemieux, Thomas, and David Card. 2001. Education, earnings, and the "Canadian G.I. Bill." *Canadian Journal of Economics* 34, no. 2 (May): 313–44.
- Maas, Inke, and Richard A. Settersten. 1999. Military service during wartime: Effects on men's occupational trajectories and later economic wellbeing. *European Sociological Review* 15, no. 2 (June): 213–32.
- Maccini, S., and Yang, D. (2006). "Under the Weather: Health, Schooling, and Socioeconomic Consequences of Early-Life Rainfall." University of Michigan, manuscript.

Meng, X. and Gregory, R. G., 2002, "The impact of interrupted education on subsequent educational attainment—a cost of the Chinese Cultural Revolution", *Economic Development and Cultural Change*, 50(4), pp.935-959.

Meng, X and Qian, N. (2006). "The Long Run Health and Economic Consequences of Famine on Survivors: Evidence from China's Great Famine." *CEPR Discussion Paper No. 5989*.

Miguel, E., and Roland, G. (2006). "The Long Run Impact of Bombing Vietnam." University of California, Berkeley manuscript.

Organski, A.F.K., and Jacek Kugler (1977) "The Costs of Major Wars: The Phoenix Factor", *American Political Science Review*, 71(4), 1347-1366.

Organski, A.F.K., and Jacek Kugler. (1980). "*The War Ledger*", Chicago: University of Chicago Press.

Richard G. Davis (2006) "Bombing the European Axis Powers: A Historical Digest of the Combined Bomber Offensive, 1939–1945", Air University Press, Alabama.

USA (1945), *The United States Strategic Bombing Survey: The Effects of Strategic Bombing on the German War Economy*, Overall Economic Effects Division, October 31, 1945.

World Bank. (2003). *Breaking the Conflict Trap: Civil War and Development Policy*. World Bank: Washington, DC.

**Figure 1.** Share of dwellings destroyed in major German cities by 1945 .



Source: Knopp (2001).

**Table 1. Summary of Allied Air Forces Area Raids**

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	<u>Area Raids</u>	<u>Other Raids</u>	<u>Total</u>	<u>Area Raids</u>
1940	1,453	12,094	13,547	11%
1941	14,475	22,631	37,106	39%
1942	39,044	11,412	50,456	77%
1943	131,668	74,520	206,188	64%
1944	324,965	876,569	1,201,534	27%
1945	96,428	384,721	481,149	20%
Total	608,033	1,281,947	1,989,980	31%

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*Source:* United Strategic Bombing Survey, The Effects of Strategic Bombing on the German War Economy (October, 1945), pp.2-5, Tables 1-4.; Diefendorf (1993)



**Table 2.Descriptive Statistics for Destruction Data**

	<u>All</u>	<u>Cities with above avg. bombing</u>	<u>Cities with below avg. bombing</u>
	(1)	(2)	(3)
<b>Panel A: District Level Data</b>			
Total Rubble in 1000 m <sup>3</sup>	17682.340 (6218.99)	2557.361 (4444.86)	1892.295 (7076.74)
Rubble in m3 per Capita	8.050 (8.640)	11.811 (9.114)	5.819 (7.549)
Rubble in m3 per km2	17682.34 (23474.76)	29515.68 (27925.97)	10660.36 (16987.62)
% Stock of Dwelling Destroyed	25.613 (24.894)	38.052 (24.496)	18.729 (22.412)
Total bombs dropped in tons	1528.993 (2932.77)	1817.464 2994.34	1020.736 2762.12
Total bombs dropped per km2	38.662 (59.942)	92.827 (77.105)	10.806 (11.055)
Area in km2 in 1939	71.410 (102.407)	66.017 (64.504)	74.338 (118.194)
Population density in 1939	1633.584 (996.52)	2162.861 (1094.65)	1346.262 (809.47)
Income per Capita in RM in 1938	489.760 (111.51)	516.346 93.64	464.004 (122.44)
% Build-up area in district	12.788 (7.834)	16.283 (8.507)	10.376 (6.343)
<b>Panel B: Regional Policy Regions ( Raumordnungsregionen, ROR) Level Data</b>			
Rubble in m3 per Capita	8.319 (8.672)	11.666 (9.132)	4.457 (6.214)
Rubble in m3 per km2	18298.150 (23660.02)	27067.970 (26036.04)	8179.129 (15423.73)
% Stock of Dwelling Destroyed	26.522 (24.863)	37.150 (23.675)	15.328 (20.971)
Total bombs dropped per km2	39.610 (60.654)	73.588 (70.976)	5.632 (5.405)
N max.	290	185	105

**Table 3. The Effect of WWII Destruction on Educational Attainment of German Households**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rubble per Cap.* Born btw.1924-1939	-0.0172 ** (0.0084)	-0.0180 ** (0.0097)	-0.0076 (0.0087)	-0.0120 (0.0088)	-0.1299 ** (0.0521)	-0.2831 *** (0.0907)	-0.0148 * (0.0089)	-0.0236 ** (0.0120)	-0.0201 ** (0.0095)
Father years of schooling			0.7885 *** (0.0397)		0.7414 *** (0.0443)				
Mother years of schooling				0.8970 *** (0.0582)		0.8118 *** (0.0623)			
Father years of schooling* Treatment					0.0131 ** (0.0056)				
Mother years of schooling* Treatment						0.0296 *** (0.0100)			
Father in war							-0.4571 *** (0.1350)		
Father died in war								-0.1566 (0.1179)	
Female*Treatment									0.0058 (0.0077)
R <sup>2</sup>	0.0708	0.0984	0.2164	0.1606	0.2182	0.1641	0.0798	0.0995	0.0709
N	5021	2526	4315	4386	4315	4386	4602	2649	5021
Only Non-Movers		Yes							

Notes: Robust standard error are reported in paranthesis. Asterisks denote significance levels (\*=.10, \*\*=.05, \*\*\*=.01). The dependent variable is the residual of the regression of years of schooling on cubic polynomial of age estimated for females and males seperately. Each column controls for region and year of birth fixed effects. Other controls in each regression are gender and rural dummies and marital status. Non-movers are defined as individuals who still reside in the city or area where they grow up.

**Table 4. The Effect of WWII Destruction on Height of German Households**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rubble per Cap.* Born btw.1930-1939	-0.0944 ** (0.0378)	-0.1214 ** (0.0535)	-0.0917 ** (0.0386)	-0.0868 ** (0.0386)	-0.2792 * (0.1717)	-0.6417 ** (0.3325)	-0.0933 ** (0.0379)	-0.0902 * (0.0496)	-0.0939 ** (0.0418)
Father years of schooling			0.6018 *** (0.1241)		0.5421 *** (0.1380)				
Mother years of schooling				0.6080 *** (0.2056)		0.4783 ** (0.2246)			
Father years of schooling* Treatment					0.0200 (0.0181)				
Mother years of schooling* Treatment						0.0609 * (0.0363)			
Father in war							-0.4703 (0.9466)		
Father died in war								-0.5263 (0.5242)	
Female*Treatment									0.0010 (0.0365)
R <sup>2</sup>	0.1720	0.2400	0.1809	0.1755	0.1814	0.1761	0.1736	0.2136	0.1733
N	2361	1162	2221	2255	2221	2250	2347	1322	2354

Only Non-Movers

Yes

Notes: Robust standard error are reported in paranthesis. Asterisks denote significance levels (\*=.10, \*\*=.05, \*\*\*=.01). The dependent variable is the residual of the regression of individuals' height on cubic polynomial of age estimated for females and males seperately. Each column controls for region and year of birth fixed effects. Other controls in each regression are gender and rural dummies and marrital status. Non-movers are defined as individuals who still reside in the city or area where they grow up.

**Table 5. The Effect of WWII Destruction on Health Satisfaction of German Households**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rubble per Cap.* Born btw.1924-1939	-0.0022 (0.0021)	-0.0025 (0.0031)	-0.0047 ** (0.0023)	-0.0048 ** (0.0023)	-0.0332 *** (0.0092)	-0.0238 ** (0.0144)	-0.0044 ** (0.0022)	-0.0061 ** (0.0028)	-0.0025 (0.0023)
Father years of schooling			0.0092 (0.0077)		-0.0065 (0.0089)				
Mother years of schooling				0.0236 ** (0.0114)		0.0139 (0.0128)			
Father years of schooling* Treatment					0.0030 *** (0.0009)				
Mother years of schooling* Treatment						0.0021 (0.0015)			
Father in war							-0.0481 (0.0498)		
Father died in war								-0.0114 (0.0277)	
Female*Treatment									0.0005 (0.0020)
R <sup>2</sup>	0.0384	0.0862	0.0419	0.0431	0.0449	0.0445	0.0428	0.0511	0.0387
N	3450	1666	2953	2995	2953	2995	3153	2188	3450
Only Non-Movers		Yes							

Notes: Robust standard error are reported in paranthesis. Asterisks denote significance levels (\*=.10, \*\*=.05, \*\*\*=.01). The dependent variable is the residual of the regression of health satisfaction on cubic polynomial of age estimated for females and males seperately. In each regrssion treatment is allowed to vary by type of residence. Each column controls for region and year of birthfixed effects. Other controls in each regression are gender and rural dummies and marrital status. Non-movers are defined as individuals who still reside in the city or area where they grow up.