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The long-term impact of war on health

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Abstract:

The toll of warfare is often assessed in the short run and in terms of mortality. Other aspects of health have received limited attention, especially after warfare ends. This paper estimates the impact of exposure to US Air Force bombing during 1965-1975 on the disability status of individuals in Vietnam in 2009. Using national census data and an instrumental variable approach, the paper finds a positive and statistically significant impact of war time bombing exposure on district level disability rates about forty years after the end of the war. A ten percent increase in bombing intensity approximately leads to a one percent increase in the prevalence of severe disability at the district level. Impacts are highest for severe disability and among persons born before 1976. Smaller yet significant positive impacts are observed among persons born after the war. Results suggest that the toll of warfare on health persists decades later.

Keywords: war, post-conflict, disability, health, Vietnam

JEL Classification: C4, H7, I1, P2.

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1. Introduction

Wars inflict death, injury and trauma. Attention is often focused on the death toll of war, especially in the short run. Wars may also have long lasting impacts on the health of survivors and of people born after war ends. These are multiple pathways through which war can impact the long term health of exposed populations.[5]

Wars destroy and reallocate resources away from health care services, disrupt vaccination and other public health programmes. As a consequence, fewer women attend antenatal clinics and give birth in inpatient facilities; fewer children attend under-five clinics and remain unprotected against communicable diseases (tuberculosis, measles, whooping cough, poliomyelitis etc.) and malaria. Displacement of communities and over-crowding compromise safe drinking-water, sanitation and hygiene. Wars reduce the availability of arable land and disrupt food production and supply chains, leading to widespread food shortages and malnutrition. Families have less economic means for their health due to war-induced disruption to education, loss of harvest and business activities, and the destruction and theft of assets. Populations live in a state of fear and experience lower levels of trust within their local community. Unexploded ordinance, landmines and chemical weapons threaten population health for generations after the cessation of conflict.

Surprisingly little evidence is currently available on the long-run effects of war on health (Justino, 2012). An emerging literature associates health in *utero* and early childhood with health and non-health outcomes in later life (Strauss and Thomas, 2008). In general, there exists limited knowledge on the dynamics of underlying factors that influence the well-being of individuals and how these relationships evolve over time (Strauss and Thomas, 2008). Using a health production function framework, it is possible that temporary shocks to health brought about through exposure to warfare may be over-come in the long-term by post-war investments in public health care and other infrastructure, and the accumulation of human capital through investment in health inputs and behaviours such as nutrient intakes, exercise, utilisation of preventative and curative care, and education (Strauss and Thomas, 2008).

There are several explanations for the lack of evidence on the long-run consequences of war on health. First, there is a lack of data. There is a lack of accurate data on warfare intensity which may be restricted in access, missing, or measured with error due to difficulties in accessing remote or damaged areas (Merrouche, 2011). There is also a lack of health data. Health data routinely collected in representative household surveys (e.g. days lost of normal activity, morbidity) may not reflect lasting or permanent health conditions or be highly subject to measurement error (Currie and Madrian, 1999).

Lost days of normal activity due to ill-health reflect time allocation decisions, that can be influenced by the wage or other work related factors (e.g. working conditions) and thus can

[5] This paragraph derives from a collection of references (Summerfield, 1988, 1987, Ugalde et al., 2000, Ugalde et al., 1999).

be influenced by many factors other than health (Stewart and Ware 1992). Morbidity is usually captured through self-reported symptoms such as nausea, fever or cough. Such symptoms sometimes may not reflect major health problems. In developing countries as Strauss and Thomas (1997) note, “it is not unusual for the poorest to appear to be the most healthy by this metric!” (p. 791). Measurement errors are thus of concern for morbidity self-reports. A similar concern applies to questions on chronic health conditions. In a developing country context, with very limited access to health care, many people may not be aware of their chronic health conditions.

This paper uses functional difficulty questions contained in the United Nations Washington City Group on Disability Statistics (the Washington Group thereafter) recommended short questionnaire. The measure collects information on the level of difficulty experienced in performing basic actions (e.g. walking, seeing, hearing) rather than the existence of a health condition or impairment (Maddens et al. 2011). The focus on measuring functioning is in contrast to medical approaches based on recording impairment or loss of various body structures, which tend to lead to underestimates of disability prevalence (Mont 2007). Designed for international comparison, the measure does not include complex activities which are influenced by cultural and socio-economic factors in the surrounding environment. For these reasons the measure is arguably less susceptible to measurement error issues associated with other lasting health measures.

Second, even when war intensity and health data are available, the impact of war on health is particularly challenging to identify. Observed heterogeneity in health outcomes may be compromised when all of the population is touched by war. There is a potential bias in estimation when the only source of variation in exposure to war is the individual age during the war, making it difficult to rule out the existence of other observed and unobserved variables which are jointly correlated with both war exposure and health. Furthermore, variation in the geographical intensity of conflict is often non-randomly distributed across geographical regions due to strategic and tactical reasons of warfare and could be correlated with spatial variation in health.

Using two unique data sets, this paper estimates the long term impact of US bombing in 1965-1975 in Vietnam. Described as the most intense aerial bombing episode in history, over six million tons of bombs and other ordinance were dropped in the Indochina region at a weight four times greater than Germany during World War II (Clodfelter, 1995, Akbulut-Yuksel, 2014). Vietnam bore the brunt of the bombing which was concentrated in a subset of regions with the highest level of bombing in the regions bordering the 17th parallel demilitarized zone, the former border between North and South Vietnam in the central region of the country. An estimated one million Vietnamese lives were lost during the wartime period (Hirschman et al., 1995). However, the long-term impacts of the war on the health of the Vietnamese population remain little documented and this paper aims to contribute to fill this gap.

The paper uses a unique US Air Force and Navy dataset containing information on the intensity of bombing and other ordinance at the district level. Our analysis extends to persons born before and after the cessation of bombing due to on-going exposure to unexploded ordinance which is a reported cause of mortality and disability among the Vietnamese population (Tran et al., 2012). To the extent that bombing is correlated with other weapons of warfare, our measure of bombing is a proxy measure for all weapons including the principal US Military herbicide Agent Orange and landmine contamination thus will pick up intergenerational effects on human health associated with those weapons (Do, 2009, Pham et al., 2013, Le and Johansson, 2001, Ngo et al., 2006, Le et al., 1990).

To measure war impacts upon health we draw upon the latest Vietnamese Population and Housing Census (2009). There are two key properties of the 2009 VPHC that allow us to measure the effect of bombs. Firstly, it is representative at the district level, and as a result it can be used to estimate the average district-level disability prevalence. Secondly, unlike previous population census, the 2009 VPHC contains an international measure of disability, known as the Washington Group Short-Set Questionnaire, which is suitable for capturing long term and chronic health conditions and less prone to measurement error than other measures of disability. The Washington Group Short-Set Questionnaire has undergone extensive cognitive and field testing in multiple languages and locations including in Vietnam (Madans et al., 2010).

US bombing in Vietnam was not random. Bombing in the northern regions aimed at destroying physical infrastructure (transportation routes, military barracks, industrial plants and storage depots) whereas in southern regions it was designed primarily to disrupt the enemy and support US troop operations with higher concentration in rural areas (Miguel and Roland, 2011, Clodfelter, 1995). To the extent that these factors are jointly correlated with the incidence of disability, estimates on the impact of wartime bombing on disability will be biased. Our identification strategy is premised on the idea that distance from the pre-war border negotiated in the 1954 Geneva Accords is indicative of the level of US wartime bombing and not correlated with disability prevalence.

Following Miguel and Roland (2011) who evaluate the long-run impact of US bombing on local poverty rates and other measures of economic development in Vietnam, we adopt an instrumental variable approach using the distance from the 17^{th} parallel demilitarized zone as an instrument to estimate the causal effects of the war upon health. Unlike the Miguel and Roland (2011) study, we find a discernible long-run impact of wartime bombing in Vietnam. More than thirty years after the cessation of the war, this paper shows a significant positive impact of wartime bombing on district level disability prevalence. Highest effects are observed for severe disability and for persons aged around 40, who were born in the years which experienced the highest density of bombing. People born after the war are also affected by the bombing, but effects are smaller for younger people.

The remainder of the article is structured as follows. Section 2 provides a review of the literature on the impact of war on human health. Section 3 provides a description of the data, compilation of key variables and descriptive statistics. Section 4 outlines the methodology and identification strategy. Section 5 presents the main empirical results. Section 6 provides a discussion of results and conclusions.

2. Literature review

Significant attention has been devoted to the causes of war (defined as both within- and inter-country conflict) (e.g. Collier and Hoeffler, 1998, 2004, Collier et al., 2009). More recently, attention has turned to the consequences of war including economic, human and social capital impacts (Justino, 2012, Miguel and Roland, 2011, Akbulut-Yuksel, 2014, Islam et al., 2015, De-Luca and Verpoorten, 2015, Collier, 1999, Merrouche, 2011, Alix-Garcia and Bartlett, 2015, Stewart and Fitzgerald, 2000). The literature on the long-term impact of war on health and wellbeing as a key determinant of human capital is heterogeneous and surprisingly small. Much of the evidence centres on nutritional status as measured by proxy anthropometric measures of height-for-age. Largely negative and long-lasting nutritional effects have been found amongst children exposed to war in Burundi, Cambodia, Cote d'Ivoire, Eritrea-Ethiopia, Germany, Iraq, Rwanda and Zimbabwe (Justino, 2012, Akbulut-Yuksel, 2014, Minoiu and Shemyakina, 2014, de-Walque, 2006). Height-for-age z-scores[6] typically range from 0.2-0.4 standard deviations lower for children exposed to war compared to the reference population (Minoiu and Shemyakina, 2014). In the context of Germany, negative health effects were further found on measures of premature mortality and self-rated health satisfaction among adults exposed to Allied Air Force bombing during childhood in World War II (Akbulut-Yuksel, 2014).

In the context of 1970's Khmer Rouge genocide in Cambodia, using descriptive methods and 2002 data, permanent disability and physical impairment was higher among men in age cohorts exposed to violence during childhood, adolescence, or young adult years through landmines, bombs and other weapons (de-Walque, 2006). This contrasts with regression-based findings on a range of health outcomes, including disability, where increased exposure to the conflict in Cambodia for primary school age children was found to have close to zero long-term effect (Islam et al., 2015).

Several papers have investigated the impact of the war in Vietnam on health using a wide range of indicators including for adults, self-reported cancer (Do, 2009), functional and mental functioning (Teerawichitchainan and Korinek, 2012), and for children, congenital impairments (Le et al., 1990), mortality (Savitz et al., 1993, Hirschman et al., 1995), infant neurodevelopment (Pham et al., 2013). Some papers deal with the impact on the overall population in Vietnam, while others focus on specific subgroups such as families who are known to have had Agent Orange exposure (Do, 2009, Le et al., 1990, Savitz et al., 1993, Pham et al., 2013, Le and Johansson, 2001, Ngo et al., 2006) and veterans (Ngo et al., 2006, Teerawichitchainan and Korinek, 2012). The literature uses different time frames: some papers compare indicators before, during and after the war (Savitz et al., 1993, Le et al., 1990), and some focus on the long term impact of the war (Teerawichitchainan and Korinek, 2012, Pham et al., 2013, Le and Johansson, 2001).

Most studies find that the war in Vietnam had a negative effect on health (Le et al., 1990,

[6] Calculated as the difference between child's height and mean height of the same-aged reference population, divided by the standard deviation of the reference population.

Pham et al., 2013, Le and Johansson, 2001, Ngo et al., 2006). The summary relative risk of congenital impairments associated with exposure to Agent Orange was found to be higher among exposed Vietnamese relative to non-Vietnamese persons, and to increase with the level of exposure (Ngo et al., 2006). Infants exposed to dioxin through breast milk during a perinatal period are found to have lower cognitive, composite motor and fine motor scores (Pham et al., 2013). Among a cohort of mothers with husbands who served during the war in areas sprayed by Agent Orange, 9% of pregnancies had miscarried and 66% of children born alive had congenital disabilities (Le and Johansson, 2001).

Not all studies offer evidence that the war negatively affected health outcomes in Vietnam. Do (2009) does not find evidence of any impact of herbicide exposure on self-reported cancer prevalence based on comparison of pre and post 1971 cohorts. Teerawichitchainan and Korinek (2012) find that veterans and those who served in combat roles are not significantly different from their civilian and non-combatant counterparts on most health outcomes later in life including measures of self-assessed functional limitations and mental health, with the exception of greater functional limitations among male veterans compared to male nonveterans.

Our paper makes several contributions to the literature on the long term impacts of wars on health. First, existing papers focus on subsamples of the Vietnam population and do not have results that are nationally representative. Second, this paper is the first to use an internationally tested measure as an indicator for health status. Existing papers do not use standardised measures consistent with contemporary definitions and measures of disability. We apply a restricted form of the current internationally recommended measure of disability, known as the Washington Group on Disability Statistics Short-Set Questionnaire. Third, this paper is the first to use an identification strategy that tries to address unobserved heterogeneity. Drawing upon national census data, a reliable health measure and an instrumental variable approach, we isolate the impact of bombings on disability prevalence at the district level about 40 years after the war.

3. Data set and Measures

This study relies on two unique data sets. The first is the density of bombs, which is measured by the total number of bombs, missiles and rockets per km^2. The data derives from a database assembled by US Defense Security Cooperation Agency[7] and contains the most detailed and accurate record of all ordinance dropped from US and allied airplanes and helicopters in Vietnam over the ten year period, 1965-1975. The data is measured at the district level (585 districts) and then matched with coordinates contained in the 1999 Vietnamese Population and Housing Census by the Vietnam Veterans of America Foundation (VVAF).[8]

[7] The database is titled 'Records of the U.S. Joint Chiefs of Staff' and is housed at the United States National Archives (Record Group 2018) (Miguel and Roland, 2011).
[8] Refer Miguel and Roland (2011) for a detailed description of the data.

To measure the disability prevalence rate at the district level, we use the 15-percent sample of the Vietnam Population and Housing Census (the 2009 VPHC), which was conducted in April 2009 by the General Statistics Office of Vietnam (GSO) with technical assistance from the United Nations Population Fund. The 2009 VPHC has two advantages. Firstly, it is representative at the district level. There are 3,692,042 households with 14,177,590 individuals, randomly sampled in the data set. Secondly, in addition to basic data on demographics, education, and housing conditions, the 2009 VPHC contains data on disability of people aged 5 and above. Respondents were asked about their difficulties in four basic functional domains: seeing, hearing, walking, and remembering. The 2009 VPHC included four of the six functional difficulty questions that are part of the United Nations Washington City Group on Disability Statistics (the Washington Group thereafter) recommended short questionnaire (Maddens et al 2011).[9] These constitute the shortest set of questions recommended by the United Nation Statistical Commission's Washington Group on Disability Statistics.[10] There are four possible response categories: (i) no difficulty, (ii) some difficulty, (iii) a lot of difficulty and (iv) cannot do at all.

Using the individual data on disability, we computed the percentage of people with limitation in different domains for all the districts. An individual is defined as one with disability if she/he has at least some difficulty in one of the four functional domains. In this paper, we refer this level of disability as a moderate or severe disability.

Table 1 presents the average percentage of people aged above five with difficulties in the four functional domains at the district level. It shows that the average rate of having difficulty in seeing and difficulty in hearing at the district level is 5.1 and 3.2 percent, respectively. The average rate of having difficulty in walking and difficulty in remembering at the district level is 3.8 and 3.6 percent, respectively. The percentage of people experiencing difficulty in at least a functional domain is around 6 percent. Table 1 also shows that districts in the highest quintile of bomb density tend to have higher rates of disability than districts in other quintiles.

[Table 1]

Table 1 also presents the district-level rate of people with a severe disability. An individual is defined as one with a severe disability if she/he has at least 'a lot of difficulty' in one of the four functional domains. More specifically, if she/he reported either 'A lot of difficulty' or 'Cannot do at all' when asked about the difficulty in different functional domain. Districts with higher level of bomb density tend to have slightly higher rate of a severe disability than district with lower level of bomb density.

Figure 1 graphs the log of the bomb density (measured by the number of total bombs,

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[9] The short set of six questions is as follows: 1. Do you have difficulty seeing, even if wearing glasses? 2. Do you have difficulty hearing, even if using a hearing aid? 3. Do you have difficulty walking or climbing steps? 4. Do you have difficulty remembering or concentrating? 5. Do you have difficulty with self-care (such as washing all over or dressing)? 6. Do you have difficulty communicating?

[10] See http://www.cdc.gov/nchs/washington_group.htm

missiles and rockets per km^2) and the log of the disability rate of districts (measured by the percentage of people with difficulty in at least a functional domain). The correlation between bomb density and a severe disability is positive, while the correlation between bomb density and moderate or severe disability is negligible.

[Figure 1]

[Table 2]

[Figure 2]

4. Methodology

We start with simple ordinary least squares (OLS) regression to estimate the effect of bomb density on disability prevalence. We assume that disability is a reduced-function of the density of bombs and other control variables as follows

$$Log(Disability_i) = \alpha + Log(bomb_i)\beta + X_i\theta + u_i \qquad (1)$$

where $Log(Disability_i)$ is the log of the rate of disability prevalence in district *i*. $Log(bomb_i)$ is the log of bomb density of district *i* which is measured by the total number of all types of bombs, missiles, and rockets per km^2 dropped in the district. X_i is the vector of exogenous control variables, and u_i denotes unobserved variables.

Most areas of Vietnam were affected by bombs, missiles and rockets except the Northern mountainous areas. However, there is a great variation in the bomb density across geographic areas. Since the U.S. bombing was not random, it can be correlated with omitted variables u_i, and as a result OLS estimators can be biased. A standard econometric method to correct this bias is through an instrumental variable approach. An instrument is required to be highly correlated with the bomb variable but not the error terms u_i. In this study, we follow the approach of Miguel and Roland (2011) who use the distance from the centroid of each district to the 17th parallel north latitude as the instrument of the density bomb in that district. The 17th parallel north latitude was set by the 1954 Geneva Accords as the border between the former northern and southern Vietnamese governments. Since this was a border, it was heavily bombed and targeted by different types of weapons. So the first-stage is expressed as follows:

$$Log(bomb_i) = \alpha + Log(Distance\_17lat_i)\beta + X_i\theta + \varepsilon_i \qquad (2)$$

where $Log(Distance\_17lat_i)$ is the log of the distance from the centroid of district *i* to the 17th parallel north latitude. It is important to note that the determination of the 17th parallel was arbitrary and the product of negotiations between the United States and Soviet Union in the context of the Cold War (Miguel and Roland, 2011). To the extent that the border was determined by factors external to Vietnam (rather than local geographical or socioeconomic factors which may be jointly correlated with disability status) and is correlated with the intensity of bombing, proximity to the former north south border can be viewed as a natural experiment with which to estimate the impact of bombing on disability prevalence.

Distance to the former north-south Vietnam border arguably represents a more exogenous source of variation than an alternate instrument in the South Vietnam-Cambodian border around which the second main concentration of bombing took place along the Ho Chi Minh trail. The entry points of the trail into South Vietnam reflected geographical conditions along the border to facilitate troop movements with the main southern point being less mountainous terrain (Miguel and Roland, 2011). It is conceivable that differences in geographical terrain along the border and, in turn, the intensity of bombing is also correlated with access to health and other services and local socio-economic conditions which may jointly affect disability status.

A concern with our instrument is that the 17th latitude is closer to Da Nang city and between the capital Hanoi and Ho Chi Minh city, which are the largest three cities in Vietnam. Distance from districts to these cities can be correlated with our instrument and affect the outcome variables through access to quality health care and rehabilitation services, for example. Thus we control for the shortest distance from a district to the three cities in the regression model. Other control variables include those that are not affected by the treatment variable of bomb density i.e. district area and elevation, the share of urban population, district capital and Northern region dummy (Heckman et al., 1999, Angrist and Pischke, 2008).

5. Results

We start with OLS regressions of disability on bombing intensity. In all models, the coefficient of the bomb variable is positive and significant (Tables 3, 4, and A.1 in Appendix). As expected, the coefficients are larger for severe disability compared to overall (moderate or severe) disability. For instance, a ten percent increase in bombing density leads to a 0.30 percent increase in severe disability prevalence and a 0.15 percent increase in overall disability prevalence.

Since the OLS estimator can be potentially biased, we mainly rely on the IV regression. The first stage regression shows a strong correlation between the instrument and the bomb density (Table A.2 in Appendix). Districts, which are far from the 17^{th} latitude, are less likely to receive bombs, missiles, and rockets. In addition, we also test the instrument. The Cragg-Donald Wald F statistic and Kleibergen-Paap Wald F statistic are equal to 226 and 101 respectively, which are high, indicating that the instrument is strong (Cragg and Donald, 1993, Staiger and Stock, 1997, Kleibergen and Paap, 2006).[11]

Table 5 shows a significant effect of bomb density on disability prevalence. If the number of bombs, missiles, and rockets per km^2 increases by ten percent, the proportions of people having difficulty in seeing, in hearing, in walking and in remembering increase by 0.44, 0.47, 0.48, and 0.76, respectively. A ten percent increase in the number of bombs, missiles, and rockets per km^2 leads to a 0.57 percent increase in the proportion of people with some difficulty in any functional domain.

[Table 4]

Table 6 presents the impact of the bomb density on the prevalence of severe disability. A ten percent increase in the number of bombs, missiles, and rockets per km^2 leads to a 0.87 percent increase in the proportion of people with severe difficulty in at least a functional domain. It shows again a higher impact of bombing on severe disability than overall disability.

Bombing primarily occurred during the war time 1964-1975. To examine whether the

[11] As a rule of thumb, if a test is under 10, the instruments might be weak (Staiger and Stock, 1997).

impact of bombing varies across age cohorts, we computed the district-level percentage of people with disability and ran regressions of the log of the disability rate on the bomb density at different age cohorts. Since the number of people in each age cohort above 75 is small, we group people above 75 years old into one group. Figure 3 presents the estimated effect of log of bomb density on log of the proportion of people with disability across different ages. There are several points that should be noted. There is an obvious invert-U shape relation between the impact of bombing on disability and age. The highest effect happens for people aged around 40, the very group born in years, which experienced the highest density of bombing and war. However, the impact of bombing on disability continues for a long period of time. People born after the war are still impacted by the bombing, although this impact tends to be smaller for younger people.

[Figure 3]

Robustness Checks

In the last column of Table 6, as a robustness check, we use another measure of disability that accounts more fully for the variation in the severity of functional limitations that people may experience. We construct a continuous measure of disability in the form of an aggregate score. For each individual, we sum up the answers to the four functional limitation questions and denote it S_i, and we normalize as follows: $(S_i - MinS)/(MaxS - MinS)$, where MinS and MaxS are the potential minimum and maximum values of S_i. Since the answers for each domain go from 1 to 4 and there are four domains, MinS and MaxS are equal to 4 and 16, respectively. After computing the score for each individual, we estimate the mean score at the district level. Results in the last column of Table 5 show that a ten percent increase in the number of bombs, missiles, and rockets per km^2 results in a 0.61 percent increase in the disability score.

[Tables 5 & 6]

We include interactions between the bombing variable and other control variables to examine whether the impact of bombs differ for, perhaps is concentrated in, districts with specific characteristics. However, these interaction terms are not significant (Table A.3 in Appendix).

Our measure of disability contains four of the six recommended Washington Group Short-Set Questionnaire functional domains. We test the robustness of this restricted census measure against the complete measure contained in the Vietnam Household Living Standard Survey (VHLSS) 2006. We find comparable positive and significant effects of bombing on the severe disability and the continuous disability score measures. In addition, we tested the association of wartime bombing with several morbidity measures contained in the VHLSS and found no statistically significant effects consistent with findings from post-war Germany (Akbulut-Yuksel, 2014), reinforcing our finding of disability as a long-term product of warfare.[12]

[12] VHLSS 2006 results are available from the authors upon request.

6. Discussion

Overall, our results contribute to the emerging literature on the impacts of war on health status, focused here on long-term effects and measured for the first time using an internationally tested and comparable measure of disability. As expected, we find a relatively larger effect among persons with a severe disability compared to any degree of disability and among persons alive during the time of bombing, now older members of the Vietnamese population. Effects decline with age for cohorts born before the war which may reflect excess mortality in these age groups compared to younger ones. We also find significant, albeit smaller, disability effects among persons born after the cessation of bombing. For the younger age cohorts, effects may be explained by the war's disruption of public health programs, destruction of infrastructure and ensuing economic hardship. They could also result from injuries obtained through unexploded bombing ordnance and disabling effects associated with the exposure to sprayed chemical and landmine weapons that were correlated with the level of bombing. Whilst we are unable to formally test bombing correlation with other weapons, high levels of Agent Orange and other defoliant spraying and US troop movements was observed in the central province regions surrounding the 17th parallel demilitarized zone and in southern regions where the Ho Chi Minh trail entered South Vietnam, consistent with bombing patterns (Stellman et al., 2003, Miguel and Roland, 2011).[13]

Our results are consistent with several studies in Vietnam which find an association between war exposure and a range of health outcomes among people born before and after the end of the war (Le et al., 1990, Pham et al., 2013, Le and Johansson, 2001, Ngo et al., 2006). In particular, Teerawichitchainan and Korinek (2012) find four-times higher levels of functional limitations among male veterans compared to male non-veterans in northern communes decades after service. As Teerawichitchainan and Korinek (2012) explain, war-induced health effects across the Vietnamese population are likely to be pervasive. Unlike these other studies, our results are nationally representative and address heterogeneity biases to establish a causal link between war and disability.

Our findings stand in contrast to those of Miguel and Roland (2011) who find no long-term impact of US bombing at the district level on poverty and economic development outcomes (consumption per capita, literacy, electricity infrastructure and population density). Miguel and Roland (2011) draw explanation for their main result of no effect on poverty from neoclassical growth theory which states that temporary economic shocks induced by war will be smoothed by a period of post-war capital accumulation until steady-state economic growth rates are achieved and no long-run effects on the economy are observed. They show empirically that levels of post-war state investment in Vietnam were higher in provinces that were more heavily bombed. Miguel and Roland (2011) do not present any result on disability but they do mention that they find a positive, albeit not significant, effect on disability using 2002 data. Using more recent and improved questions on disability, we do

[13] Furthermore, more than 95% of all herbicides were dispensed by the US Airforce which suggests some degree of correlation with bombing (Stellman et al. 2003).

find a significant positive effect of bombing on disability in 2009.

Whilst at the population level the economic impacts of war on poverty and development may have disappeared over time in Vietnam, our results suggest an indirect pathway to economic ramifications of warfare through disability. In Vietnam, and elsewhere, there exists a close relationship between disability and poverty (Mont and Nguyen, 2011, Palmer et al., 2015, World Health Organization and World Bank, 2011).[14] Our results suggest that postwar economic recovery patterns may be different from human capital patterns measured through disability prevalence, which is consistent with findings from post-war Germany (Akbulut-Yuksel, 2014). We offer several explanations from the literatures in Vietnam.

Prominent among these is that the public health care system in Vietnam deteriorated in the 1980's due to economic difficulties in the post-reunification period (Segall et al., 2002). Whilst the network of community health stations was extensive, resources were not made available in a timely fashion to meet health worker salaries and the provision of drugs (Ensor and San, 1996). The resulting impact on the quality of services led to a series of health care reforms as part of a wider economic reform package known as *Doi Moi* in the late 1980's. The introduction of user fees at public health facilities led to a decline in the use of formal health care and delays in treatment among the poor and rural population (Ensor and San, 1996). In this background, and mindful of the fact that the majority of bombing was in rural areas, health conditions acquired as a consequence of the war may have deteriorated into functional difficulties or their difficulties increased in degree. Disability specific health care services including rehabilitation and the supply of assistive devices were likely to have been in very minimal supply in the post-war period. Even in the present day in Vietnam, there exist large shortages in the supply of rehabilitation services and assistive devices which affect levels of functioning and recorded rates of disability in the country (Palmer et al., 2015).

Historically, Vietnam has offered benefits to veterans with disabilities and their families who contributed to the reunification efforts. While in recent times the country has made strides in the legal recognition and entitlements for all persons with disabilities (Palmer et al., 2015), there still remains significant attitudinal and environmental barriers which impede the equalisation of opportunities and accumulation of human capital among the Vietnamese disabled population (Palmer et al., 2015). Access to education, as an important input to the production of health, remains a difficulty for many persons with disabilities in

[14] First, there are foregone earnings (Haveman and Wolfe, 2000). People with disabilities are less likely to be in the work force, and when working they often receive lower wages, in part because of the barriers they face in receiving an education (World Health Organization and World Bank, 2011). The gap between what they earn and what they would be expected to earn if they were not disabled, summed over all the people with disabilities, is a measure of the loss in GDP caused by disability. An ILO study in 2009 estimates this loss is between 1 and 7 percent of GDP (Buckup, 2009). Second, are the direct costs to families that can include disability specific items, such as assistive devices, but also regular items purchased in additional amounts because of a person's disability, such as medical services (Tibble, 2005). In Vietnam, these have been estimated to impose an additional cost of over 11% of income (Mont and Nguyen, 2011).

modern day Vietnam. There exist multiple barriers to education that result in relatively low levels of education attainment among the disabled population in Vietnam (Ngo et al., 2013, Mont and Nguyen, 2011, Vu et al., 2014, Le and Johansson, 2001). In a study of children with fathers who served during the war in areas sprayed by Agent Orange, two-thirds of children with disabilities had not attended school (Le and Johansson, 2001). Furthermore, persons with disabilities in Vietnam, and elsewhere, require additional resources to achieve an equivalent standard of living as a person without disabilities due to the direct costs associated with disability which impacts upon their socio-economic status and, in turn, health production (Mont and Nguyen, 2011, Palmer et al., 2015).

Our results focus on survivors 40 years after the conflict and persons born after the conflict. We do not capture the total effect of the war on health in general, nor disability in particular. Millions of people have died during the war or after. Some may have died after living with a disability. We thus offer a partial and long term estimate of the effect of war on health for the entire population of Vietnam, which is new in the literature. Overall, the magnitude of the effects of the bombing on long term health of the Vietnamese population is small though statistically significant. The finding is surprising as the effect of the war on health four decades later might have been confounded by any number of factors relating to institutional, social and policy differences across regions as well as armed conflicts with Cambodian and Chinese forces after 1975.

Our findings are subject to several limitations. We note that the Washington Group Short-Set questionnaire adopted in this study is not suitable to capture the range of mental health conditions commonly associated with warfare exposure, such as depression, anxiety and post-traumatic stress disorder (Do and Iyer, 2012). Arguably, mental health conditions are an important aspect of health that may be affected by war in the long term and are nor measured in available census and survey data.

We employ an instrumental variable approach which address selection effects. The approach also corrects for measurement error associated with the bombing variable.[15] Our results, however, must be viewed with caution. While many authors before us have relied upon geographical factors as instruments, such instruments are criticized as not strictly exogenous in that they are derived external to a structural model (Deaton, 2009). An instrument that is not strictly exogenous will not yield consistent estimates. Our results remain subject to bias associated with unobserved factors that may be correlated with the instrument and the outcome variable. One possible concern, which we have noted, relates to correlation of the instrument with distance to major metropolitan hubs in Vietnam. To the extent that distance from major cities is correlated with poor economic and health status, there exists a negative correlation with our instrument and poverty and health status thus positively biasing our results. We control for distance to the three main economic centres in Vietnam to mitigate this potential bias and note further that no significant relationship between bombing and long-term poverty has been found using the same IV specification which suggests that that the potential bias associated with remoteness and low-income is

[15] Up to several months of bombing data is missing and there exists potential errors in entry in mission logs by aircraft personnel (Miguel and Roland, 2011).

non-founded (Miguel and Roland, 2011).

Another potential threat to the exclusion restriction relates to public investments during and after the war. Since the areas around the north-south border were subject to intense war activity it is reasonable to presume that state investments were relatively low. While we can not test this directly and assume that significant proportion of state funds went towards fuelling the war efforts, state funded school expansion and literacy campaigns are reported to have continued throughout the war years particularly in northern regions of the country (Ngo, 2006). In the post-war period, state investments which constituted the main form of investment due to global economic isolation were positively correlated with bombing intensity. Using provincial level data for years 1981-85, Miguel and Roland (2011) report that heavily bombed regions received 30% more state investment in per capita terms relative to other regions. They also find long-term increases in electricity infrastructure using the same IV specification which further supports the hypothesis of state rebuilding efforts in heavily bombed regions in the post war period.

The net effect of state investments in heavily bombed regions during and after the war years is surmised to have a downward or neutral bias on our estimates on war-induced disability. Indicators of district level infrastructure, such as quality roads and the number of doctors, are found to lessen the link between disability and poverty in Vietnam (Mont and Nguyen, 2013). Since poverty is an important determinant of health capital it is anticipated that state investment is negatively correlated with disability status (Grossman, 1972). This negative bias in the post war years is potentially offset by relatively low investments in education programs and the accumulation of human capital during the war years. Unfortunately, postwar investment data is not disaggregated so it is not possible to examine the relationship between postwar public health investment and bombing intensity. Whilst not a priority sector it seems reasonable that state level funding in the public health sector after the war mirrored that of overall state investment with relatively higher allocation in heavily bombed regions, biasing our results further downward.

A final and noteworthy threat to the robustness of our results relates to migration. Large numbers of the Vietnamese population were displaced during the war period and widespread migration occurred in the period following the war. Migration in the active or post conflict period can lead to systematic differences in the composition of survey samples. It is unclear how migration may be nonrandom across disability status. Intuitively, persons with physical or other disabilities may be less likely to migrate in the post-war period due to mobility difficulties and care-giving support needs. At the same time, persons with disabilities may migrate to seek better health care or to follow migrating caregivers. Unfortunately, there exists no reliable record of migration during or in the immediate post-war period. However, using national living standards data in 1997-98, Miguel and Roland (2011) find that bombing does not have a consistent effect on the proportion of people not born in their current village of residence. The interpretation is that most households displaced by the war returned to their home areas shortly after the war. Whilst we cannot rule out selective migration on the basis of disability status in heavily bombed regions, these findings suggest that any potential bias is small.

7. Conclusions

This is the first study to measure the long-run impacts of exposure to war on health at the population level using a contemporary internationally validated measure of disability. The findings from this study carry important implications for other war affected countries. The findings underpin the importance of efforts to promoting health equity in conflict-affected fragile states so as to ensure adequate service provisions and financial protections from the costs of care for vulnerable population groups (Ranson et al., 2007, Newbrander et al., 2011). Specifically, the findings support calls to develop disability services and increase capacity to address the health needs of people with disabilities in conflict-affected countries with respect to rehabilitation, assistive devices, and mental health services (Kett and Ommeren, 2009).

More broadly, improved opportunities for education and secure livelihoods will help to ensure the full and effective participation of persons with disabilities in society. In line with the international Convention on the Rights of Persons with Disabilities, there is scope for international cooperation to support national efforts to protect the rights of persons with disabilities as countries emerge out of violent conflict. Assistance for the health and social protections for persons with disabilities and other vulnerable population groups in conflict-affected fragile states is recommended (Newbrander et al., 2011, Kett and Ommeren, 2009, Stewart and Fitzgerald, 2000).

The toll of warfare is often assessed only in terms of the number of people killed; however, the long-term consequences of warfare on disability is significant and, as this study suggests, deserves closer attention by researchers and policymakers alike.

Tables

Table 1: District-level disability prevalence

	Districts by quintiles of the number of bombs, missiles, and rockets					Total
	Lowest quintile	Near lowest quintile	Middle quintile	Near highest quintile	Highest quintile	
Disability prevalence by functioning domain						
Seeing	5.27	5.00	4.83	4.96	5.61	5.13
Hearing	3.50	3.09	3.09	3.04	3.47	3.24
Walking	3.94	3.60	3.63	3.55	4.09	3.76
Remembering	3.70	3.47	3.53	3.50	3.95	3.63
Any domain	6.31	5.76	5.85	5.72	6.53	6.03
Severe disability prevalence by functioning domain						
Seeing	0.65	0.59	0.61	0.63	0.72	0.64
Hearing	0.66	0.60	0.62	0.61	0.70	0.64
Walking	0.90	0.85	0.88	0.89	1.03	0.91
Remembering	0.79	0.78	0.81	0.81	0.94	0.83
Any domain	1.47	1.40	1.45	1.45	1.67	1.49

Table 2: The district-level prevalence rate of disability for people born before and since 1976

	Districts by quintiles of the number of bombs, missiles, and rockets					Total
	Lowest quintile	Near lowest quintile	Middle quintile	Near highest quintile	Highest quintile	
People born before 1976						
Disability in any domain	12.59	11.11	11.53	11.36	12.47	11.81
Severe disability in any domain	2.71	2.44	2.57	2.58	2.88	2.63
People born since 1976						
Disability in any domain	1.55	1.33	1.45	1.39	1.51	1.44
Severe disability in any domain	0.53	0.53	0.57	0.56	0.64	0.57

Table 3: OLS regression of disability prevalence rates

Explanatory variables	Seeing	Hearing	Walking	Remembering	Any domain
Log of bombs, missiles, rockets per km2	0.0158*	0.0115*	0.0125*	0.0219***	0.0146**
	(0.0086)	(0.0063)	(0.0066)	(0.0070)	(0.0058)
Log of area of district	-0.0282	-0.0671***	-0.0364	-0.0446*	-0.0336
	(0.0311)	(0.0248)	(0.0262)	(0.0261)	(0.0226)
Log of mean elevation	-0.0177	0.0036	-0.0261***	-0.0105	-0.0080
	(0.0114)	(0.0097)	(0.0094)	(0.0101)	(0.0086)
Northern (yes=1, no=0)	0.2132***	0.3906***	0.3397***	0.3375***	0.3120***
	(0.0385)	(0.0331)	(0.0317)	(0.0349)	(0.0292)
Capital district of province (yes=1, no=0)	-0.0537	0.0140	0.0251	0.0490	0.0377
	(0.0763)	(0.0515)	(0.0525)	(0.0541)	(0.0466)
Log of distance to closest cities: Hanoi, Da Nang, or HCMC	0.0574**	0.0633***	0.0619***	0.0487**	0.0486***
	(0.0250)	(0.0190)	(0.0206)	(0.0195)	(0.0172)
Share of urban population	-0.3116***	-0.5928***	-0.4464***	-0.5437***	-0.4694***
	(0.1178)	(0.0866)	(0.0797)	(0.0855)	(0.0748)
Constant	1.4334***	1.0651***	1.1531***	1.1672***	1.6342***
	(0.1595)	(0.1413)	(0.1390)	(0.1400)	(0.1233)
Observations	612	612	612	612	612
R-squared	0.118	0.401	0.300	0.304	0.337

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: OLS regression of severe disability prevalence rates

Explanatory variables	Seeing	Hearing	Walking	Remembering	Any domain	Mean score
Log of bombs, missiles, rockets	0.0304***	0.0255***	0.0286***	0.0391***	0.0297***	0.0185***
per km2	(0.0089)	(0.0074)	(0.0075)	(0.0073)	(0.0065)	(0.0069)
Log of area of district	-0.0343	-0.0532*	-0.0402	-0.0585**	-0.0444*	-0.0424
	(0.0345)	(0.0291)	(0.0295)	(0.0291)	(0.0263)	(0.0259)
Log of mean elevation	-0.0131	0.0029	-0.0278***	-0.0110	-0.0101	-0.0141
	(0.0126)	(0.0112)	(0.0107)	(0.0111)	(0.0099)	(0.0096)
Northern (yes=1, no=0)	0.3609***	0.4376***	0.3625***	0.4085***	0.3609***	0.3174***
	(0.0419)	(0.0378)	(0.0353)	(0.0365)	(0.0332)	(0.0326)
Capital district of province	-0.0904	-0.0210	0.0141	0.0227	0.0335	-0.0016
(yes=1, no=0)	(0.0781)	(0.0622)	(0.0594)	(0.0593)	(0.0544)	(0.0559)
Log of distance to closest cities:	0.0572**	0.0495**	0.0477**	0.0308	0.0389*	0.0551***
Hanoi, Da Nang, HCMC	(0.0268)	(0.0232)	(0.0231)	(0.0211)	(0.0199)	(0.0201)
Share of urban population	-0.4370***	-0.5549***	-0.3896***	-0.4950***	-0.4513***	-0.4406***
	(0.1199)	(0.0971)	(0.0887)	(0.0887)	(0.0807)	(0.0888)
Constant	-0.7340***	-0.6565***	-0.2448	-0.2485	0.2733*	0.3395**
	(0.1836)	(0.1588)	(0.1541)	(0.1531)	(0.1418)	(0.1386)
Observations	612	612	612	612	612	612
R-squared	0.218	0.347	0.249	0.316	0.312	0.273

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: IV regression of disability prevalence rates

Explanatory variables	Seeing	Hearing	Walking	Remembering	Any domain
Log of bombs, missiles, rockets per km^2	0.0438***	0.0470***	0.0481***	0.0756***	0.0567***
	(0.0131)	(0.0102)	(0.0103)	(0.0119)	(0.0094)
Log of area of district	-0.0281	-0.0670***	-0.0362	-0.0443	-0.0334
	(0.0309)	(0.0252)	(0.0267)	(0.0274)	(0.0235)
Log of mean elevation	-0.0114	0.0116	-0.0181*	0.0014	0.0014
	(0.0116)	(0.0099)	(0.0095)	(0.0106)	(0.0089)
Northern (yes=1, no=0)	0.2281***	0.4095***	0.3586***	0.3660***	0.3343***
	(0.0385)	(0.0334)	(0.0325)	(0.0360)	(0.0300)
Capital district of province	-0.0597	0.0065	0.0176	0.0376	0.0288
(yes=1, no=0)	(0.0774)	(0.0546)	(0.0560)	(0.0600)	(0.0514)
Log of distance to closet	0.0538**	0.0587***	0.0573***	0.0417**	0.0432**
cities: Hanoi, Da Nang, or HCMC	(0.0245)	(0.0192)	(0.0208)	(0.0205)	(0.0178)
Share of urban population	-0.3241***	-0.6087***	-0.4623***	-0.5677***	-0.4883***
	(0.1166)	(0.0873)	(0.0808)	(0.0886)	(0.0771)
Constant	1.3684***	0.9827***	1.0706***	1.0427***	1.5365***
	(0.1625)	(0.1479)	(0.1459)	(0.1507)	(0.1318)
Observations	612	612	612	612	612
R-squared	0.099	0.367	0.261	0.224	0.272

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: IV regression of severe disability prevalence rates

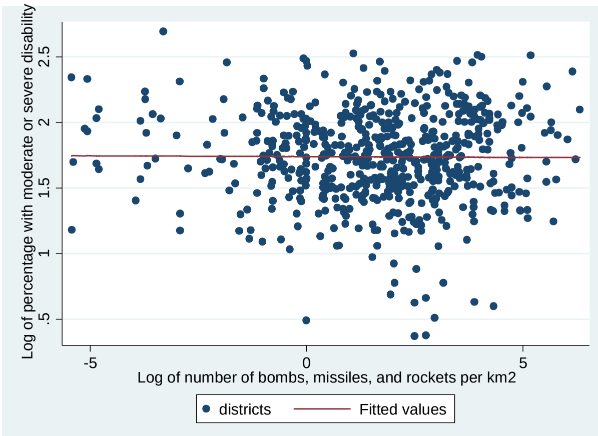
Explanatory variables	Seeing	Hearing	Walking	Remember-ing	Any domain	Mean score
Log of bombs, missiles,	0.0858***	0.0782***	0.0777***	0.1008***	0.0870***	0.0606***
rockets per km2	(0.0141)	(0.0120)	(0.0128)	(0.0118)	(0.0108)	(0.0104)
Log of area of district	-0.0340	-0.0529*	-0.0400	-0.0581*	-0.0442	-0.0422
	(0.0348)	(0.0300)	(0.0304)	(0.0306)	(0.0278)	(0.0265)
Log of mean elevation	-0.0008	0.0146	-0.0169	0.0028	0.0027	-0.0047
	(0.0129)	(0.0115)	(0.0112)	(0.0114)	(0.0103)	(0.0098)
Northern (yes=1, no=0)	0.3902***	0.4655***	0.3885***	0.4412***	0.3913***	0.3397***
	(0.0429)	(0.0392)	(0.0367)	(0.0385)	(0.0352)	(0.0333)
Capital district of province	-0.1021	-0.0321	0.0037	0.0097	0.0214	-0.0105
(yes=1, no=0)	(0.0835)	(0.0677)	(0.0654)	(0.0673)	(0.0624)	(0.0599)
Log of distance to closest	0.0500*	0.0427*	0.0414*	0.0228	0.0315	0.0496**
cities: Hanoi, Da Nang, HCMC	(0.0270)	(0.0236)	(0.0235)	(0.0221)	(0.0208)	(0.0202)
Share of urban population	-0.4618***	-0.5784***	-0.4115***	-0.5226***	-0.4769***	-0.4595***
	(0.1217)	(0.1002)	(0.0922)	(0.0936)	(0.0855)	(0.0898)
Constant	-0.8623***	-0.7785***	-0.3586**	-0.3915**	0.1405	0.2419*
	(0.1902)	(0.1695)	(0.1630)	(0.1662)	(0.1545)	(0.1462)
Observations	612	612	612	612	612	612
R-squared	0.161	0.288	0.187	0.223	0.212	0.218

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figures

Figure 1: log of the bomb density and log of the percentage of disability

Correlation between bomb density and disability rate



Correlation between bomb density and severe disability rate

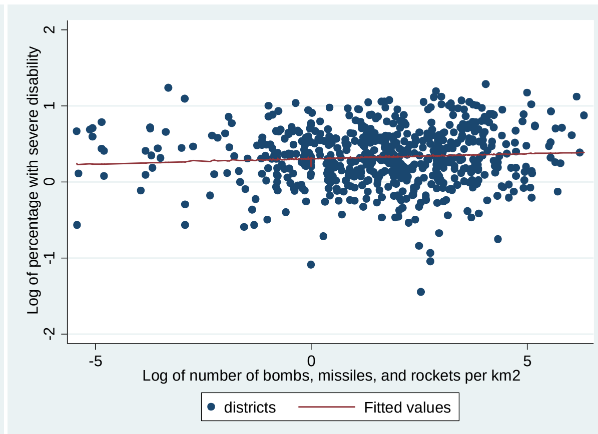


Figure 2: Bomb density and disability rate at the district level

Number of bombs, missiles and rocket per km2 | Percentage of people with disability in any domain | Percentage of people with severe disability in any domain

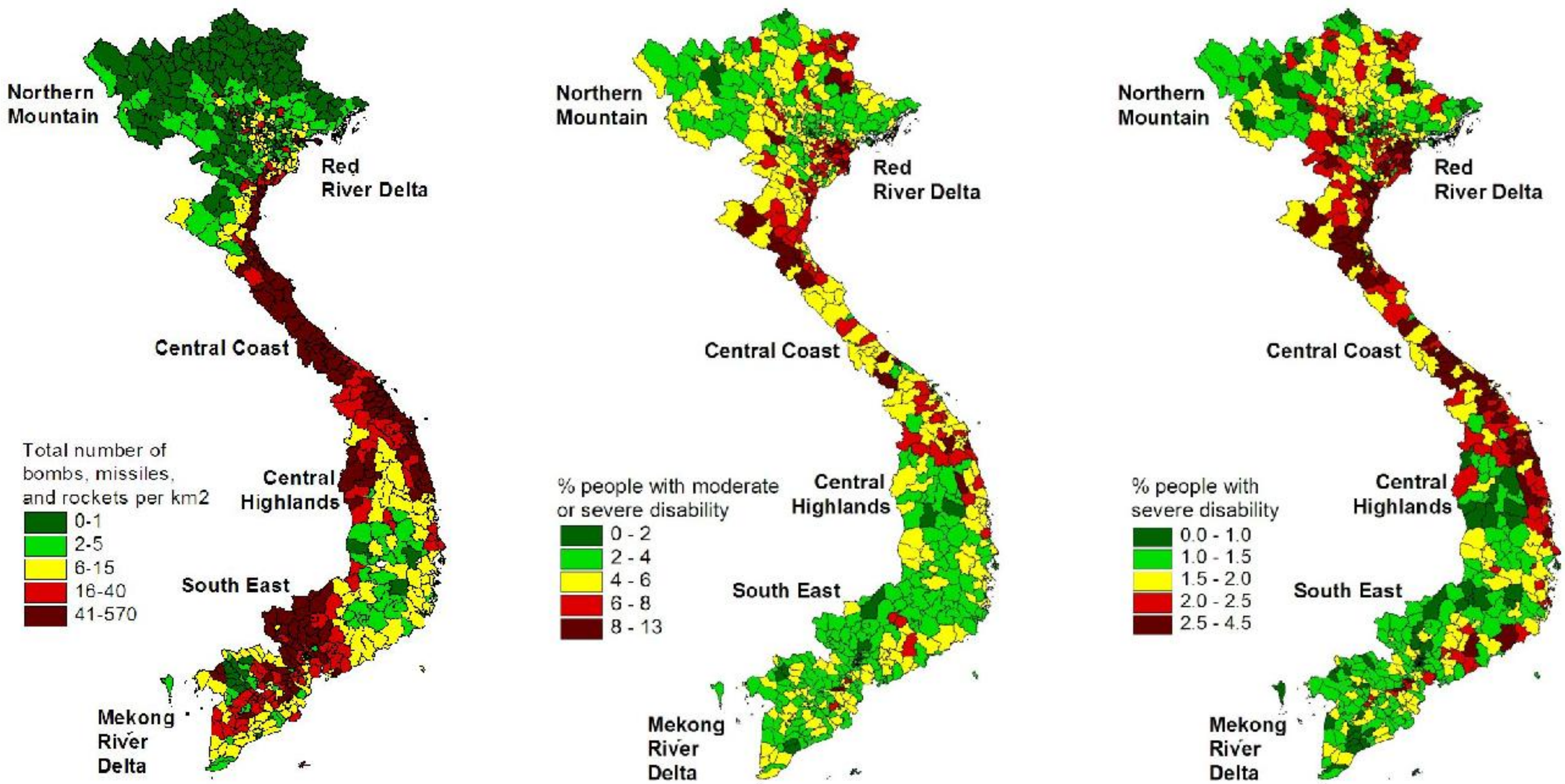
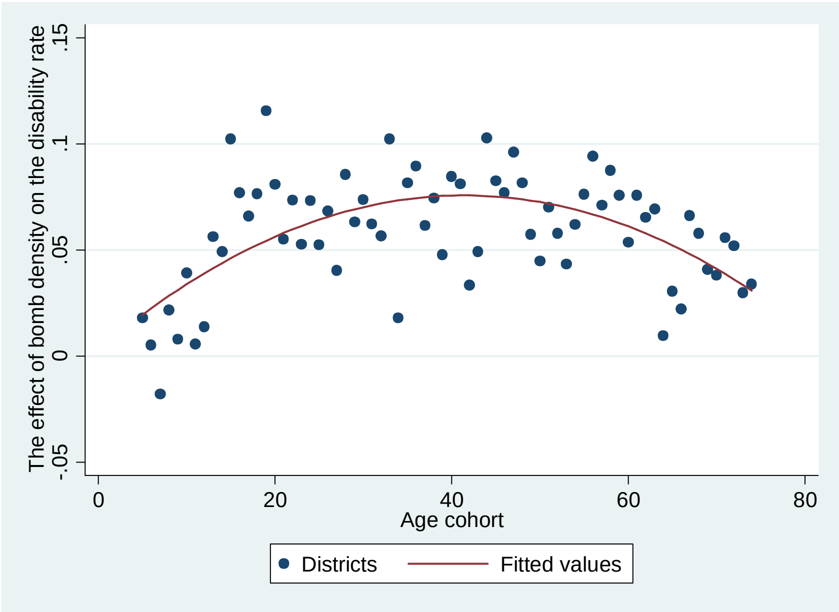


Figure 3: The estimated effect of log of bomb density on log of the proportion of people with disability



Appendix Table A.1: OLS regression of disability rates for people born before and since 1976

Explanatory variables	People born before 1976		People born since 1976	
	Disability in any domain	Severe disability in any domain	Disability in any domain	Severe disability in any domain
Log of bombs, missiles, rockets per km^2	0.0102*	0.0232***	0.0198***	0.0425***
	(0.0054)	(0.0066)	(0.0056)	(0.0056)
Log of area of district	-0.0007	-0.0114	0.0268	-0.0236
	(0.0208)	(0.0266)	(0.0252)	(0.0222)
Log of mean elevation	0.0082	0.0036	0.0387***	0.0121
	(0.0081)	(0.0100)	(0.0090)	(0.0089)
Northern (yes=1, no=0)	0.2411***	0.3224***	0.2863***	0.2786***
	(0.0274)	(0.0331)	(0.0304)	(0.0311)
Capital district of province (yes=1, no=0)	0.0039	0.0051	0.0039	0.0171
	(0.0465)	(0.0577)	(0.0497)	(0.0517)
Log of distance to closest cities: Hanoi, Da Nang, HCMC	0.0452***	0.0292	0.0484**	0.0616***
	(0.0164)	(0.0203)	(0.0192)	(0.0170)
Share of urban population	-0.3928***	-0.3811***	-0.4395***	-0.4396***
	(0.0696)	(0.0810)	(0.0743)	(0.0751)
Constant	2.1174***	0.6716***	-0.3251***	-0.9555***
	(0.1059)	(0.1355)	(0.1223)	(0.1236)
Observations	612	612	612	612
R-squared	0.336	0.278	0.459	0.361

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A.2. First-stage regression of the bomb density

Explanatory variables	Log of bombs, missiles, and rockets per km^2
Log of distance to the 17th latitude	-1.4011***
	(0.1396)
Log of area of district	-0.0697
	(0.1400)
Log of mean elevation	-0.3825***
	(0.0478)
Northern (yes=1, no=0)	-0.5560***
	(0.1600)
Capital district of province (yes=1, no=0)	0.2063
	(0.3395)
Log of distance to closest cities: Hanoi, Da Nang, HCMC	0.1840*
	(0.1044)
Share of urban population	0.1850
	(0.4494)
Constant	5.0371***
	(0.7457)
Observations	612
R-squared	0.334

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A.3. IV regressions with interactions

Explanatory variables	Disability in any domain	Severe disability in any domain	Disability in any domain	Severe disability in any domain
Log of bombs, missiles, rockets per km2	0.0792	0.1845***	0.2861***	0.1023***
	(0.1489)	(0.0466)	(0.0872)	(0.0309)
Log of bombs, missiles, rockets per km2 *	0.0007*	-0.0001		
Log of mean elevation	(0.0004)	(0.0001)		
Log of bombs, missiles, rockets per km2 *			0.1826	0.2378
Share of urban population			(0.4711)	(0.2056)
Log of area of district	-0.1899	-0.0687*	-0.1619	-0.0509
	(0.1251)	(0.0402)	(0.1386)	(0.0488)
Log of mean elevation	-0.1154	0.0300	0.0068	0.0073
	(0.0811)	(0.0259)	(0.0479)	(0.0147)
Northern (yes=1, no=0)	2.0884***	0.5534***	1.8889***	0.5395***
	(0.1773)	(0.0563)	(0.1908)	(0.0655)
Capital district of province (yes=1, no=0)	-0.0699	-0.0353	-0.0483	-0.0310
	(0.2484)	(0.0937)	(0.2799)	(0.1186)
Log of distance to closest cities: Hanoi, Da	0.2828***	0.0417	0.1961	0.0160
Nang, HCMC	(0.0984)	(0.0329)	(0.1277)	(0.0516)
Share of urban population	-2.5763***	-0.6911***	-3.0442**	-1.2201**
	(0.3721)	(0.1233)	(1.1842)	(0.5042)
Constant	5.3641***	1.0961***	5.0186***	1.3397***
	(0.7015)	(0.2309)	(0.7635)	(0.2641)
Observations	612	612	612	612
R-squared	0.297	0.142	0.251	0.058

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

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