# Hard to forget.
# The long-term impact of war on mental health[☆]

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**Abstract**

War can have long-term effects on individual mental health through war trauma. In this paper, we explore the impact of constantly recalling painful episodes related to the Bosnia and Herzegovina's 1992-1995 conflict on individual mental health using the Center for Epidemiologic Studies Depression (CES-D) scale. Potential endogeneity and reverse causality issues are addressed using objective measures of war intensity recorded at the municipality level. We find that individuals experiencing war trauma have worse mental health six years after the end of the conflict. In particular, instrumental variables estimates show that they score 16 points (more than 1.5 standard deviations) more in the CES-D scale (with higher scores meaning more depression symptoms) and have a 60 percentage points higher probability of being at risk of depression. Our results are robust to a number of sensitivity checks accounting for individual geographical mobility and different treatment intensities, and suggest that the negative effects on mental health are not mainly mediated by physical health problems. Back of the envelope calculations show large economic costs of war-trauma. [I1,O1]
*Keywords:* war trauma, mental health, depression, Bosnia and Herzegovina

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"*We will never forget that Bosnia was as much a moral cause as a military conflict. The tragedy of Srebrenica will haunt our history forever.*" Kofi Annan, 1999.

## 1. Introduction

The civil wars that broke out in the 1990s on the territory of former Yugoslavia are often described as Europe's deadliest conflict since World War II (WWII, hereafter). Along with civilian casualties and disruption, the armed conflict has become infamous for the war crimes involved, including ethnic cleansing, rape and crimes against humanity. A growing body of literature has been providing evidence on disruptive effects of military conflicts in different contexts in terms of human capital costs of survivors, and lower economic growth and development (Blattman and Miguel 2010; Justino, 2009; Akresh et al.2011). Beyond the latter losses though, the cumulative exposure to traumatic episodes of violence may have other 'intangible' consequences on affected individuals such as long-term changes in mental health and psychological well-being.

Mental health is an important dimension of human capital with a significant impact on many aspects of human life, e.g. well-being, employment, earnings, wealth, stigma etc.. Yet, while the 'tangible' costs of wars through the impact on survivors' physical health, education and economic wealth are routinely assessed, evaluations of psychological costs of wars, including those on mental health, are far more scarce. This paper aims at filling this gap by assessing the long-term impact of war on mental health in post-conflict Bosnia and Herzegovina (BiH hereafter). The Bosnian war (1992-1995) came about from the breakup of Yugoslavia and resulted in a brutal conflict between the three main ethnic groups, Serbs, Croats and Bosniaks (i.e. Bosnian muslims), which devastated much of the country's infrastructure and imposed a severe toll on the whole economy (DFID, 1999).

To assess the mental health effects of violence, we depart from the assumption that the effects are homogenous across groups or individuals whereas we account for the degree of individual exposure to violence, i.e. *war trauma*. This is so as war may have particularly traumatizing effects on those directly exposed to terror (Miller and Rasmussen 2010). This is even more true when violence and crimes are systematically targeted against some specific groups in the population as it was the case for ethnic conflicts in general, and for the process of 'ethnic cleansing' perpetrated during the Bosnian war in particular.

Our empirical analysis is based on the BiH Living Standards Measurement Survey (LSMS), which provides a highly reliable individual mental health measure, the Center for Epidemiologic Studies Depression (CES-D) scale (Radloff, 1977). A higher CES-D score indicates more depression symptoms (i.e. worse mental health). By matching each individual to detailed local-area (municipality) war statistics gathered the high quality Bosnian Book of the Dead database on war-related casualties, and using survey information on a proxy for war trauma, we are able to assess the long-term impact of war on mental well being. Our identification strategy is based on instrumental variables (IVs) estimation. We use a proxy for an individual's war trauma (i.e., recalling painful war events) which is instrumented by using arguably exogenous variation in the intensity of war violence measured by the casualty rates at the municipality level. Past research findings, and the nature of the Bosnian conflict, which was driven by the desire of creating ethnically homogenous geographic areas, support the validity of our identification strategy, i.e. the exogeneity of war intensity with respect to individual mental health.

We add to the existing literature by focusing on the direct link between war trauma and mental distress of survivors, and by providing a precise assessment of the magnitude of these effects. Our paper also adds to the policy debate on the legacies of war and on the optimal design of post-conflict policies for recovery.

Our IVs estimates point out that individuals who recall the war 'quite a bit' or 'extremely often' are significantly more likely to suffer from worse mental health. In particular, they score about 1.6 standard deviations higher in the CES-D score, with higher scores meaning that an individual shows more depression symptoms. Recalling the war causes an increase in the likelihood of suffering from depression (CES-D score higher than 15) of 60 percentage points (p.p., hereafter). These effects must be interpreted as local average treatment effects (LATE), i.e. as the effects on the individuals whose recall war status is triggered by the instrument (war intensity). Using nonlinear models, which allow to recover average treatment effects on the treated (ATET), we obtain lower effects of recalling the war both on the CES-D score and on the probability of depression, which are one standard deviation of the CES-D score, and 50 p.p., respectively. Our results are robust to a number of sensitivity checks, which take into account individual geographical mobility and allow for different treatment intensities, and show that the negative effects on mental health are not mainly mediated by physical health problems.

We further provide some evidence on the economic costs of war trauma, by estimating its

effect on individual labour force participation, working hours and monthly labour incomes. Using both linear and nonlinear models, large negative effects are found on all these outcomes. When aggregating the forgone labour income at the national level using simple back of the envelope calculations, we find that war trauma could have been responsible for a fall of 4.2% in BiH's 2001 GDP.

The remainder of the paper is organized as follows. Section 2 summarizes earlier findings in the literature relevant for our study. Some background information on the BiH conflict is provided in Section 3. Section 4 describes the data used in our empirical analysis, and Section 5 discusses our conceptual framework and the identification strategy. The the main results of the empirical analysis are reported in Section 6, and Section 7 reports some robustness checks. In Section 8, we estimate the labor market effects of war trauma, and make some back-of-the-envelope calculations of the total costs for the country. Section 9 summarizes the main findings and concludes.

## 2. Exposure to violence and mental health: A brief literature review

The consequences of wars have received considerable attention in the recent literature. Studies on the countrywide impact of conflict show that affected countries and populations adjust relatively fast and often return to their pre-conflict growth trajectories (Davis and Weinstein, 2002; Brakman et al., 2004; Miguel and Roland, 2011). On the other hand, a growing body of research at the micro-level finds that conflict situations cause more mortality and disability than any major disease, destroy communities and families, and disrupt the development of the social and economic fabric of nations (Justino 2009, 2012a). The effects of war include short- and long-term physical harm, as well as reduction in material and human capital (Murthy and Lakshminarayana 2006). Akresh et al. (2012), for instance, examined the consequences of the Ethiopian-Eritrean war on the height of young children in Eritrea and found that children exposed to the war were shorter than the reference population by 0.42 standard deviations. Similarly, Akresh et al. (2012) showed that individuals exposed to the Nigerian civil war (1967-70) at all ages between birth and adolescence exhibited reduced adult stature and that these impacts were largest in adolescence (see also Bundervoet et al. 2009; Akresh et al. 2012). The educational effects of violent conflict are also substantial. The existing literature shows that violent conflict almost always results in reductions in educational access and

attainment (Alderman, Hoddinott, and Kinsey 2006; Akresh and de Walque 2008; Swee, 2013; Justino, Leone and Salardi 2014). Relatively minor shocks to educational access during childhood can lead to significant and long-lasting detrimental effects on individual human capital accumulation (Akbulut-Yuksel 2009; Ichino and Winter-Ebner 2004; Leon 2012).

Comparatively much less evidence exists on the mental health effects of conflict. However, mental health is an important component of human capital supporting individual well-being and productivity. Poor mental health may entail poor labor market conditions, income losses, and higher health expenses (Miranda and Patel, 2005). Studies of individual behavior have documented the impact of mental health on employment, productivity and earnings (Ettner et al. 1997; Bartel and Taubam, 1986), criminal activity (Steadman et al. 1998), child abuse and neglect (Kelleher et al, 1994), homelessness (Jenks, 1994), fertility and divorce (Bartel and Taubman, 1986), and offspring's education (Bratti and Mendola, 2014). Emerging data from low- and middle-income countries further indicate a strong association between mental illness and low education, food insecurity, inadequate housing, poverty and financial stress (Das et al. 2008; Patel and Kleinman 2003). In addition to these large personal costs, collective economic costs are also significant, due to higher direct health costs and indirect costs related to higher levels of unemployment together with increase in alcohol abuse, drug addiction and social exclusion. According to World Health Organization's (WHO), the cost of mental health problems is estimated to be between 3% and 4% of GNP in developed countries (WHO, 2003). Unipolar depressive disorders alone rank as the third leading contributor to the global burden of diseases, accounting for about 12% of years lived with disability (WHO's Global Burden of Disease 2001).[1]

Researchers have estimated the causal effects of war exposure on soldiers' mental health. Their findings suggest that deployment to combat zones, exposure to enemy firefight and to dead, dying, or wounded people, generally cause a decrease in mental health status and raise the risk of suffering from post-traumatic stress disorder (PSTD) or depression (Gade and Wenger 2011; Cesur et al. 2013). Less evidence is available on the effects of wars on mental health of the general population. In particular, although a number of papers report correlations between individual war exposure and mental health problems (see the review in Murthy and Akshmi-

[1] http://www.who.int/healthinfo/global_burden_disease/estimates_regional_2001/en/.

narayana 2006), studies addressing causality are remarkably rare.

Two main obstacles must be overcome when investigating the mental health effects of war (see Do and Iyer, 2012). First, there are very few surveys collecting reliable measures of mental health. Second, researchers must address endogeneity, i.e. take into account potential individual unobservable factors simultaneously affecting war victimization and mental health, and reverse causality issues when self-reported measures of war-trauma (recalling the war) like those provided in the BiH LSMS are employed. Indeed, mentally depressed individuals may be more likely to remember stressful events, including those related to war, making the effect of war on mental health appear larger than it is in reality. On the other hand, random errors in the self-reported measure (i.e. misclassification error) or the tendency to under-report war trauma to avoid the social stigma associated with mental health problems or specific war episodes (e.g., rape) could bias the OLS effect towards zero.

In order to address endogeneity and measurement error issues a source of plausibly exogenous and more objective variation in an individual's degree of exposure to violence is necessary. The latter is provided in the context of veterans' mental health by random variation in deployment zones (e.g, combat vs. non-combat). When the goal is to investigate mental health in the general population, a similar approach consists in using exogenous variation in war intensity existing across geographical areas, such as the countries (Kesternich et al. 2014) or the municipalities (Do and Iyer 2012) where individuals resided during the war. Kesternich et al. (2014) found, for instance, that exposure to WWII combats increased the risk of depression for individuals aged 50 or more. Do and Iyer (2012), instead, use the same BiH LSMS data and do not report any significant negative effect of objective measures of war intensity (casualty rates by municipality) on individual mental health (CES-D score). Two main aspects differentiate our paper from Do and Iyer (2012)'s analysis. First, we only employ the 2001 wave of the LSMS, which allows us to use a more complete measure of mental health (the 14-item CES-D score instead of the 7-item version, which is available in the 2003 and 2004 waves).[2] Second, while Do and Iyer (2012) estimate the average effect of war both on victims and non-victims

[2]Moreover, extending the analysis to the period 2001, 2003 and 2004 would increase the number of observations but decrease the number of individuals, since only about half of respondents to the first (2001) wave were followed in later waves.

of war trauma, we only focus on the former.[3] This is motivated by the fact that among the many mechanisms through which wars could affect mental health, such as backward-looking (memories of past traumatic events), current (e.g., a slower economic recovery associated with current lower income), or forward-looking mechanisms (less trust and willingness to cooperate after the war), the literature on natural disasters and economic crises suggests that the first are the most likely to be at work (Friedman and Thomas 2008; De Mel et al. 2008). Unlike others, backward-looking mechanisms, though, are likely to operate differently on the victims of violence and on the non-victims.[4]

## 3. The BiH conflict

BiH is historically an ethnically diverse state. In 1991 the population of BiH was approximately 4.4 million, including various ethnic groups, with the three largest ones being the Bosniaks with 43.5 percent of the population, Serbs with 31.2 percent, and Croats with 17.4 per cent. There are differences among these ethnic groups in respect of their religious belonging, Bosniaks being mainly Muslims, the Serbs of Orthodox religion, and the Croats of Roman Catholic religion. Before its independence, Bosnia was a constituent republic of the former Yugoslavia. In 1991 and 1992, Yugoslavia disintegrated under the pressures of ethnic conflict, economic issues, and political interests. The secessions of Slovenia and Croatia triggered warfare in both new nations, with the United Nations inserting a peacekeeping force in mid-1992 to stabilize the situation. Bosnia's declaration of independence from Yugoslavia in 1992 raised the violence to a new level, triggering a war that lasted over three years and exemplified the complexities of the "post-Cold War" strategic environment. Initially, Croats and Serbs expanded their territorial control at the expense of the Bosnian state, with the Serbs, supported by Serbia and the Yugoslav National Army (JNA), eventually controlling about 70% of BiH. Shifts in territorial control were accompanied by the execution of widespread "ethnic cleansing" in occupied areas, creating horrific scenes of refugees and concentration camps that seemed unthinkable in

[3] This point will be further discussed in Section 5.1.

[4] This does not exclude, however, that for exposure to other traumatic events, such those related to non-war crime, the indirect costs for the non-victims may also be substantial (Cornaglia et al. 2014). The main difference between these different traumatic events is indeed that large economic crises, natural disasters and wars are much more rare events than ordinary crime episodes for the populations living in certain geographical areas, and the fear of future victimization (i.e., forward-looking mechanisms) for the non-victims may be accordingly quite low.

modern Europe. After Serb attacks on the Srebrenica "safe area" in 1995, a dual arrangement between the U.N. and NATO was established to control tactical air power in response to Serbian attacks. The conflict and partitioning displaced 1.3 million people (see Kondylis, 2010). In December 1995 the Dayton Peace Agreement ended four years of ethnic conflict in BiH.

The Bosnian war was characterized by the use of extreme violence, by carrying out purposeful policies of ethnic cleansing, mainly against civilians (Mrvić-Petrovic 2001). In particular, the use of violence was targeted against ethnic communities with the aim to lead to their departure from areas over which the warring parties fought for control. Thus, war intensity was mainly driven by the intentions of hostile ethnic groups to create homogenous group territories such that Bosnia has become a pivotal case study for empirical research on ethnic violence in civil wars (e.g. Weidmann, 2011; Beger, 2012). For our purpose this means that the violence of the conflict by municipality was largely uncorrelated to individual-level characteristics such as mental health or well-being.

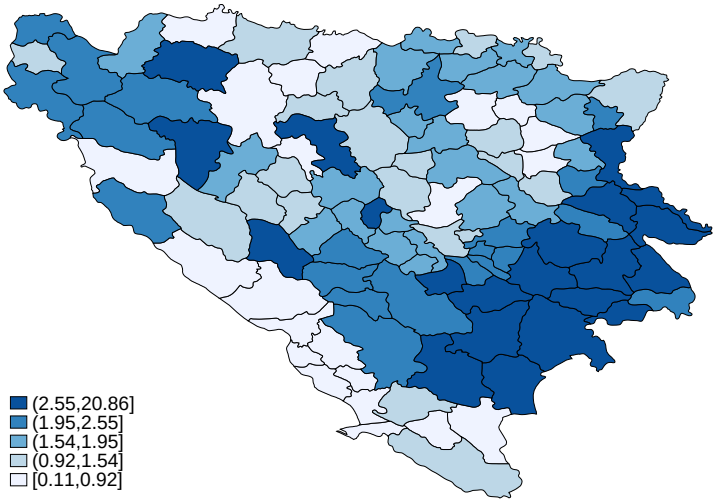
Detailed information on war casualties is provided at the municipality level by the Bosnian Book of the Dead published by the Research and Documentation Center (RDC) in Sarajevo. This database includes 97,207 names of Bosnia and Herzegovina's citizens, who were killed or were missing during the 1992-1995 war. The research findings were evaluated by an international team of experts before the results were released. According to the database, of the 97,207 documented casualties: 40% had civilian status, 90% were male, 65% Bosniaks, 25% Bosnian Serbs and about 8% Bosnian Croats. Figure 1 reports casualty rates by municipality computed on the (1991 Census) population. Although there are some data shortcomings (e.g. information was collected by a number of sources such as individual informants, eye witnesses, close relatives, friends, neighbors, but also from press reports, books, NGOs, government sources, and no standardized documents were required to prove statements of the respondents), the overall quality of the database is considered as high (Ball et al. 2007).[5]

## 4. Data and descriptive evidence

Our empirical analysis is based on the BiH LSMS, a survey conducted in 2001 by the World Bank in co-operation with the Republika Srpska Institute of Statistics (RSIS), the Fed-

[5]It should be noted that, as far as our identification strategy is concerned, measurement error that is uncorrelated with individual mental health status would only affect the instruments' strength.

Figure 1: Casualty rates (%) by BiH municipality




Note: Casualty rates are computed on the (1991 Census) population. Municipalities in darker tonalities of blue are in higher quintiles of the distribution. Data on casualties are provided by the Bosnian Book of the Dead collected by the Research and Documentation Center in Sarajevo (RDC).

eral Institute of Statistics (FOS) and the Agency for Statistics of BiH (BHAS). The survey is nationally representative and contains over 5,400 households sampled from 25 municipalities (11 in Republika Srpska and 14 in the Federation of Bosnia Herzegovina) and more than 9,000 individuals.[6] Questions were asked to each household member of age 15 or older, while for younger members information was provided by parents or guardians. The survey contains detailed information on individual health status (both self-reported general health status and physical disabilities) and educational levels along with detailed demographic characteristics of household members, household asset endowments and wealth, ethnicity, migration, and current area of residence. Crucial for our identifying strategy is the availability of retrospective information on individuals' municipality of residence before the war (see the following section).

As for mental health, the first wave (2001) includes a battery of questions that can be used to compute the CES-D scale. Despite being subjective, as the questionnaire asks individuals about their internal states and associated behavior, this scale has been validated in the psychological

[6]Approximately half of the LSMS respondents were re-interviewed in other three waves, collected in 2002-2004 (the Living in Bosnia and Herzegovina survey). The attrition rate across the panel waves is around 5%, which is relatively low compared to other national panels. As our excluded instrument is time invariant, using panel data would not improve our identification strategy since individual fixed effects cannot be included in the estimation. Moreover, the panel would include a much lower number of individuals, and we would have to focus on the 7-item version of the CES-D questionnaire.

literature. In particular, the CES-D scale has been subjected to a specific validation for Bosnia and Herzegovina (Kapetanovic, 2009). In the current study, we use the full battery of 14 items that were administered in the 2001 wave[7] (our translation of the questions in module 4.B of the Bosnian questionnaire):

(9) 'How often in the past week, including today, did you feel you had no energy or slowed down?'

(10) 'How often in the past week, including today, did you accuse yourself for different things?

(11) 'How often in the past week, including today, did you cry easily?'

(12) 'How often in the past week, including today, did you feel loss of appetite?'

(13) 'How often in the past week, including today, did you have problems falling asleep or sleeping?'

(14) 'How often in the past week, including today, did you feel hopeless in terms of future?'

(15) 'How often in the past week, including today, did you feel sad (melancholic)?'

(16) 'How often in the past week, including today, did you feel lonely?'

(17) 'How often in the past week, including today, did you think of ending your life?'

(18) 'How often in the past week, including today, did you feel as you were captured or trapped?'

(19) 'How often in the past week, including today, did you feel that you worried too much about different things?'

(20) 'How often in the past week, including today, did you feel that you had no interest in things about yourself?'

(21) 'How often in the past week, including today, did you feel that everything was an effort?'

(22) 'How often in the past week, including today, did you feel worthless?'

The possible answers are 'Not at all', 'A little', 'Quite a bit', and 'Extremely often', which are assigned scores of 0, 1, 2, and 3, respectively. Scores in single questions are then summed to obtain an aggregate score ranging between a minimum of 0 (no depression symptoms) and

[7]This represents a major difference with respect to Do and Iyer (2012) which use instead the 7-item version of the questionnaire also available in the 2003 and 2004 waves.

a maximum of 42 (very severe depression symptoms). Higher CES-D scores indicate worse mental health. On a 20-item (60 point) scale, the cutoff score of 16 is generally considered as indicative of 'significant' depressive symptomatology. In the analysis which follows, the score of the 14-item scale was converted into the 60-point scale.[8]

The 2001 of BiH LSMS also includes the following question: 'During the previous week, including today, how many times did you constantly recall most painful events you experienced during the war?'. The possible answers are defined on the Likert scale described above. In 2001, 49% of the individuals aged 16 or more answered 'Not at all', 28.7% 'A little', 14.75% 'Quite a bit' and 7.6% 'Extremely often'. In the current paper, we consider as victims of war trauma individuals who answered 'quite a bit' or 'extremely often', and for brevity we will refer to these individuals at to those 'recalling the war'.

Table 1 reports the means of the CES-D score by war trauma status and their differences, split by gender and ethnicity. All differences by recall war status are statistically significant at the 1% level, in particular individuals recalling the war have worse mental health. The differences in means are very similar by gender (with a slightly larger effect on depression for women), and by ethnic group, with slightly larger differences for 'other' ethniciy, which represents however a small minority of the population. For this reason, in what follows we will report regressions pooling men and women, an in which we impose a common effect of the treatment (war trauma) across the different ethnic groups.

The same positive association between worse mental health and war trauma is also clear in Figure 2 which plots the whole distributions of the CES-D score for individuals recalling the war and for those not doing it.

## 5. Conceptual framework and empirical strategy

We are interested in the effect of war trauma on individual mental health in the aftermath of the BiH conflict. War trauma is defined as a situation in which an individual recalls painful events related to the war. As we mentioned above, the BiH LSMS does not ask direct questions about war victimization, but one about recalling the war.[9] The possible answers are: not at all;

[8] By multiplying the observed scores by 60 and dividing them by 42, i.e. the maximum scores in the 20-item and the 14-item scales, respectively.

[9] Our proxy of war trauma differs from that used by Bellows and Miguel (2009) which refers to killings, injuries or refugee experiences of household members.

Table 1: Differences in CES-D score and depression by recall war status

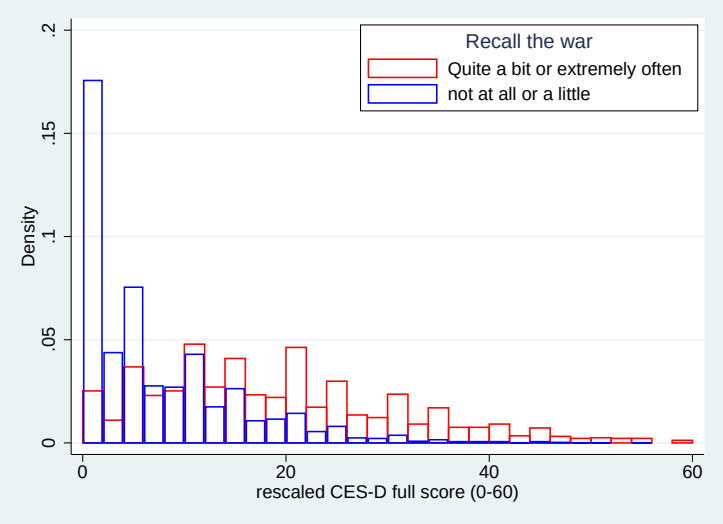
| | Recall the war[(a)] (A) | Does not recall the war[(b)] (B) | Diff. (A)-(B) | t-test s.e. |
|---|---|---|---|---|
| CES-D score | | | | |
| All sample | 18.9 | 7.1 | 11.8*** | 0.26 |
| *Gender* | | | | |
| man | 15.6 | 5.5 | 10.1*** | 0.35 |
| woman | 21.3 | 8.6 | 12.7*** | 0.38 |
| *Ethnicity* | | | | |
| Bosniak | 18.5 | 6.6 | 11.9*** | 0.37 |
| Serb | 19.4 | 8.1 | 11.3*** | 0.43 |
| Croat | 17.3 | 4.1 | 13.3*** | 1.08 |
| other | 23.5 | 8.0 | 15.5*** | 2.17 |
| unreported | 18.5 | 8.1 | 10.5*** | 1.01 |
| Depression | | | | |
| All sample | 0.53 | 0.13 | 0.40*** | 0.01 |
| *Gender* | | | | |
| man | 0.40 | 0.08 | 0.32*** | 0.01 |
| woman | 0.62 | 0.18 | 0.44*** | 0.02 |
| *Ethnicity* | | | | |
| Bosniak | 0.52 | 0.11 | 0.42*** | 0.02 |
| Serb | 0.53 | 0.16 | 0.37*** | 0.02 |
| Croat | 0.53 | 0.07 | 0.46*** | 0.04 |
| other | 0.67 | 0.13 | 0.54*** | 0.08 |
| unreported | 0.48 | 0.15 | 0.33*** | 0.04 |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

[(a)] Recall the war 'quite a bit' or 'extremely often'.

[(b)] Recall the war 'a little' or 'not at all'.

Figure 2: Distribution of CES-D score by recall war status



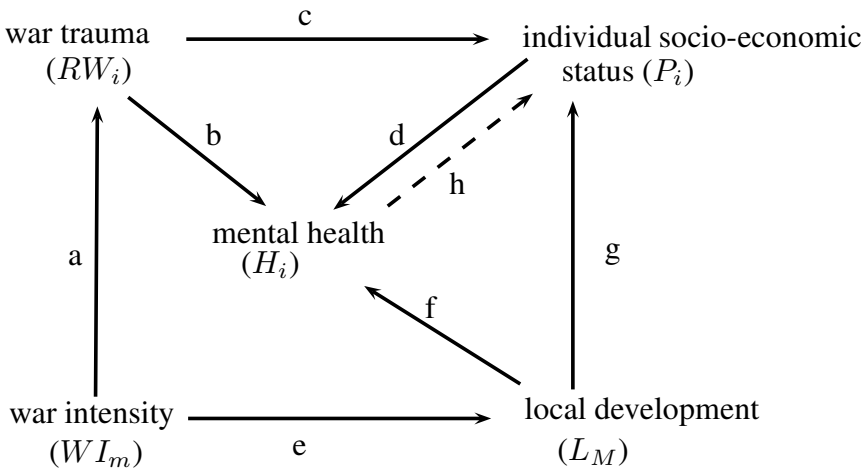

Note: A higher CES-D score means worse mental health.

a little; quite a bit; extremely often. For the purpose of our analysis, the last two answers are grouped into a dichotomous indicator, which will be referred to as 'recalling the war' (*RW* for brevity), that is our proxy of war trauma.[10]

The main elements of our conceptual framework are shown in Figure 3. War intensity in individual $i$'s municipality $m$ of residence before the war ($WI_m$) increases his/her likelihood of suffering from a war trauma ($RW_i$), which in turn negatively affects his/her mental health ($H_i$). This is the *direct effect of war trauma* on mental health (pathway b). War trauma also has an indirect effect (pathway d) which is mediated by the individual's socio-economic status (SES, $\mathbf{P}_i$). Indeed, war trauma may reduce the individual's productivity in the labor market, and affect in this way also his/her employment opportunities and wage (*indirect effect of war trauma*). War intensity also has an 'aggregated' effect on mental health, which is not mediated by war trauma (pathway f). Human and physical capital losses affect the level of development of the area in which the individual currently resides ($\mathbf{L}_M$), and therefore individual SES, e.g. via the likelihood that he/she finds a job or the income level. Notice that mental health may

[10]Thus *RW* takes the value of one if individuals recalled the war 'quite a bit' or 'extremely often' and zero otherwise. The results obtained when all categories are considered separately are reported in Section 7.

Figure 3: Conceptual framework




Note. *i*, *m* and *M* are the individual, the pre-war municipality (of residence) and the current municipality (of residence) subscripts, respectively.

have a feedback on individual SES for reasons which are unrelated to the war.

Figure 3 also makes explicit some of the assumptions and the difficulties underlying our IVs identification strategy and helps derive our empirical specification. On the one hand, in order to use war intensity as an instrument for war trauma and to comply with the exclusion restriction assumption (i.e. war intensity only affects mental health through war trauma), we need to control in the mental health equation for all potential non-trauma effects of the war. In particular, it is important to control for the individual's SES. On the other hand, controlling for the SES poses two problems. First, SES would capture part of the trauma-effect of the war (pathway c).[11] Second, SES is potentially endogenous with mental health (pathway h). Mentally vulnerable individuals, for instance, are less likely to work. We try to address both these issues by including in the regressions (aggregated) average local economic characteristics instead of individual SES. We argue that these characteristics are likely to capture well the non-trauma effects of war intensity (i.e. human and physical capital loss), and that they are more likely to be exogenous, i.e. uncorrelated with an individual's mental vulnerability, than

[11] Indeed, in Section 8 we will investigate the economic costs of war trauma in terms of lower individual labor force participation, less working hours and lower incomes.

individual SES.

We can formally describe the conceptual framework above by introducing the individual's mental health equation. Let us define as $H_i$ the stock of mental health of individual $i$ who lived before the war in municipality $m$, and is currently living in municipality $M$. Accordingly, we specify the following production function $f(.)$ for the *current stock of mental health*

$$H_i = f(RW_i, \mathbf{P_i}(RW_i, \mathbf{L}_M), \mathbf{X_i}, \varepsilon_i) \tag{1}$$

where $RW_i$ (recalling the war, i.e. our proxy of war trauma) and $\mathbf{L}_M$ are both a function of war intensity $WI_m$. $\mathbf{X_i}$ is a vector of personal characteristics not affected by war intensity,[12] such as gender and age, and $\varepsilon_i$ an idiosyncratic unobservable factor (e.g., mental vulnerability).

The total effect of war on mental health is therefore

$$\frac{\partial H_i}{\partial WI_m} = \underbrace{\frac{\partial f}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m}}_{\text{direct effect of war trauma (A)}} + \underbrace{\frac{\partial f}{\partial \mathbf{P}_i}\frac{\partial \mathbf{P}_i}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m}}_{\text{indirect effect of war trauma (B)}} + \underbrace{\frac{\partial f}{\partial \mathbf{P_i}}\frac{\partial \mathbf{P_i}}{\partial \mathbf{L}_M}\frac{\partial \mathbf{L_M}}{\partial WI_m}}_{\text{non-trauma effects of war (C)}} . \tag{2}$$

In equation (2) we can distinguish between three effects of the war on mental health. The first effect is the *direct effect of war trauma* (A), i.e. the consequences of direct exposure to war-related violence. This is the effect that is not mediated by individual SES. A second effect is the *indirect effect of war trauma* mediated by individual SES, e.g. by lower labor market productivity (B). The last effect (C) is that related to other "stressors" which although being affected by the war do not originate from war-trauma, e.g. the stressful social and material conditions that are often caused or exacerbated by destruction caused by armed conflict (e.g., lower income owing to lower economic development). This distinction roughly corresponds to the distinction between *trauma-focused research* and the *psychosocial model* made by Miller and Rasmussen (2010). Controlling for the input $\mathbf{L}_M$ in the mental health production function (i.e. including these variables in a regression framework), one aims at isolating the effect of war trauma on mental health. In the current paper, by focusing on the effect of recalling the war on mental health and omitting individual SES characteristics,[13] we estimate the effect

[12] These variables were omitted from the Figure since they are not relevant to assess the mental health effects of the war.

[13] We already said that if they are affected by war trauma they are likely to be endogenous.

$\frac{\partial f}{\partial RW_i} + \frac{\partial f}{\partial P_i}\frac{\partial P_i}{\partial RW_i}$. This is a major difference with respect to Do and Iyer (2012), which do not focus on recalling the war in equation (1) but directly on the effect of war intensity ($WI_m$) on mental health, controlling for individual SES and excluding therefore all effects mediated by the latter. Thus, they estimate the parameter $\frac{\partial f}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m}$, which is the combined effect of the direct effect of war trauma on mental health and of the rise in the probability of being traumatized owing to higher war intensity. To put it in other words, we focus on the average mental health effects of war on the victims of war trauma while Do and Iyer (2012) on the average effect in the whole population, including the non-victims.

*5.1. Identification strategy*

We consider war trauma as the "treatment" to which individuals are exposed, and we are interested in assessing its effect on individual mental health. Since unobservable factors may make some individuals more likely to recall the war and suffer from mental health problems (e.g., mental vulnerability), or the latter may influence the former (reverse causality), we need a source of potentially exogenous variation in treatment intensity. To this aim, we use data on war intensity at the geographical level (municipality) gathered by the Bosnian Book of the Dead (see Section 3). More formally, our IVs identification strategy can be illustrated by means of two equations. The first equation is the mental health equation

$$H_i = \alpha_0 + \alpha_1 RW_i + \alpha_2{}' \mathbf{C_{imM}} + \varepsilon_i, \tag{3}$$

where $\mathbf{C_{imM}} = (\mathbf{L}_m, \mathbf{L}_M, \mathbf{X_i})$ a vector of personal and municipality-level controls (some of which may be affected by the war), $\varepsilon_i$ is an idiosyncratic error term, and the $\alpha$'s the parameters to be estimated. With respect to the conceptual framework in Figure 3, we further include a vector of pre-war municipality controls ($\mathbf{L}_m$) to control for factors which might influence both the degree of violence of the war and individual mental health (see the following section). The other variables are as defined above. In particular, we take $RW_i$ as a proxy of individual war trauma, i.e. of how closely and intensively an individual was involved in war-related violence. One thing is worth noting in equation (3), since the CES-D score is *higher* for those having *worse* mental health, we expect a *positive* coefficient on $RW_i$, i.e. $\alpha_1 > 0$ implies a *negative* effect of war trauma on mental health.

A problem with estimating equation (3) is that individuals with worse (latent) mental health (i.e. more mentally vulnerable) may also be more likely to recall all painful events, including

those related to war (see, for instance, Neuner, 2010), generating a reverse causality problem. In order to tackle this issue, and other issues related to the potential endogeneity of recalling the war (i.e., the correlation between the unobservables entering the error term of the mental health equation and $RW_i$), we need a source of exogenous variation in $RW$ to identify $\alpha_1$. We argue that this source of variation can be provided by the interaction between objective measures of war intensity at the geographical level and individual ethnicity. Thus the second equation, for recalling the war, is defined as

$$RW_i = \beta_0 + \beta_1 WI_m + \sum_{j=2}^{J} \beta_j (WI_m \times ethnic_i^j) + \gamma' \mathbf{C_{imM}} + u_i. \quad (4)$$

where $ethnic_i^j$ is a dichotomous indicator for individual $i$ being of ethnicity $j$, and $u_i$ an error term. Information needed to compute war intensity (i.e. the total number of casualties for the period of the war) is taken from the Bosnian Book of the Dead, and matched to the LSMS on the basis of an individual's residence just before the war, i.e. in April 1992, which is provided by the survey.[14] It is worth noting that the number of casualties for the whole duration of the war is imputed to individuals according to their pre-war municipality of residence. First, casualties by year of death are not available. Second, although when imputed according to pre-war residence war intensity has the disadvantage of being less precise for movers (potentially affecting the strength of the instrument), it has nonetheless the advantage of being 'more exogenous', that is less related to the decision to migrate, which is likely to depend on the intensity of the conflict (see Kondylis, 2010). The interaction terms with ethnicity are used as war victimization was not evenly distributed across ethnic groups, with most victims being Bosniaks.

Our instrumental variables, namely war intensity (which captures the effect of war intensity on the excluded ethnicity group) and the war intensity-ethnicity interactions, must satisfy the usual three conditions. The first one is *exogeneity* of the instruments with respect to mental health (i.e., they must be uncorrelated with $\varepsilon_i$). As for the first component of the instruments, i.e. war intensity ($WI_m$), the Bosnian war was mainly a racial war (see the discussion in Kondylis 2010 and Section 3) and we have no reason to expect violence being especially targeted at individuals with poor mental health. In particular, violence was perpetrated

[14] The exact wording of the question is: 'In which municipality and settlement did you live just before the war (April 1992)?'. Unfortunately, we do not have casualties at the settlement level.

against other ethnic communities with the aim to lead to their departure and create ethnically-homogenous territories. Weidmann (2011) reports war intensity to be mainly predicted by the ethnic composition of the local population and distance to the Croat and Serbian borders, and unrelated with potential correlates of mental health such as the level of percapita GDP before the war. This is also evident in Figure 1 where casualty rates are higher closer to the Serbian border. A potential threat to our identification is that war intensity might in reality capture latent higher conflictuality already present in a municipality, which may also affect mental health. For this reason we have included in the recall war equation the Ethno-Linguistic Fractionalization (ELF) index computed from the 1991 population census, which is aimed to control for the latent lack of trust and greater conflictuality which might prevail in more culturally diverse environments (Alesina and La Ferrara, 2002). As for the second component of the instruments, i.e. ethnicity, a potential threat to identification could be generated by some ethic groups being more targeted by violence and more prone to worse mental health at the same time. For this reason, ethnicity is controlled for in the mental health equation.[15]

The second requirement for the instruments is the *exclusion restriction assumption*. In our case, this means that war intensity should not have a direct effect on mental health after the conflict over and above war trauma. Providing that an individual's income and labor force status are important correlates of mental health, war intensity might have had a long-lasting effect through these mediating variables (see Miller and Rasmussen, 2010).[16] In this case,

[15]Like other papers on the effect of the war (Do et al. 2008, Miguel and Roland 2011, Do and Iyer 2012, etc.) our analysis is also subject to a triple form of sample selection. Indeed, individuals have to satisfy three selection criteria in order to be observed in the survey sample: they must survive during the war; they have to survive during the post-war period, until 2001; and they have to live in BiH in 2001. We already argued that the first kind of selection is unlikely to have produced a selected sample in terms of mental health. As to the second, one could put forward that if the war had a negative effect on mental health, we should expect relatively healthier individuals to have survived until 2001 (e.g. severely depressed individuals may have made suicide), and our estimates could be interpreted as *lower bounds*. (Remember that a positive coefficient on recalling the war in equation (3 means worse mental health.) Concerning the third kind of selection, on migration, Begin and Mcdonald (2006) found that Bosnian refugees in the US reported significantly greater levels of PTSD than members of their Bosnian resident cohort, but not greater levels of anxiety or depression. Hunt and Gakenyi (2005) comparing Bosnian refugees in the UK with Bosnian residents also found a higher incidence of traumatic symptoms on the former, and concluded that there may be more serious long-term psychological problems in people who are forced to leave their country during wartime. Thus, from the existing evidence we put forward that also the last form of selection is likely to introduce a negative bias in our estimates, making the estimated positive effect of the war on depression smaller than the true effect.

[16]Physical capital recovery, however, could be very fast. Waldinger (2012) shows, for instance, that physical capital destruction unlike human capital loss did not have long-term effects on the productivity of German science departments after WWII.

it could be not war trauma but the underdevelopment of municipalities which suffered more intense destruction causing worse mental health.[17] As we anticipated, in order to corroborate the exclusion restriction assumption, we include in the regressions average municipality-level economic characteristics in the current municipality of residence. One may claim, for instance, that geographic areas which underwent more intense human and physical capital destruction remained less economically developed six years after the war.

The third requirement of the instrument is its *relevance*: the instruments must be an economically and statistically significant predictors of our proxy of war trauma ($RW_i$). Evidence supporting the instruments' relevance is provided in the following section.

Table A.1 reports the list of variables and and the sample descriptive statistics.

## 6. Main results

We consider two main indicators of mental health, the CES-D score and a dichotomous version of it, which takes the value of one in case the CES-D score is at least 16 and zero otherwise (i.e., for brevity we label this variable as 'depression'); as we said, 16 is the cutoff point generally considered as indicative of being at risk of depression. In spite of the discrete bounded (between zero and 60) nature of the first indicator, and the dichotomous nature of the second, in this section we use linear models for both. The same is done for the endogenous treatment (recall war) equation. Linear models have become quite popular among applied economists (see Angrist and Pishke, 2009) and have a number of convenient features. First of all they do not require using a specific distribution for the error term in the mental health and recall war equations. The advantages are even larger when one is interested in the effect of an endogenous treatment, since instrumental variables (IVs) can be used. Unlike non-linear models, linear models do not require in our specific case both the mental health and the endogenous (treatment) dummy equations to be correctly specified to deliver consistent estimates of the regression's coefficients. In this sense, they are 'true' instrumental variables estimators (Lewbel et al., 2012). Yet linear models also have a number of less convenient features when they are applied to dichotomous variables. Horrace and Oaxaca (2006) showed, for instance, that the Linear Probability Model (LPM) is inconsistent when the linear predictions fall outside

[17] This represents nonetheless the causal effect of war, for the part which is mediated by material destruction (effect C in equation 2).

the unit interval (i.e. predicted probabilities are less than zero or greater than one). However, these and other issues will be addressed in the following Section.

As we already said, both the recall war and the mental health equations include individual variables and municipality level controls which might be simultaneously correlated with the violence of the conflict and the socio-economic conditions associated with mental health of the local population. Namely, we included gender, a quadratic in age, ethnicity, highest educational qualification attained, and the characteristics of the municipality of residence (urban or rural). At the pre-war municipality level, we controlled for the Ethno-Linguistic Fractionalization (ELF) index computed from the 1991 population census. The former is aimed to control for the latent lack of trust and greater conflictuality which might prevail in more culturally diverse environments (Alesina and La Ferrara, 2002), potentially affecting both the onset and intensity of conflict and latent individual mental health. We did not include current municipality of residence fixed effects as working with cross-section data the effect of recalling the war on mental health would only be identified by non returning migrants.[18] However, to control for the current state of the local economy (and to preserved the exclusion restriction assumption, i.e. to account for the non-trauma effects of the war) we included in all regressions the average monthly wage and the unemployment rate in the current municipality of residence (computed from the BiH LSMS data).

Before addressing the potential endogeneity of recalling the war, it is important to have a benchmark, which is represented by the application of OLS to the linear models. OLS estimates of the CES-D score equation are reported in column 1, and those of the depression equation in column 2 of Table 2. Recalling the war is associated with a 9.7 points ($t = 14.1$) increase in the CES-D score (i.e. one standard deviation) and a 33.2 ($t = 13.1$) p.p. rise in the probability of depression. Other factors turn out to be significantly associated with mental health such as gender (women have worse mental health) and education (highly educated individuals have better mental health status, but the effect is non-monotonic).

Column 3 and 4 of Table 2 report the IV-GMM estimates of the mental health and the depression equations, respectively. The $F-$statistic of the excluded instruments in the first-stage is 24.9, showing no sign of a weak instruments problem. Individuals who resided just

[18] On this specific point see the following Section.

Table 2: Effect of recalling the war on mental health (linear models)

| | (1) OLS *CES-D score* | (2) OLS *Depression* | (3) IV-GMM *CES-D score* | (4) IV-GMM *Depression* |
|---|---|---|---|---|
| **Main equation: Mental health** | | | | |
| recall the war[(a)] | 9.656*** | 0.332*** | 16.159*** | 0.598*** |
| | (0.686) | (0.025) | (3.152) | (0.108) |
| age | 0.085* | -0.000 | 0.038 | -0.003 |
| | (0.043) | (0.002) | (0.056) | (0.002) |
| age squared | 0.001 | 0.000** | 0.001* | 0.000*** |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| female | 2.820*** | 0.093*** | 2.503*** | 0.079*** |
| | (0.219) | (0.009) | (0.245) | (0.010) |
| *Education (elementary)* | | | | |
| general secondary | -0.917 | -0.046 | -0.531 | -0.022 |
| | (0.669) | (0.029) | (0.569) | (0.027) |
| other secondary | -4.129*** | -0.150*** | -3.392*** | -0.127** |
| | (0.796) | (0.049) | (0.959) | (0.054) |
| vocational secondary | -1.392*** | -0.062*** | -1.340*** | -0.055*** |
| | (0.440) | (0.019) | (0.317) | (0.018) |
| technical secondary | -0.949*** | -0.039*** | -0.861*** | -0.031** |
| | (0.296) | (0.013) | (0.209) | (0.013) |
| post-secondary non-university (2-3 yrs) | -2.270*** | -0.073*** | -2.052*** | -0.054** |
| | (0.601) | (0.024) | (0.495) | (0.023) |
| university or higher | -1.873*** | -0.043** | -1.296** | -0.018 |
| | (0.509) | (0.019) | (0.581) | (0.025) |
| not reported | 3.336*** | 0.101*** | 3.411*** | 0.110*** |
| | (0.613) | (0.025) | (0.545) | (0.021) |
| *Ethnic group (Bosniak)* | | | | |
| Serb | 0.195 | 0.012 | 0.521 | 0.024* |
| | (0.466) | (0.017) | (0.350) | (0.012) |
| Croat | -3.357*** | -0.086** | -1.760 | -0.034 |
| | (1.164) | (0.033) | (1.166) | (0.033) |
| other | 2.202*** | 0.048 | 1.926*** | 0.043* |
| | (0.796) | (0.029) | (0.711) | (0.025) |
| not reported | 0.777 | 0.008 | 1.206** | 0.005 |
| | (0.652) | (0.023) | (0.587) | (0.021) |
| *Residence (capital)* | | | | |
| other urban | 0.725 | 0.031 | 0.852 | 0.025 |
| | (0.971) | (0.028) | (0.799) | (0.021) |
| rural | 0.569 | 0.011 | 0.332 | -0.003 |
| | (1.035) | (0.030) | (0.931) | (0.027) |
| **First stage: Recall the war** | | | | |
| $F-$statistic excluded instruments [$p-$value] | | | 24.85 [0.00] | 24.85 [0.00] |
| Anderson-Rubin Wald statistic [(b)] [$p-$value] | | | 30.76 [0.00] | 46.73 [0.00] |
| Hansen J-statistic[(c)] | | | 5.968 [0.20] | 5.85 [0.21] |
| Pre-war municipality controls | Yes | Yes | Yes | Yes |
| Current municipality controls | Yes | Yes | Yes | Yes |
| N. observations | 6796 | 6796 | 6796 | 6796 |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

[(a)] Answer to the question: "During previous week, including today, how many times did constantly recall most painful events you experienced during the war?". Recall war takes on value one if individuals answered 'quite a bit' or 'extremely often' and zero otherwise.

[(b)] Weak instruments' robust inference test (null hypothesis: coefficient of the instruments in the reduced form is zero).

[(c)] Overidentification test (null hypothesis: instruments are valid).

Note. The excluded instruments are the casualty rate in the pre-war municipality of residence of the individual and its interactions with ethnicity dummies. Full first stage results are reported in Table A.1. Heteroskedasticity-robust standard errors are clustered at the pre-war municipality of residence level (94 clusters).

before the war in municipalities characterized by higher war casualty rates are significantly more likely to recall the war. In particular, from the first stage (in A.1) a one p.p. increase in the war casualty rate causes a 1.8 p.p. ($t = 3.7$) rise in the likelihood of recalling the war, and the effect is not different for Bosniaks, Serbs and Croats (the only statistically significant interaction term is that related with 'other ethnicity', which is positive). The Hansen-J statistic of over-identification always supports the instruments' validity. In the second stage, recalling the war is estimated to increase the CES-D score by 16.2 points ($t = 5.13$) and the probability of depression by 59.8 p.p. ($t = 3.8$). The estimated effects are quite large. Just to have an idea of their size, recalling the war has on the CES-D score an effect which is about 8 times that of lowering the educational achievement of an individual from the non-university post-secondary[19] to the primary level, and about 6.5 times the gender gap in mental health (women score 2.5 points higher than men in the CES-D score). As for the probability of depression, recalling the war has an effect which is about 7.5 times as large as the gender gap.

Different explanations could be given for the large magnitude of the estimated effects with IV-GMM, which are well above the OLS estimates. Although one might have expected an upward bias in the OLS estimates because of endogeneity[20] (i.e. mentally vulnerable people tend to recall war more frequently), misreporting in recalling the war (misclassification error) is likely to produce a doward bias in the estimated effects (Lewbel, 2007), i.e. to bias the estimates towards zero. IVs, which addresses both these sources of bias, seem to suggest that the latter is the most relevant bias. Another possible explanation for the larger magnitude of the IVs estimates is the usual Local Average Treatment Effect (LATE) interpretation, i.e. compliers with the war-intensity instrument (individuals whose recall war status is triggered by war intensity) may be a peculiar population, in particular one which is especially sensitive to mental health issues. Last but not least, we are also worried that using a linear model for dichotomous dependent variables may affect the magnitude of the estimated effects. We try to shed light on this and related issues in the next section.

[19] In BiH education at the tertiary level is two to three years in duration at *visa skola* and *visoka skola* (post-secondary non-university institutions), and four to six years at universities.

[20] If the true effect of war on depression is positive, OLS would produce larger positive estimates.

## 7. Robustness checks

In this section, we check the robustness of our main results to adding additional controls, and to using nonlinear models.

*Geographical mobility*. A first potential issue with our analysis is the role played by movers. We already said that current municipality fixed effects (FEs) are not included in the analysis, since after their inclusion the causal effect of recalling the war would be only identified by permanent movers, i.e. individuals whose current and pre-war municipalities do not coincide. In the absence of movers, indeed, war intensity in the first stage regression would be completely absorbed by current municipality fixed effects.[21] While in the previous Section we preferred not to include such FEs in order to identify the effect using both movers and non-movers, here we check the robustness of our IV-GMM estimates to including these FEs. Ex-ante, movers and non-movers may be very different sub-populations, and it is difficult to predict whether the effects of recalling the war are larger for the former or the latter. In the estimation sample used so far 53% of individuals are movers. If movers are those who suffer most from war-related violence, for instance, we might expect larger effects of recalling the war on them. Quite interestingly, this is not the case. Columns 1 and 2 of Table 3 report the estimates of recalling the war on the CES-D score and depression obtained with IV-GMM controlling for current municipality FEs. The estimated effects are in line with those reported in Table 2, namely 15.7 points ($t = 5.7$) and 54 p.p. ($t = 5.5$) on the CES-D score and depression, respectively. Our analysis may provide an additional explanation for the strong negative effects of war-induced displacement on individual labor market outcomes found by Kondylis (2010): individuals who migrated because of high war intensity are also more likely to have worse mental health.[22]

*Physical health*. Up to now, we have mainly focused our analysis on mental health. A possible reason why individuals constantly recall the war is that they suffered physical harm, which still persists and has a feedback into their current mental condition. This channel of influence would imply very different policies to address individuals' mental health problems, centered on physical rather than on mental therapy. We investigate this potential channel in-

[21] There is still some variation induced by war intensity-ethnicity interactions, but it is insufficient to identify the model.

[22] In her analysis Kondylis (2010) instruments displacement with municipality-level war intensity, and includes controls for individuals' physical health but not for mental health problems.

Table 3: Robustness checks (geographical mobility and physical health)

| | (1) IV-GMM *CES-D score* | (2) IV-GMM *Depression* | (3) IV-GMM *CES-D score* | (4) IV-GMM *Depression* |
|---|---|---|---|---|
| **Main equation: Mental health** | | | | |
| recall the war[(a)] | 15.661*** | 0.540*** | 17.673*** | 0.625*** |
| | (2.767) | (0.098) | (2.925) | (0.101) |
| age | 0.010 | -0.003* | 0.066 | -0.002 |
| | (0.054) | (0.002) | (0.057) | (0.002) |
| age squared | 0.001** | 0.000*** | 0.000 | 0.000** |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| female | 2.523*** | 0.084*** | 2.527*** | 0.081*** |
| | (0.223) | (0.010) | (0.248) | (0.010) |
| *Education (elementary)* | | | | |
| general secondary | -0.954 | -0.045 | -0.227 | -0.012 |
| | (0.654) | (0.029) | (0.519) | (0.025) |
| other secondary | -3.318*** | -0.139*** | -2.585*** | -0.103* |
| | (0.946) | (0.053) | (0.922) | (0.055) |
| vocational secondary | -1.285*** | -0.057*** | -1.063*** | -0.048*** |
| | (0.377) | (0.018) | (0.321) | (0.017) |
| technical secondary | -0.924*** | -0.038*** | -0.607*** | -0.024** |
| | (0.229) | (0.014) | (0.194) | (0.012) |
| post-secondary non-university (2-3 yrs) | -2.167*** | -0.063*** | -1.655*** | -0.044* |
| | (0.523) | (0.025) | (0.501) | (0.023) |
| university or higher | -1.799*** | -0.034 | -0.640 | 0.002 |
| | (0.487) | (0.023) | (0.556) | (0.024) |
| not reported | 2.946*** | 0.084*** | 2.940*** | 0.094*** |
| | (0.528) | (0.023) | (0.442) | (0.019) |
| *Ethnic group (Bosniak)* | | | | |
| Serb | -0.184 | -0.023 | 0.357 | 0.017 |
| | (0.539) | (0.025) | (0.336) | (0.012) |
| Croat | -0.234 | -0.000 | -1.675 | -0.034 |
| | (0.697) | (0.017) | (1.178) | (0.034) |
| other | 2.314*** | 0.046* | 1.613** | 0.033 |
| | (0.632) | (0.024) | (0.738) | (0.025) |
| not reported | 0.202 | -0.007 | 0.798 | -0.005 |
| | (0.550) | (0.019) | (0.512) | (0.019) |
| *Residence (capital)* | | | | |
| other urban | 2.246*** | 0.026 | 0.592 | 0.018 |
| | (0.488) | (0.025) | (0.754) | (0.021) |
| rural | 0.971 | 0.037 | 0.000 | -0.013 |
| | (0.656) | (0.029) | (0.875) | (0.025) |
| days with limitations in ADL | | | 0.347*** | 0.012*** |
| | | | (0.059) | (0.002) |
| **First stage: Recall the war** | | | | |
| $F-$statistic excluded instruments [$p-$value] | 23.79 [0.00] | 23.79 [0.00] | 37.01 [0.00] | 37.01 [0.00] |
| Anderson-Rubin Wald test[(b)] [$p-$value] | 42.59 [0.00] | 52.00 [0.00] | 42.58 [0.00] | 65.77 [0.00] |
| Hansen J-statistic[(c)] | 1.93 [0.74] | 1.61 [0.81] | 5.97 [0.20] | 5.90 [0.21] |
| Pre-war municipality controls | Yes | Yes | Yes | Yes |
| Current municipality controls | No | No | Yes | Yes |
| Current municipality FEs | Yes | Yes | No | No |
| N. observations | 6796 | 6796 | 6794[(c)] | 6794[(c)] |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

[(a)] Answer to the question: "During previous week, including today, how many times did constantly recall most painful events you experienced during the war?". Recall war takes on value one if individuals answered 'quite a bit' or 'extremely often' and zero otherwise.

[(b)] Weak instruments' robust inference test.

[(c)] Two observations are dropped from the sample because days with ADL's limitations are missing.

Note. The excluded instruments are the casualty rate in the pre-war municipality of residence of the individual and its interactions with ethnicity dummies. Heteroskedasticity-robust standard errors are clustered at the pre-war municipality of residence level (94 clusters).

cluding among the controls the number of days with limitations in Activities of Daily Living (ADL) during the last 4 weeks, as a proxy of physical health status.[23] Physical health, in this sense, is just another psychosocial stressor and a potential mediating factor which might affect mental health. After controlling for it, we only focus on the effect of war mental traumas on mental health. The results are reported in columns 3 and 4 of Table 3. The estimated effects of recalling the war increase, and are 17.7 points ($t = 6$) on the CES-D score and 62.5 p.p. ($t = 6.2$) on the probability of depression. Interestingly, each day an individual spends with ADL limitations is associated with a 0.35 points ($t = 5.9$) increase in the CES-D score and a 1.2 p.p. ($t = 6.2$) rise in the likelihood of being depressed. When using an indicator for having a chronic disease instead of the number of days with ADL's limitations, the estimated effects are 12.7 points ($t = 3.2$) on the CES-D score and 53.7 p.p. ($t = 4.8$) on depression. In all cases the instruments are not weak, and the Hansen-J statistic confirms their validity.[24] Overall, this evidence suggests that although physical conditions strongly affect an individual's mental health status, they are not the main channel through which recalling the war reduces individual mental well-being.

*Nonlinear models*. Using linear models to model non-linear outcomes may affect the consistency of the estimates. Lewbel et al. (2012) give examples in which even the sign of the estimated effects is wrong, and researchers can get significant negative effects when the true treatment effects of interest are instead positive. Apart from these extreme cases, linearity is likely to have a bearing on the magnitude of the estimated effects. For this reason, in the current Section we check the sensitivity of the estimated effects to using non-linear models. In particular, we use an endogenous treatment regression model, in which the CES-D score is modeled linearly and the recall war equation as a probit model (*endogenous treatment regression*), and a bivariate probit (more precisely an *endogenous treatment probit*, ET-Probit hereafter) model for depression, in which both the recall war and the depression equations are modeled as probit. On the one hand, both these models rely on joint normality, and on much stronger identifying assumption than those reported in the previous Section. On the other hand, the additional distributional assumptions, if correct, are likely to greatly increase the estimates' precision (i.e. to

[23]The exact wording of the question is 'How many days in the previous 4 weeks you did not perform the usual activities due to illness ?'.

[24]The complete results of these estimates are not shown in the table and are available on request.

increase efficiency), and, unlike linear IVs, allows us to obtain other parameters of interest such as Average Treatment Effects (ATE) and Average Treatment Effects on the Treated (ATET).

Table 4: Effect of recalling the war on mental health (nonlinear models)

| | (1) ET-regression[(b)] *CES-D score* | (2) ET-probit[(b)] *Depression* |
|---|---|---|
| **Main equation: Mental health** | | |
| recall the war[(a)]: ATE | 10.669*** | 0.308*** |
| | (0.834) | (0.056) |
| recall the war: ATET | | 0.504*** |
| | | (0.098) |
| $\rho^{(c)}$ | -0.076** | -0.284 |
| | (0.037) | (0.275) |
| **Treatment equation: Recall the war** | | |
| $\chi^2$ excluded instruments [$p-$value] | 47.67 [0.00] | 52.61 [0.00] |
| Pre-war municipality controls | Yes | Yes |
| Current municipality controls | Yes | Yes |
| N. observations | 6796 | 6796 |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

[(a)] Answer to the question: "During previous week, including today, how many times did constantly recall most painful events you experienced during the war?". Recall war takes on value one if individuals answered 'quite a bit' or 'extremely often' and zero otherwise.

[(b)] ET stands for 'Endogenous Treatment'. In the Table the coefficient on recall war status, which corresponds both to the ATE and the ATET, is reported in column (1). In column (2), the ATE is computed as the the average partial effect (APE) on the estimation sample, and the ATT as the APE on the sample of individuals for whom war recall status equals one.

[(c)] Correlation coefficient between the errors in the mental health and the recall war equations.

Note. The 'excluded instruments' are the casualty rate in the pre-war municipality of residence of the individual and its interactions with ethnicity dummies. All models include the same controls as in the linear models of Table 2. Standard errors are heteroskedasticity-robust and clustered at the pre-war municipality of residence level (94 clusters) in column (2), and clustered by pre-war municipality in column (1).

Column 1 of Table 4 reports the estimates of the endogenous treatment regression model for the CES-D score. The excluded 'instruments' are highly statistically significant in the recall war equation ($\chi^2(5) = 47.7$).[25] The estimated ATE of recalling the war on the CES-D score is 10.7 ($z = 12.8$), lower than that obtained with IV-GMM estimation in Table 2. Interestingly enough, the estimated correlation between the error terms in the CES-D score and the recall war equations is negative (-0.08) and statistically significant, suggesting that latent unobserved traits which makes individuals more likely to recall the war are *negatively* correlated with those

[25]The complete estimates of the recall war equation in the models reported in this Section are available on request.

worsening their mental health status (as a higher CES-D score means less mental well being). This negative correlation is consistent with the downward bias found in the OLS estimates when compared to the IV-GMM estimates. A possible explanation is that individuals who are more mentally vulnerable may tend not to report of remembering the war as a self-protection mechanism, generating false negatives in the treatment. Column 2 shows the estimates of the ET-probit model. In this case too the excluded variables used to identify the model are highly statistically significant in the first stage ($\chi^2(5) = 52.6$), and the estimated correlation between the error terms is negative but insignificant (-0.28). The estimated ATE of recalling the war on the probability of depression is 30.8 p.p. ($z = 5.5$),[26] smaller than the one obtained with IV-GMM in the LPM (62.5 p.p.). However, when marginal effects are computed only on the treated individuals (ATET), the estimates are much closer to those obtained with IV-GMM. The estimated ATET is indeed 50.4 p.p. ($z = 5.5$). Overall, these results suggest that the effects on the treated are larger than those on the overall population, and that this is partly responsible for the large magnitude of the IV-GMM estimates.

It must be kept in mind, though, that the ET-probit model (i.e. practically a bivariate probit model, BP hereafter) may be inconsistent in case the true data generating process is not jointly normal, and for this reason Chiburis et al. (2012) recommend to run the Murphy (2007) Rao score test in order to detect when the BP model is misspecified, and hence BP estimation is inconsistent. The value of the score test for the model in column (2) of Table 4 is 12.21 (distributed as $\chi^2(9)$) with a p-value of 0.2. Thus the null hypothesis of joint normality cannot be rejected in our data, and the ATE and ATET estimates obtained with the ET-probit model can be considered as reliable.

*Different treatment-intensities*. In all previous models, we have build a dichotomous indicator for the frequency of recalling the war by grouping the two highest categories of the possible answers. However, one might be interested in assessing the robustness of our results when considering treatments of different intensity corresponding to the four answers in the Likert scale. At what frequency recalling the war does become a problem? To give an answer to this question, we estimated a linear regression joint with an ordered probit for the CES-D score,

[26] This is computed as the average change in the probability of depression produced by switching the recall war status from zero to one in the estimation sample.

and a probit model joint with an ordered probit for the likelihood of depression.[27] We used in this case the same set of controls as in Table 2, and the results are shown in Table 5. Column 1 shows that all individuals remembering the war have worse mental health, the estimated effects, which are all statistically significant at the 1% level, are 4.8 points for remembering 'a little', 9.8 points for remembering 'quite a bit' and 17.8 points for remembering 'extremely often'. Consistently with these results, the effect that we obtained with the IV-GMM estimator after dichotomizing the treatment in Section 6 is very close to that found for the top category (i.e. remembering 'extremely often'). The estimates in column 2 are consistent with those in Section 6 too. The last two categories are indeed the most important in terms of raising the probability of depression, with estimated ATEs of 12 p.p. ($z = 2.8$), 29 p.p. ($z = 3.1$) and 52.5 p.p. ($z = 3.4$) for rembering the war 'a little', 'quite a bit' and 'extremely often, respectively. The ATETs for the same treatments are 12.5 p.p., 32.5 p.p. and 57 p.p., respectively, always statistically significant at the 1% level.

## 8. The economic burden of war trauma

As shown in the previous Section, war victimization has long-lasting negative effects on individual mental health. In this Section, we make an attempt to quantify some of the economic burdens of war trauma. There are different types of costs for individuals or firms at a micro-economic level and for the society as a whole at a macro-level. (WHO 2009). Providing hard figures for such costs is difficult and requires many assumptions. Just focusing on individuals, for instance, reaching a comprehensive estimate of all of the costs is very difficult because of the many aspects an individual's life involves, such as the direct costs of health expenditures (including health insurance), the loss of productivity and output, the consequences for other household members (who may react to an individual's reduced health with various coping mechanisms), the effects on human, physical and financial capital accumulation, non-market impacts (e.g., leisure) and other economic welfare losses. Many of these components are difficult to quantify. The part of these costs which is probably easier to estimate using micro-data is the labor market effect of a particular health condition. WHO (2009) recommends the use of the *output-related approach* (Goldschmidt-Clermont, 1987), which aims at

[27] These models were estimated using the `cmp` command in STATA.

Table 5: Different intensities of war-trauma (i.e. recalling the war)

| | (1) Simultaneous equation model *CES-D score* | (2) Simultaneous equation model *Depression*$^{(b)}$ |
|---|---|---|
| **Main equation: Mental health** | | |
| *Remember the war*$^{(a)}$ *(not at all)* | | |
| ATE: | | |
| a little | 4.772*** | 0.120*** |
| | (0.665) | (0.043) |
| quite a bit | 9.823*** | 0.290*** |
| | (0.971) | (0.095) |
| extremely often | 17.789*** | 0.525*** |
| | (1.508) | (0.156) |
| ATET: | | |
| a little | | 0.125*** |
| | | (0.045) |
| quite a bit | | 0.325*** |
| | | (0.099) |
| extremely often | | 0.570*** |
| | | (0.148) |
| **Treatment equation: Recall the war** | | |
| $\chi^2$ excluded instruments [$p-$value] | 49.85 [0.00] | 52.10 [0.00] |
| N. observations | 6796 | 6796 |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

$^{(a)}$ Answer to the question: "During previous week, including today, how many times did constantly recall most painful events you experienced during the war?". Recall war takes on value one if individuals answered 'quite a bit' or 'extremely often' and zero otherwise.

$^{(b)}$ ATE is computed as the average partial effect (APE) in the estimation sample. ATET is computed as the APE computed only on the sample of individuals for which each specific treatment is equal to one.

Note. The excluded instruments are the casualty rate in the pre-war municipality of residence of the individual and its interactions with ethnicity dummies. All models include the same controls as in the linear models of Table 2. The model in column 1 is an ordered probit (recall the war) jointly estimated with a linear equation (CES-D score). The model in column 2 is an ordered probit (recall the war) jointly estimated with a probit (depression). Heteroskedasticity-robust standard errors are clustered at the pre-war municipality of residence level.

isolating only the fraction of market production lost by an individual due to a specific health condition, by making comparisons between individuals with and without such condition.

In particular, in the current paper we are not interested in the economic burden of mental illness and depression per se (see, for instance, Das et al. 2008) but just in that caused by war trauma. In what follows, therefore, we measure the (potentially negative) effects that recalling the war has on an individual's labor force participation status, weekly working hours and net monthly incomes. When evaluating these effects, it should be noted that they may be an upper bound of the corresponding costs for households, which may use several coping mechanisms to alleviate the negative consequences produced by the onset of a negative health shock to one of its members (e.g. other household members may increase their labor supply in response to the reduced working capacity of the ill member). However, it is also true that some of these coping mechanisms are only temporary (WHO, 2009), that they may not prevent more negative consequences in the long-run (e.g., reduced investment in children's human capital) and that in principle also negative spillovers on other healthy family members are possible (e.g. healthy members might need to take care of the ill member and withdraw from the labour market).

In this section, we estimate the labor market effects of war victimization by both using linear IV-GMM and nonlinear models, focusing in this latter case on the ATET. We start from the latter, which are reported in panel A of table 6. All models include the controls used in Table 2 and the number of days with ADL's limitations as a proxy of an individual's physical health, which is likely to negatively affect labor market outcomes. Column 1 uses an ET-probit model and shows that recalling the war reduces the probability of labor force participation by about 23 p.p. ($z = -8.9$). This is a very large effect given that the average probability of participating in the labour market is 55% in the estimation sample for individuals not recalling the war. A significant effect emerges also for the number of weekly working hours in column 2 (where for both unemployment and non-participation hours are set to zero)[28]: individuals recalling the war work -12.1 ($z = -4.9$) hours less per week. When translated into monetary terms these negative effects amount to an about 65 ($z = -3.3$) Convertible Marks (KM) lower income (column 3), which corresponds to about 0.6 of a standard deviation in income (109 KM in our sample).

[28]This is done to account for the fact that war trauma may cause a complete withdrawal from the labour market.

Table 6: Labor market effects of war trauma

Panel A. Nonlinear models

| | (1) ET-probit[(b)] *labor force participation* | (2) ET-regression *weekly working hours* | (3) ET-regression *net monthly income* |
|---|---|---|---|
| **Main equation: Labor market outcomes** | | | |
| Recall the war[(a)] | -0.270*** | -12.172*** | -64.709*** |
| | (0.038) | (2.496) | (19.825) |
| $\rho^{(c)}$ | 0.534*** | 0.352*** | 0.147*** |
| | (0.110) | (0.060) | (0.050) |
| **First stage: Recall the war** | | | |
| $\chi^2$ excluded instruments [$p-$value] | 79.24 [0.00] | 63.77 [0.00] | 68.6 [0.00] |
| N. observations | 6794[(d)] | 6745[(d)] | 6794[(d)] |

Panel B. Linear IV-GMM models

| | IV-GMM[(b)] *labor force participation* | IV-GMM *weekly working hours* | IV-GMM *net monthly income* |
|---|---|---|---|
| **Main equation: Labor market outcomes** | | | |
| Recall the war[(a)] | -0.489*** | -23.128*** | -141.888*** |
| | (0.142) | (3.957) | (40.336) |
| **First stage: Recall the war** | | | |
| F-statistic excluded instruments [$p-$value] | 37.01 [0.00] | 37.42 [0.00] | 37.01 [0.00] |
| Anderson-Rubin Wald statistic [$p-$value] | 91.67 [0.00] | 40.4 [0.00] | 64.34 [0.00] |
| Hansen-J statistic [$p-$value] | 5.41 [0.25] | 8.46 [0.13] | 8.86 [0.06] |
| N. observations | 6794 | 6745[(d)] | 6794 |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

[(a)] Answer to the question: "During previous week, including today, how many times did constantly recall most painful events you experienced during the war?". Recall war takes on value one if individuals answered 'quite a bit' or 'extremely often' and zero otherwise.

[(b)] APEs for the individuals recalling the war are reported in this column, which corresponds to ATET.

[(c)] Correlation coefficient between the errors in the recall war and the labour outcome equations.

[(d)] 44 individuals who reported more than 72 weekly working hours (99th percentile) are omitted from the estimation sample.

Note. The excluded instruments are the casualty rate in the pre-war municipality of residence of the individual and its interactions with ethnicity dummies. All models include the same controls as in the linear models of Table 2. Heteroskedasticity-robust standard errors are clustered at the pre-war municipality of residence level. Income is expressed in Convertible Marks.

In order to have a rough idea of the aggregate cost of war trauma in terms of labour income losses, we make some simple back-of-the envelope calculations. Multiplying the average income loss per individual (-64.7 KM), by the fraction of the population aged 15 or more in 2001 (estimated at 3,105,544 in the World Bank's Development Indicators) recalling the war (3,105,544$\times$ 22%=683,220) and by 12 months, we obtain an increase of about 530 million KM in total annual labour incomes size years after the end of the war,[29] corresponding to 4.2% of GDP in 2001 (12.6 billion KM according to the World Bank World Development Indicators).

Panel B of table 6 reports the effects estimated with linear IV-GMM. The effects on individual labor market are generally larger, and amount at -49 p.p. on labour force participation, -23 weekly working hours and -142 KM in monthly wages, and are all statistically significant at the 1% level.

## 9. Concluding remarks

War-related violence may have long-lasting effects on an individual's mental health. However, assessing the causal effect of war on mental health is not an easy task given the paucity of high-quality data on individual war victimization and mental health. In this paper, we address this issue by matching the BiH LSMS, which contains a medically validated depression scale (CES-D), with high-quality data on war intensity at the municipality level provided by the Bosnian Book of the Dead. We add to the existing literature on the consequences of the BiH war by focusing on the effect of war trauma, proxied by constantly recalling painful war episodes, on individual mental health.

The IV-GMM estimates suggest that war trauma causes an increase of 16 points (more than one standard deviation) in the CES-D score (i.e., worse mental health) and 60 p.p. increase in the likelihood of showing depression symptoms (CES-D score$\geq$16). Robustness checks indicate that the estimates are robust to a number of issues, such as considering geographical mobility and allowing for different treatment intensities, and that the negative effects on mental health are not mainly mediated by physical health problems. Given that linear IV-GMM give local estimates (LATE), we also estimated nonlinear models, which provides very similar effects of war trauma on mental health. Using simple back-of-the-envelope calculations, we

[29] Precisely, 7,956,776 KM.

compute that the war-trauma effect of the war could have been as large as to account for 4.2% of BiH's GDP in 2001.

Our paper points to the existence of large negative effects of war violence on individual mental health, which last several years after the end of the conflict, and which are not mediated by other socio-economic stressors (unrelated to war trauma). Policies of reconstruction and investment, and economic recovery, may not be sufficient alone to completely remove the mental health legacy of war, while specifically targeted health programs may be needed for victimized individuals to overcome the psychological distress caused by the conflict.

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## Appendix A. Supplementary tables

Table A.1: Sample summary statistics

| Variable | N. obs. | Mean | St. Dev. |
|---|---|---|---|
| CES-D score (mental health) | 6796 | 9.703 | 10.239 |
| depression (CES-D≥16) | 6796 | 0.215 | 0.411 |
| recall war (war trauma) | 6796 | 0.220 | 0.414 |
| age | 6796 | 45.507 | 17.469 |
| age squared | 6796 | 2390.473 | 1674.141 |
| female | 6796 | 0.529 | 0.499 |
| *Education (elementary)* | | | |
| general secondary | 6796 | 0.028 | 0.164 |
| other secondary | 6796 | 0.006 | 0.078 |
| technical secondary | 6796 | 0.123 | 0.329 |
| vocational secondary | 6796 | 0.297 | 0.457 |
| post-secondary non-university | 6796 | 0.041 | 0.198 |
| university or higher | 6796 | 0.056 | 0.229 |
| missing | 6796 | 0.107 | 0.309 |
| *Ethnicity (Bosniak)* | | | |
| Serb | 6796 | 0.402 | 0.490 |
| Croat | 6796 | 0.084 | 0.278 |
| Other | 6796 | 0.021 | 0.142 |
| Not reported | 6796 | 0.078 | 0.268 |
| *Residence (capital)* | | | |
| other urban | 6796 | 0.406 | 0.491 |
| rural | 6796 | 0.343 | 0.475 |
| Activities of Daily Living (ADL) limitations | 6794 | 2.190 | 5.940 |
| *Pre-war municipality characteristics* | | | |
| ELF (pre-war municipality) | 6796 | 0.548 | 0.160 |
| *Post-war municipality characteristics* | | | |
| unemployment rate | 6796 | 0.383 | 0.129 |
| current municipality average monthly wage | 6796 | 338.924 | 123.288 |
| *Excluded instruments* | | | |
| casualty rate | 6796 | 2.166 | 2.459 |
| casualty rate × Serb | 6796 | 0.872 | 1.458 |
| casualty rate × Croat | 6796 | 0.079 | 0.353 |
| casualty rate × other | 6796 | 0.038 | 0.365 |
| casualty rate × unreported | 6796 | 0.201 | 1.122 |
| *Economic outcomes (cost of war trauma)* | | | |
| labour force participation | 6794 | 0.518 | 0.500 |
| weekly working hours - including non workers[(a)] | 6745 | 15.107 | 21.279 |
| net monthly wages (KM) - including non workers | 6794 | 109.906 | 231.411 |

[(a)] The sample excludes individuals who reported more than 72 weekly working hours (99th percentile).

Note. Summary statistics refer to the sample used in Table 2, and to the sample used in Table 6 only for the Economic outcomes used to compute the costs of war trauma.

Table A.2: First stage of IV-GMM estimates

| | IV-GMM |
|---|---|
| age | 0.010*** |
| | (0.002) |
| age squared | -0.000** |
| | (0.000) |
| female | 0.023** |
| | (0.012) |
| *Education (elementary)* | |
| general secondary | -0.055 |
| | (0.035) |
| other secondary | -0.064 |
| | (0.054) |
| technical secondary | -0.045** |
| | (0.022) |
| vocational secondary | -0.030* |
| | (0.016) |
| post-secondary non-university (2-3 yrs) | -0.092*** |
| | (0.033) |
| university or higher | -0.121*** |
| | (0.024) |
| not reported | 0.050* |
| | (0.027) |
| *Ethnic group (Bosniaks)* | |
| Serb | 0.003 |
| | (0.050) |
| Croat | -0.095 |
| | (0.084) |
| other | -0.098*** |
| | (0.032) |
| not reported | 0.044 |
| | (0.035) |
| *Residence (capital)* | |
| other urban | 0.014 |
| | (0.046) |
| rural | 0.065 |
| | (0.044) |
| *Excluded instruments* | |
| casualty rate | 0.018*** |
| | (0.005) |
| casualty rate × Serb | -0.005 |
| | (0.013) |
| casualty rate × Croat | 0.004 |
| | (0.047) |
| casualty rate × other | 0.024* |
| | (0.012) |
| casualty rate × unreported | -0.006 |
| | (0.007) |
| Pre-war municipality controls | Yes |
| Current municipality controls | Yes |
| N. observations | 6796 |

*, **, *** statistically significant at the 10%, 5% and 1% level, respectively.

Note. The dependent variable is a dichotomous indicator for recalling the war 'quite a bit' or 'extremely often'. The excluded instruments are the casualty rate in the pre-war municipality of residence of the individual and its interactions with ethnicity dummies. Heteroskedasticity-robust standard errors are clustered at the pre-war municipality of residence level.