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Hard to forget:
The long-lasting impact of war on mental health

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Abstract:
This paper examines the impact of war trauma experienced during the 1992-1995 Bosnia and Herzegovina conflict on individual mental health. By using a medically-validated depression scale and an instrumental-variable approach we show that, six years after the conflict, traumatised individuals are significantly more likely to be at risk of depression. Results are robust to a number of sensitivity checks accounting for individual geographical mobility and different treatment intensities, and suggest that the negative effects of war trauma are not mainly mediated by physical health problems. Moreover, war trauma has sizeable negative effects on individual labour market outcomes. [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.

"*Serbia's PM Aleksandar Vucic has been chased away by stone-throwing protesters from a ceremony marking the 20th anniversary of the Srebrenica massacre in Bosnia-Herzegovina.*" BBC Europe, 11th July 2015.

1. Introduction

The civil wars that broke out during the 1990s in 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 the disruptive effects of military conflicts in different contexts in terms of the human capital costs of survivors and lower economic growth and development (Blattman and Miguel 2010). 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 and stigma. Yet, while the 'tangible' costs of wars through the impact on survivors' physical health, education and economic wealth are routinely assessed, evaluations of the psychological costs of wars, including those on mental health, are far more scarce. This paper aims at filling this gap by assessing the long-lasting impact of war on mental health in post-conflict Bosnia and Herzegovina (BiH hereafter). The Bosnian war (1992-1995) came about following 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 took a severe toll on the whole economy (DFID 1999).

We add to the existing literature on the consequences of conflicts by focusing on the direct link between war trauma and the 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 the optimal design of post-conflict policies for recovery.

To assess the mental health consequences of violence, we depart from the assumption that the effects are homogeneous across groups or individuals and we account for the degree of individual exposure to violence, i.e. *war trauma*. This is done because war may have particularly traumatic effects on those directly exposed to terror (Miller and Rasmussen 2010, Kesternich et al. 2014). This is even more true when violence and crimes are systematically targeted against some specific groups in the population, as it is 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). By matching each individual to detailed local-area (municipality) war statistics gathered by the Bosnian Book of the Dead database on war-related casualties, and using survey information on war trauma, we are able to assess the lasting impact of war on mental well-being. Our identification strategy is based on instrumental variables (IV) estimation. We use survey information on individuals reporting to constantly recall painful war events as a proxy for war trauma. Yet, in order to address potential endogeneity and measurement concerns related to the latter variable, we instrument self-reported war trauma by using arguably exogenous variation in the intensity of war violence measured by the casualty rates at the municipality level. Indeed, war did not affect all BiH municipalities in the same way but there was some variation in war intensity and duration across geographical areas (Kondylis 2010, Swee 2015). Extant evidence as well as the nature of the Bosnian conflict, which was driven by the desire to create ethnically homogeneous geographic areas, support the exogeneity of war intensity with respect to individual's potential determinants of mental health, hence the validity of our identification strategy (Weidmann 2011).

Our IV estimates indicate that individuals who frequently recall the war are significantly more likely to have worse mental health. In particular, they score approximately 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 of 61 percentage points (p.p., hereafter). This effect must be interpreted as a local average treatment effect (LATE), i.e. the average effect on individuals whose recall war status is triggered by the instrument (war intensity). Using nonlinear models, which allow for recovering average treatment effects (ATE), we obtain effects of smaller magnitude both on

the CES-D score and on the probability of depression, which are one standard deviation of the CES-D score, and 47 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 income. Large negative effects are found on all of these outcomes. When aggregating the forgone labour income at the national level using simple back-of-the-envelope calculations, we find that war trauma may be responsible for a fall of 4.2 per cent in the 2001 BiH's 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. Section 6 reports the main results of our empirical analysis, and some robustness checks. In Section 7, we estimate the labour market effects of war trauma, and do some back-of-the-envelope calculations of the total costs for the country. Section 8 summarizes the main findings and concludes.

2. Exposure to violence and mental health: the background

The consequences of wars have received a considerable growing attention in the literature. Aggregate studies on the impact of conflict at country-level show that affected economies and populations adjust relatively quickly 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; 2012). 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 those exposed during adolescence (see also Bundervoet et al. 2009). 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 et al. 2006, Akresh and de Walque 2008, Justino et al. 2014, Swee 2015). Relatively minor shocks to educational access during childhood can lead to significant and long-lasting detrimental effects on individual human capital accumulation (Ichino and Winter-Ebmer 2004, León 2012, Akbulut-Yuksel 2014).

Comparatively much less evidence exists on the mental health effects of wars. Yet, this an important dimension to be considered in the study of conflicts since war and exposure to violence is one of the most (if not the most) serious shocks an individual may experience and – even if the conflict does not impose (by chance) any physical loss – it is likely to have a direct effect on individuals' mental health and distress. Mental well-being is an important component of human capital with long-lasting implications for individual productivity and economic outcomes. Weak mental health may entail poor labour market conditions, income losses, and higher health expenses (Miranda and Patel 2005). Studies of individual behaviour have documented the impact of mental health on employment, productivity and earnings (Ettner et al. 1997, Bartel and Taubman 1986), criminal activity (Steadman et al. 1998), child abuse and neglect (Kelleher et al. 1994), homelessness (Jencks 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 (Patel and Kleinman 2003, Das et al. 2008). In addition to these large personal costs, collective economic costs are also substantial, due to 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 OECD, 'the direct and indirect costs of mental ill-health are very high, and can amount to over 4% of GDP' (OECD 2014).

Two main obstacles must be overcome, though, when investigating the mental health effects of war. First, there are very few surveys collecting reliable measures of mental health and war trauma. Second, researchers must address endogeneity issues (i.e. potential individual unobservable factors simultaneously affecting war trauma and mental health) as well as reverse

causality concerns when self-reported measures of war-trauma are employed. On the one hand, 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, some vulnerable individuals may under-report war trauma or remove it from memories ('avoidance'), biasing the estimated effects of war trauma towards zerofootnote This happens because of misclassification error (Lewbel 2007). So the direction of the bias is a priori unknown.

To address endogeneity, reverse causality and measurement error issues, a source of plausibly exogenous and objective variation in the individual degree of war exposure is needed. The latter is provided in the context of veterans' mental health, for example, by the random variation in deployment zones e.g, combat vs. non-combat (Gade and Wenger 2011, Cesur et al. 2013).[1] When the goal is to investigate the mental health effects in the general population, a similar approach entails the use of exogenous variation in the war intensity across geographical areas, e.g. countries (Kesternich et al. 2014) or municipalities (Do and Iyer 2012) of residence at the time of the war. Kesternich et al. (2014) find, for instance, that exposure to WWII combats increases the risk of depression for individuals aged 50 or more. Do and Iyer (2012), instead, use the 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 the latter study. 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 shorter, 7-item, version, which is available in the 2003 and 2004 waves).[2] Second, and importantly, while Do and Iyer (2012) estimate the average effect of war both on victims and non-victims of war (mental) trauma, we only focus on the former.[3] This is motivated by the fact that there are different pathways through which war can affect mental health, i.e. backward-looking (memory of past traumatic events), current (e.g., slower economic recovery associated with current lower income) and forward-looking mech-

[1]Their findings suggest that deployment to combat zones, exposure to enemy fire 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 (PTSD) or depression.

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

[3]This point will be further discussed in Section 5.2.

anisms (less trust and willingness to cooperate after the war). According to the literature the first type of mechanism is most likely to be at work in case of huge and unexpected shocks such as natural disasters, economic crises and conflicts (Friedman and Thomas 2008, de Mel et al. 2008). On the other hand, in case of more common shocks, such as crime exposure in the society, forward-looking mechanisms may also play a role. Yet, while ordinary crime may directly hit both victims and non-victims through the fear of potential future victimisation (e.g. Cornaglia et al. 2014), more rare traumatic events such as natural disasters or wars are less likely to affect victimised and non-victimised people in the same way. In other words, in case of extreme and traumatic events, the fear of future victimisation is less relevant than the backward memory mechanism, which is indeed more likely to be at work for people being victimised. Hence, having war trauma and recalling conflict-related episodes may be the main pathway through which war can affect individual mental health. This is the reason why looking at the impact of war on the population as a whole, or using alternative proxies for war trauma (e.g. living in areas affected by the war or death of family members or friends) may lead to estimated effects smaller in magnitude (or biased towards zero) than it is the case when the main relevant mechanism, i.e. individual backward memory, is considered into the analysis.[4] Going beyond average effects and precisely identify war-victimised people is especially important when studying the consequences of internal or ethnic conflicts where violence and crimes are systematically targeted against specific sub-population groups.

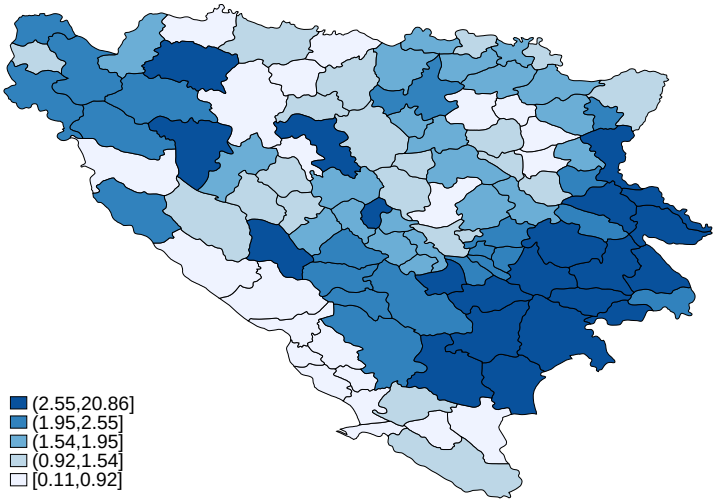
[4]Different proxies for being 'victimised' other than recalling the war, e.g. those having killings, injuries or refugee experiences of neighbours, friends or household members, may forgo the backward memory mechanism if these victimised people are able to go on with their lives and somehow forget the traumatic event. Yet, one aspect to be considered when using recalling the war as a proxy for war trauma, is the time elapsed since the traumatic event. Indeed, estimated war effects may be larger a few years after the conflict than later on in life, yet they may not completely disappear even in the long run (see Bramsen and van der Ploeg 1999, on WWII survivors).

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 with respect to 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 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 approximately 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 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 (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, 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 of leading 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 homogeneous 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 intensity of the conflict by municipality was largely unrelated to individual-level characteristics such as mental health or well-being.

Figure 1: Casualty rates (%) by BiH municipality



Note: Casualty rates are computed on the 1991 Census population. Municipalities in darker tonalities 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.

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% were Bosniaks, 25% were Bosnian Serbs and approximately 8% were Bosnian Croats. Although there are some data shortcomings,[5] the overall quality of the database is considered as high (Ball et al. 2007). Figure 1 reports casualty rates by municipality computed on the (1991 Census) population. Casualty rates were higher along the border with Serbia and Montenegro.[6]

[5]Information was collected by a number of sources, including individual informants, eye witnesses, close relatives, friends, neighbours, as well as from press reports, books, NGOs, government sources, and no standardized documents were required to prove statements of the respondents.

[6]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.

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 Federal 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.[7] Questionnaires were administered 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 behaviour, this scale has been validated in the psychological 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, which are reported in Appendix A.

The possible answers to these questions are 'Not at all', 'A little', 'Quite a bit', and 'Extremely often', which are assigned scores of 0, 1, 2, and 3, respectively. Scores on single questions are then summed to obtain an aggregate score ranging between a minimum of 0 (no depression symptoms) and a maximum of 42 (very severe depression symptoms). Higher CES-D scores indicate worse mental health. On a 20-item (60-point) scale, the cut-off score of 16 is generally considered as indicative of significant depressive symptomatology. In the analysis that follows, the score of the 14-item scale was converted into the 60-point scale.[8]

[7] Approximately half of the LSMS respondents were re-interviewed in the other three waves, collected in 2002-2004 (the Living in Bosnia and Herzegovina survey). The attrition rate across the panel waves is approximately 5%, which is relatively low compared to other national panels. As our excluded instruments are time invariant (see Section 5), using panel data would not improve our identification strategy because 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.

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

The first (i.e. 2001) wave of BiH LSMS also includes the following question: 'During the previous week, including today, how many times did you constantly recall the 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 age 16 or older answered 'Not at all'; 28.7% 'A little'; 14.75% 'Quite a bit'; and 7.6% 'Extremely often'. For the purpose of the current paper, we consider as 'victims of war (mental) trauma' individuals who answered 'Quite a bit' or 'Extremely often', and for brevity, we will refer to these individuals as to those 'recalling the war'.[9]

Table 1 reports the means of the CES-D score and depression 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, and in particular, individuals recalling the war have worse mental health. In the sample, individuals exposed to war trauma are 40 p.p. more likely to suffer from depression. Mental health of members of all ethnicity groups is negatively affected by war trauma, although Croats are the least likely to still recall the war. Mental health of women who did experience war trauma is comparatively worse than that of men who did.

The same positive association between mental ill-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 who do not. The distribution of the CES-D score for the former is shifted to the right.

5. Conceptual framework and empirical strategy

5.1. Conceptual framework

The conceptual framework underpinning the empirical analysis can be formally described 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. We specify the production function $f(.)$ for the *current stock of mental health* as follows:

$$H_i = f(\mathbf{X_i}, RW_i(WI_m, u_i), \mathbf{Y}_i, L_M, \varepsilon_i) \tag{1}$$

and the 14-item scales, respectively.

[9]By defining 'victims of war trauma' as those who remember the war 'quite a bit' and 'extremely often' we do not mean to say that all other people were not traumatised by the war. This is simply an analytical category.

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

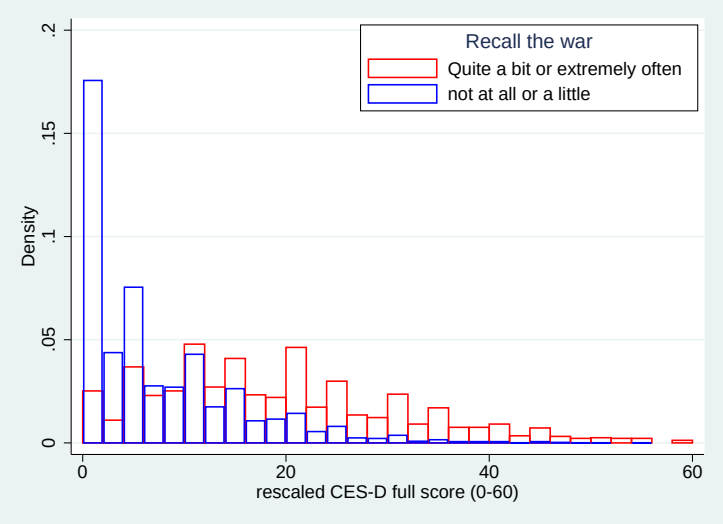
	Recall the war[(a)]		Does not recall the war(b)			
	mean (A)	% RW=1	mean (B)	% RW=0	Diff. (A)-(B)	t-test s.e.
CES-D score (0-60)						
All sample	18.9	22	7.1	78	11.8***	0.26
Gender						
man	15.6	19.39	5.5	80.61	10.1***	0.35
woman	21.3	24.33	8.6	75.67	12.7***	0.38
Ethnicity						
Bosniak	18.5	22.8	6.6	77.2	11.9***	0.37
Serb	19.4	23.17	8.1	76.83	11.3***	0.43
Croat	17.3	9.58	4.1	90.42	13.3***	1.08
other	23.5	17.14	8	82.86	15.5***	2.17
unreported	18.5	26.42	8.1	73.58	10.5***	1.01
Depression (CES-D≥16)						
All sample	0.53	22	0.13	78	0.40***	0.01
Gender						
man	0.4	19.39	0.08	80.61	0.32***	0.01
woman	0.62	24.33	0.18	75.67	0.44***	0.02
Ethnicity						
Bosniak	0.52	22.8	0.11	77.2	0.42***	0.02
Serb	0.53	23.17	0.16	76.83	0.37***	0.02
Croat	0.53	9.58	0.07	90.42	0.46***	0.04
other	0.67	17.14	0.13	82.86	0.54***	0.08
unreported	0.48	26.42	0.15	73.58	0.33***	0.04

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

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

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

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



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

where $\mathbf{X_i}$ is a vector of exogenous personal characteristics such as age and gender, RW_i is our individual war trauma indicator (as proxied by recalling the war), $\mathbf{Y}_i$ is a set of individual socio-economic characteristics and L_M captures the economic conditions of the individual's current area of residence. As reported in the equation above, RW_i is a function of war intensity in the individual's municipality of residence during the war (WI_m) since the exposure to the latter increases the individual likelihood of suffering from war trauma. This is the exogenous source of variation we use to identify the causal effect of war trauma on mental health. Indeed, as recalling the war also depends on some unobservable characteristics u_i (e.g., mental vulnerability) potentially correlated with mental health (through the unobservables ε_i), we have to deal with an endogeneity problem, as we discuss in details below.

Yet, there are different pathways through which both war intensity and trauma can affect mental health and we need to account for them in our identification strategy. First, war trauma may have not only a direct effect but also an indirect effect on mental health through individual socio-economic outcomes, e.g. productivity and labour market outcomes. This is so as war-traumatised individuals may be less likely to find a job or earn high wages. Differently said, by being affected by war trauma socio-economic outcomes are likely to be endogenous.

Moreover, war intensity can have an aggregate effect on the level of local development of the municipalities in which individuals are currently living through physical capital destruction and income opportunities, which in turn affect individual socio-economic status (SES). Hence, we can re-write equation (2) above as follows:

$$H_i = f(\mathbf{X_i}, RW_i(WI_m, u_i), \mathbf{Y}_i(RW_i, L_M), L_M(WI_m), \varepsilon_i). \tag{2}$$

From this equation we can compute the total effect of war intensity (WI) on mental health

$$\frac{\partial H_i}{\partial WI_m} = \underbrace{\frac{\partial f}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m}}_{\text{direct trauma effect of WI (A)}} + \underbrace{\frac{\partial f}{\partial \mathbf{Y}_i}\frac{\partial \mathbf{Y}_i}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m}}_{\text{indirect trauma effect of WI (B)}} + \underbrace{\left(\frac{\partial f}{\partial \mathbf{Y}_i}\frac{\partial \mathbf{Y}_i}{\partial L_M} + \frac{\partial f}{\partial L_M}\right)\frac{\partial L_M}{\partial WI_m}}_{\text{non-trauma effect of WI (C)}}. \tag{3}$$

In equation (3), we can distinguish between three effects of the war on mental health. The first effect is the *direct trauma effect of war intensity* (A), i.e. the consequences of direct exposure to war-related violence. A second effect is the *indirect trauma effect of war intensity*, mediated by individual SES, e.g., by lower labour market productivity (B). The last effect (C), i.e. the *non-trauma effect of war intensity*, is related to other 'stressors', which although being affected by the war, do not originate from war-trauma, e.g., worse social and material conditions possibly caused or exacerbated by war destruction. This distinction roughly corresponds to the distinction between *trauma-focused research* and the *psychosocial model* made by Miller and Rasmussen (2010).

Equations (2) and (3) are useful to highlight the main differences between the current paper and the analysis in Do and Iyer (2012). While estimating (2), we are interested in the effect of war trauma and omit SES variables among controls because of endogeneity concerns.[10] Instead, in order to isolate the effect of mental trauma, we do control for local development L_M by including physical capital destruction in the regression equations.[11] This is to say that we

[10] While it would be important to control for individual SES (since high war intensity may lead to low economic development, negatively affecting individual mental well being) to capture the non-trauma effects of the war, SES could partially capture the trauma effect of the war, and in this sense is a 'bad' control. Indeed, in Section 7 we investigate the economic costs of war trauma in terms of individual labour force participation, working hours and incomes. Moreover, SES is also al 'bad control' because SES is potentially affected by mental health. By not controlling for individual SES we avoid the potential reverse causality problem.

[11] See Deuchert and Huber (2014) for a discussion of the importance of control variables in IV estimation.

estimate the gross effect of war trauma on mental health (i.e. $\frac{\partial f}{\partial RW_i} + \frac{\partial f}{\partial \mathbf{Y}_i}\frac{\partial \mathbf{Y}_i}{\partial RW_i}$) while controlling for the non-trauma effects of the war. This is a major difference with respect to Do and Iyer (2012), which do not focus on recalling the war in equation (2) but directly estimate the effect of war intensity (WI_m) on mental health, while controlling for individual SES (namely individual employment status and the logarithm of per capita consumption) and hence excluding all the effects mediated by the latter. In our framework, looking at equation (3), they would estimate $\frac{\partial f}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m} + \frac{\partial f}{\partial L_M}\frac{\partial L_M}{\partial WI_m}$ that is a combination of the direct effect of trauma generated by war intensity on mental health and the non-trauma effects of war intensity that are not mediated by SES.[12] In other words, we focus on the average effect of remembering the war (i.e. 'war trauma'), while Do and Iyer (2012) focus on the average effect of war intensity on the whole population, including those little or no affected by war trauma.

5.2. Identification strategy

In a regression framework, our identification strategy can be illustrated using two equations. The first one is the mental health equation

$$H_i = \alpha_0 + \alpha_1 RW_i + \alpha_2{}' \mathbf{C_{imM}} + \varepsilon_i, \tag{4}$$

where $\mathbf{C_{imM}} = (L_m, L_M, \mathbf{X_i})$ is a vector of personal and municipality-level controls, ε_i is an idiosyncratic error term, and the α's are the parameters to be estimated. We use RW_i as a proxy of individual war trauma. It is worth noting that, because 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. The vector $\mathbf{C_{imM}}$ includes: gender, a quadratic in age, ethnicity, highest educational qualification attained, and the characteristics of the current municipality of residence (capital, other urban, rural). At the pre-war municipality level, we control for the Ethno-Linguistic Fractionalization (ELF) index computed from the 1991 population census. The latter aims at capturing the latent lack of trust and higher conflict that 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. To control for local economy characteristics (i.e. to account for the non-trauma effects of the

[12] It is worth noting that the first addend ($\frac{\partial f}{\partial RW_i}\frac{\partial RW_i}{\partial WI_m}$) is the effect of war trauma on mental health weighted by the effect of war intensity of war trauma (i.e. the Intention to Treat Effect).

war and preserve the exclusion restriction assumption) we further include a proxy for physical capital destruction in the post-war municipality of residence (the number of damaged housing units in 1995 collected by the UNHCR, normalized by population in 1991).[13] This variable also help capture destruction suffered by health infrastructures in different municipalities. A problem with estimating equation (4) with OLS is that the error term ε_i and recalling the war may be correlated. In particular, factors making an individual remember often the war may be correlated with her mental vulnerability. The direction of the correlation, and the OLS bias, is uncertain ex-ante. On the one hand, individuals with worse (latent) mental health (i.e. more mentally vulnerable) may be more likely to recall all painful events, including those related to war (see, for instance, Neuner 2010), leading to a positive bias to the OLS estimates (reverse causality). On the other hand, mental health problems are generally associated with social stigma and the most mentally vulnerable individuals may under-report war recalling (Boley 2007), negatively biasing the OLS estimates. This second problem is mainly a measurement issue, since we do not know whether an individual constantly recalls the war, but only what she reports.

To address these endogeneity, reverse causality and measurement issues, we need a source of exogenous (i.e. uncorrelated with ε_i) variation in RW_i to identify α_1. We argue that this source of variation can be provided by the interaction between objective measures of war intensity at the municipality level and individual ethnicity. Thus, the second equation, for recalling the war, is defined as

$$RW_i = \beta_0 + \beta_1 WI_m + \sum_{j=2}^{J} \beta_j (WI_m \times ethnic_i^j) + \gamma' \mathbf{C_{imM}} + u_i. \tag{5}$$

where $ethnic_i^j$ is a dichotomous indicator for individual i being of ethnicity j, and u_i is the error term. Information on war intensity (i.e. the total number of war-related casualties) from the Bosnian Book of the Dead is matched to the LSMS on the basis of the reported individual's residence just before the war, i.e. in April 1992.[14] It is worth noting that the number of ca-

[13] We do not include current municipality of residence fixed effects because working with cross-section data the effect of recalling the war on mental health would only be identified by non-returning migrants. On this specific point, see the following section.

[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 data on casualties at the settlement level.

sualties 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 publicly 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 because 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, i.e. Bosniaks) 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 ε_i). Concerning war intensity, we have no reason to expect that violence was especially targeted at individuals with poor mental health (see the discussion in Kondylis 2010, and Section 3). Indeed, violence was perpetrated against other ethnic communities with the aim of displacing them and creating ethnically homogeneous territories. Weidmann (2011) reports war intensity at the municipality level to be mainly predicted by the ethnic composition of the local population and by the distance to Croat and Serbian border (see Figure 1), and to be unrelated with potential correlates of mental health such as the level of per capita GDP before the war. A potential threat to identification is that war intensity might, in reality, capture latent higher conflict already present in a municipality, which may also affect pre-war mental health. For this reason, in the recall war equation we include the 1991 ELF index which controls, as mentioned above, for the latent lack of trust and greater conflict that might prevail in more culturally diverse environments. As for the second component of the instruments, i.e. ethnicity, a potential threat to identification may 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]

[15]Like all papers on the effects of the war on individual outcomes, our analysis is also subject to a triple form of sample selection. Indeed, individuals have to satisfy three selection criteria to be observed in the survey sample: they must have survived during the war; they must have survived during the post-war period, until 2001; and they must live in BiH in 2001. We already argued that the first type of selection is unlikely to have produced a selected sample in terms of mental health. As for the second, one may argue that if the war had a negative effect on mental health, we should expect relatively healthier individuals to have survived until 2001, and our estimates should be interpreted as lower bounds. Concerning the third type of selection on migration, Begic and McDonald (2006) find

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. Provided that an individual's income and labour force status are important correlates of mental health, war intensity may have a long-lasting effect through these mediating variables (Miller and Rasmussen 2010).[16] In this case, it could be not war trauma per se but the underdevelopment of municipalities that suffered more intense destruction causing worse mental health.[17] As we already mentioned, to corroborate the exclusion restriction assumption, we include in the regressions the municipality's level of physical capital destruction.

The third instrument requirement is its *relevance*: the instruments must be 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 B.1 in Appendix B reports the list of variables and the sample descriptive statistics.

6. Results

6.1. 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 if the CES-D score is at least 16 and zero otherwise (for brevity we label this variable as 'depression').[18] 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 (war recall) equation. Linear models have become quite popular among applied economists (see Angrist and Pischke 2009) and have a number of convenient features. First, in our case they

that Bosnian refugees in the US report 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 find a higher incidence of traumatic symptoms in the former and conclude that there may be more serious long-term psychological problems in people who are forced to leave their country during wartime. As displacement can also be considered an effect of war intensity, from the existing evidence, we argue 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 (lower bound).

[16] Physical capital recovery, however, could be fast. See, for instance, Miguel and Roland (2011) and Waldinger (2012).

[17] This nonetheless represents the causal effect of war, concerning the part that is mediated by material destruction (effect C in equation 3).

[18] As we mentioned above in the main text, 16 is the cut-off point generally considered as indicative of being at risk of depression.

do not require using a specific distribution for the error term in the mental health and the war recall equations. Second, the advantages are even greater when one is interested in endogenous treatment effects, because IV can be used. Unlike non-linear models, to deliver consistent estimates of the regression coefficients, linear models do not require both the mental health and the endogenous (treatment) dummy equations to be correctly specified. Hence, they are true IV estimators (Lewbel et al. 2012). Yet, linear models also have a number of less convenient features when they are applied to dichotomous variables, which will be discussed in the following section.

Table 2 reports main results, both OLS estimates as a benchmark and IV results. Column 1 reports OLS estimates of the CES-D score equation while column 2 reports those of the depression equation. Recalling the war is associated with a 9.6 points ($t = 13.8$) increase in the CES-D score (i.e. about one standard deviation) and a 33.1 ($t = 13.2$) 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 generally have better mental health status, but the effect is non-monotonic).

Columns 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 20.8, showing no sign of a weak instruments problem. Individuals who resided just 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 (see Table B.2 in the Appendix B), a one p.p. increase in the war casualty rate causes a 1.7 p.p. ($z = 3.4$) rise in the likelihood of recalling the war for Bosniaks. The effect is not statistically different for Serbs and Croats (the only statistically significant interaction term is that related with 'other ethnicity', which is positive).

In the second stage, recalling the war is estimated to increase the CES-D score by 15.8 points ($z = 4.7$) and the probability of depression by 60 p.p. ($z = 5.3$).[19] Overall, the IV effects

[19]We also estimated models not controlling for education. The latter may be indeed potentially affected by war trauma (Swee 2015) and including it may make our estimated causal effects on mental health more 'partial' (i.e. excluding the effect mediated by education). The estimated effects of war trauma without controls for education are slightly larger, 16.9 ($z = 5.89$) and 65.2 p.p. ($z = 6$) on the CES-D score and depression, respectively. Moreover, Swee (2015) shows that the negative effect of war intensity on secondary education attainment was mainly mediated by military draft.

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

	(1) OLS *CES-D score*	(2) OLS *Depression*	(3) IV *CES-D score*	(4) IV *Depression*
Main equation: Mental health				
recall the war[(a)]	9.642***	0.331***	15.764***	0.602***
	(0.698)	(0.025)	(3.335)	(0.113)
age	0.085*	-0.000	0.045	-0.002
	(0.044)	(0.002)	(0.057)	(0.002)
age squared	0.001	0.000**	0.001*	0.000***
	(0.001)	(0.000)	(0.001)	(0.000)
female	2.787***	0.093***	2.494***	0.081***
	(0.221)	(0.009)	(0.253)	(0.010)
Education (elementary)				
general secondary	-1.102	-0.050*	-0.757	-0.022
	(0.675)	(0.030)	(0.589)	(0.026)
other secondary	-4.269***	-0.152***	-3.563***	-0.117**
	(0.831)	(0.049)	(0.938)	(0.055)
technical secondary	-1.573***	-0.066***	-1.462***	-0.054***
	(0.472)	(0.019)	(0.341)	(0.017)
vocational secondary	-1.022***	-0.040***	-0.881***	-0.029**
	(0.310)	(0.013)	(0.217)	(0.013)
post-secondary non-university (2-3 yrs)	-2.406***	-0.076***	-2.175***	-0.052**
	(0.631)	(0.024)	(0.483)	(0.023)
university degree or higher	-2.085***	-0.048**	-1.582***	-0.022
	(0.494)	(0.020)	(0.570)	(0.024)
not reported	3.368***	0.102***	3.534***	0.111***
	(0.606)	(0.025)	(0.501)	(0.021)
Ethnic group (Bosniak)				
Serb	0.942	0.024	0.809	0.021
	(0.630)	(0.018)	(0.511)	(0.014)
Croat	-3.914***	-0.095**	-1.964	-0.037
	(1.279)	(0.036)	(1.234)	(0.034)
other	2.231***	0.047	1.819***	0.040
	(0.775)	(0.029)	(0.700)	(0.025)
not reported	0.941	0.010	1.334**	0.007
	(0.688)	(0.024)	(0.554)	(0.021)
Residence (capital)				
other urban	1.578**	0.050**	1.433***	0.037**
	(0.618)	(0.020)	(0.554)	(0.017)
rural	1.399*	0.030	0.758	0.009
	(0.739)	(0.024)	(0.730)	(0.023)
ELF index (pre-war residence)	-0.858	-0.053	-1.373	-0.034
	(3.003)	(0.091)	(2.311)	(0.070)
buildings damaged (current residence)	0.023	0.000	-0.001	-0.001
	(0.041)	(0.001)	(0.038)	(0.001)
First stage: Recall the war				
$F-$statistic excluded instruments [$p-$value]			20.83 [0.00]	20.83 [0.00]
Anderson-Rubin Wald statistic [(b)] [$p-$value]			44.43 [0.00]	58.97 [0.00]
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: coefficients on the instruments in the reduced form are jointly zero).

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

are larger in magnitude than the OLS estimates. We already mentioned that the direction of the OLS bias is unknown a priori. Indeed, on the one hand mental vulnerability may make individuals more likely to experience flashback or recollection of war events, leading to a positive bias of the OLS estimates. On the other hand, some individuals may under-report war recall to avoid the social stigma, producing misclassification errors in recalling the war and biasing the OLS estimates toward zero (Lewbel 2007). Moreover, in case of heterogeneous effects of recalling the war on mental health, IV estimates with a continuous instrument recover a weighted average of the Local Average Treatment Effects (LATE) defined for all pairs of instrument values in the support of the instrument. The LATE are the effects of the treatment on those individuals whose treatment status is changed when switching from one value of the instrument to a larger value, in our specific case those individuals whose war recall status is 'switched on' by an increase in war intensity. It might be well the case that these individuals have specific characteristics that make the negative effects of war trauma larger than for the average individual in the population. Individuals who 'switched on' their 'recall the war' status due to variation in the instrument, for instance, may be those already having high CES-D scores before the war, but below the 16 point clinical threshold. In this case, the trauma effect of the war estimated with IV on these 'marginal' individuals could be larger than that suffered by the average individual in the population, and we would be estimating an upper bound of the Average Treatment Effect (ATE). Also for this reason, in the next section we will provide estimates of the ATE obtained from limited dependent variables models.

6.2. Robustness checks

In this section, we check the robustness of our main results by adding extra controls in the regressions, and by using nonlinear models.

Geographical mobility. A first potential issue with our analysis is the role played by movers. As discussed while describing the context above, the BiH conflict had a huge effect on people displacement and internal mobility. In the estimated specifications reported so far, we do not include current-municipality fixed effects (FEs) because upon their inclusion, the causal effect of recalling the war would be identified by permanent movers only, i.e., by individuals whose

current and pre-war municipality of residence are different.[20] Thus, in the previous section, we identify the mental health effect by using both movers and non-movers. Here, though, we check the robustness of our IV estimates to the inclusion of current-municipality FEs. 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 our estimation sample, 53% of individuals are movers. If movers are those who suffer the most from war-related violence, for instance, we might expect larger effects of recalling the war on them. 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 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 provides an additional explanation for the strong negative effects of war-induced displacement on individual labour market outcomes found by Kondylis (2010): individuals who migrated because of high war intensity are also more likely to have worse mental health.[21]

Physical health. Up to now, we have focused our analysis on mental health. A possible reason why individuals constantly recall the war, though, is that they suffered physical harm, which still persists and has a feedback effect on their current mental condition. This channel of influence would imply very different policies to address individuals' mental health problems, centred on physical rather than on mental therapy. We investigate this potential channel by including 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.[22] Physical health is just another psychosocial stressor but also a potential mediating factor that 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 16.6 points ($z = 5.2$) on the CES-D score and 60.6 p.p. ($z = 5.4$) regarding the probability of depression. Interestingly, each day an individual spends

[20] Indeed, in the absence of movers, in the first-stage regression, the war-intensity variable would be completely absorbed by current-municipality fixed effects. There is still some variation induced by war intensity-ethnicity interactions, but it is insufficient to identify the model.

[21] In her analysis, Kondylis (2010) uses municipality-level war intensity as an instrument for geographical displacement, and includes controls for individuals' physical health but not for mental health status.

[22] 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 ?'

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

	(1) IV *CES-D score*	(2) IV *Depression*	(3) IV *CES-D score*	(4) IV *Depression*
Main equation: Mental health				
recall the war[(a)]	15.661***	0.540***	16.631***	0.606***
	(2.767)	(0.098)	(3.220)	(0.112)
age	0.010	-0.003*	0.077	-0.001
	(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***	2.538***	0.084***
	(0.223)	(0.010)	(0.254)	(0.010)
Education (elementary)				
general secondary	-0.954	-0.045	-0.448	-0.014
	(0.654)	(0.029)	(0.530)	(0.025)
other secondary	-3.318***	-0.139***	-2.691***	-0.091*
	(0.946)	(0.053)	(0.896)	(0.055)
technical secondary	-1.285***	-0.057***	-1.183***	-0.048***
	(0.377)	(0.018)	(0.343)	(0.017)
vocational secondary	-0.924***	-0.038***	-0.659***	-0.024**
	(0.229)	(0.014)	(0.206)	(0.012)
post-secondary non-university (2-3 yrs)	-2.167***	-0.063***	-1.786***	-0.044*
	(0.523)	(0.025)	(0.498)	(0.023)
university degree or higher	-1.799***	-0.034	-0.956*	-0.005
	(0.487)	(0.023)	(0.547)	(0.023)
not reported	2.946***	0.084***	3.076***	0.095***
	(0.528)	(0.023)	(0.426)	(0.019)
Ethnicity group (Bosniak)				
Serb	-0.184	-0.023	0.490	0.011
	(0.539)	(0.025)	(0.483)	(0.013)
Croat	-0.234	-0.000	-1.719	-0.033
	(0.697)	(0.017)	(1.229)	(0.034)
other	2.314***	0.046*	1.503**	0.029
	(0.632)	(0.024)	(0.721)	(0.026)
not reported	0.202	-0.007	0.874*	-0.005
	(0.550)	(0.019)	(0.486)	(0.019)
Residence (capital)				
other urban	2.246***	0.026	1.113**	0.027
	(0.488)	(0.025)	(0.543)	(0.017)
rural	0.971	0.037	0.524	0.002
	(0.656)	(0.029)	(0.620)	(0.021)
ELF index (pre-war residence)	2.246	0.078	-1.285	-0.033
	(1.979)	(0.075)	(2.344)	(0.071)
buildings damaged (current residence)			-0.005	-0.001
			(0.036)	(0.001)
days with limitations in ADL			0.363***	0.012***
			(0.059)	(0.002)
Current municipality FEs	Yes	Yes	No	No
First stage: Recall the war				
$F-$statistic excluded instruments [$p-$value]	23.79 [0.00]	23.79 [0.00]	28.79 [0.00]	28.79 [0.00]
Anderson-Rubin Wald test[(b)] [$p-$value]	42.59 [0.00]	52.00 [0.00]	51.95 [0.00]	79.15 [0.00]
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 (null hypothesis: coefficients on the instruments in the reduced form are jointly zero).

[(c)] Two observations are dropped from the sample because days with ADL 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 indicators. Heteroskedasticity-robust standard errors (in parentheses) are clustered at the pre-war municipality of residence level (94 clusters).

with ADL limitations is associated with a 0.36 points ($z = 6.1$) increase in the CES-D score and a 1.2 p.p. ($z = 5.9$) rise in the likelihood of showing depression symptoms. When using an indicator for having a chronic condition instead of the number of days with ADL limitations (results are not reported in the table), the estimated effects are 12.8 points ($z = 3$) on the CES-D score and 57.8 p.p. ($z = 5.3$) on depression. In both cases the instruments are not weak. 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 be problematic. In particular, linearity is likely to have a bearing on the magnitude of the estimated effects. Horrace and Oaxaca (2006) shows that the Linear Probability Model (LPM) is inconsistent when the linear predictions fall outside the unit interval (i.e., predicted probabilities are less than zero or greater than one). Lewbel et al. (2012) give examples in which even the sign of the estimated effects may be wrong, and researchers can get significant negative effects when the true treatment effects of interest are instead positive. For this reason, we further check the sensitivity of our estimates to using non-linear models. We use an endogenous treatment regression model, in which the CES-D score is modelled as linear and the recall war equation as a probit model (*endogenous treatment regression*). We also use 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 modelled 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 significantly increase the estimates' precision (i.e. efficiency). Moreover, unlike linear IV, limited dependent variables models allows us to obtain other parameters of interest such as the ATE.

Column 1 (Panel A) 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 ($\chi^2(5) = 49.7$).[23] The estimated ATE of recalling the war on the CES-D score is 10.6 ($z = 11$), lower than that obtained with IV in Table 2. Interestingly, the estimated

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

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

	(1) *CES-D score*[(b)]	(2) *Depression*[(b)]
Panel A. Dichotomous treatment		
Main equation: Mental health		
recall the war[(a)] (ATE)	10.614***	0.468***
	(0.966)	(0.156)
$\rho^{(c)}$	-0.072	-0.317
	(0.045)	(0.214)
Treatment equation: Recall the war		
χ^2 excluded instruments [$p-$value]	49.69 [0.00]	50.75[0.00]
N. observations	6796	6796
Panel B. Multinomial (ordered) treatment		
Main equation: Mental health		
Remember the war[(a)] *(not at all)*		
a little (ATE)	4.853***	0.122***
	(0.685)	(0.051)
quite a bit (ATE)	9.900***	0.293***
	(0.998)	(0.107)
extremely often (ATE)	17.878***	0.529***
	(1.630)	(0.177)
$\rho^{(c)}$	-0.074	-0.025
	(0.054)	(0.229)
Treatment equation: Recall the war		
χ^2 excluded instruments [$p-$value]	47.96 [0.00]	49.64 [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)] Models. Panel A, column (1): ET-regression; Panel A, column (2): ET-probit; Panel B, column (1): simultaneous equation model with ordered probit and linear equation; Panel B, column (2): simultaneous equation model with ordered probit and probit. ATE is computed in the ET-probit using the `biprobittreat` STATA command as the average difference in the marginal probabilities of depression when changing recalling the war status from zero to one. Standard errors are bootstrapped. The model in panel B column (2) is estimated using the `cmp` STATA command, and ATE are computed as average marginal effects.

[(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 indicators. All models include the same controls as in the linear models of Table 2. Standard errors (in parentheses) are heteroskedasticity-robust and clustered at the pre-war municipality of residence level (94 clusters).

correlation between the error terms in the CES-D score and the recall war equations is negative (-0.07) but not statistically significant, suggesting that latent unobserved traits that make individuals more likely to recall the war are *negatively* correlated with those 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 estimates. A possible explanation is that individuals who are more mentally vulnerable may tend not to report remembering the war to avoid social stigma, generating false negatives in the treatment status. Column 2 (Panel A) shows the estimates of the ET-probit model. In this case as well, the excluded variables used to identify the model are highly statistically significant in the recall war equation ($\chi^2(5) = 50.8$), and the estimated correlation between the error terms is negative but insignificant (-0.32). The estimated ATE of recalling the war on the probability of depression is 46.8 p.p. ($z = 3$), smaller than the effect obtained with IV in the LPM (60 p.p.) but larger than the OLS estimates (33 p.p.).

It should be noted though that the effects obtained with limited dependent variables models may be inconsistent in case the true data-generating process is not jointly normal, and for this reason Chiburis et al. (2012) recommend running the Rao score test (Murphy 2007) to detect when the model is misspecified, and hence estimates are inconsistent. The value of the score test for the model in column 2 of Table 4 is 14.89 (distributed as $\chi^2(9)$) with a $p-$value of 0.09. Thus the null hypothesis of joint normality cannot be rejected in our data at the 5% level.

Different treatment intensity. In all of the previous models, we have used 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 does recalling the war become a problem? To give an answer to this question, we estimated a linear regression jointly with an ordered probit for the CES-D score and a probit model jointly with an ordered probit for the probability of depression.[24] We included the same set of controls as in Table 2, and the results are shown in panel B of Table 4. Column 1 (Panel B) shows that all individuals remembering the war have worse mental health, the estimated effects, which are all statistically significant at the 1% level, are

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

4.9 points for remembering 'A little', 9.9 points for remembering 'Quite a bit' and 17.9 points for remembering 'Extremely often'. Consistent with these results, the effect we obtained with the IV 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 (Panel B) are also consistent with those in Section 6. The last two categories are indeed the most important in terms of increasing the probability of depression, with estimated ATE of 12.2 p.p. ($z = 2.4$), 29.3 p.p. ($z = 2.7$) and 52.9 p.p. ($z = 3$) for remembering the war 'A little', 'Quite a bit' and 'Extremely often, respectively.[25]

7. The economic burden of war trauma

As shown in the previous section, war trauma has long-lasting negative effects on individual mental health. In this section, we provide some evidence on 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 difficult because of the many aspects of an individual's life involved, such as the direct costs of health expenditures (including health insurance), the loss of productivity and output, the consequences for other household members, 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 very difficult to quantify. The component of these costs that is probably easier to estimate using BiH LSMS data is the labour market effect of a particular health condition. WHO (2009) recommends the use of the *output-related approach* (Goldschmidt-Clermont 1987), which aims at 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 a condition. These indirect costs are substantial, and account for the largest share (76%) of the total costs of depression in the European Union (Sobocki et al. 2006).

In what follows we measure the effects that war trauma has on an individual's labour force

[25]The coefficient on the highest category is very close to that obtained with IV using the dichotomous definition of war trauma. This result confirms our initial suspicion that it could be individuals with high pre-war CES-D scores who cross the 16 points threshold due to variation in our instrument, and who are weighted higher in our IV estimator of the LATE.

Table 5: Labour market effects of war trauma (ATE)

	(1) ET-probit[(b)] *labour force participation*	(2) ET-regression *weekly working hours*	(3) ET-regression *net monthly income*
Main equation: Labour market outcomes			
Recall the war[(a)]	-0.283***	-12.235***	-68.172***
	(0.045)	(2.464)	(21.113)
$\rho^{(c)}$	0.588***	0.355***	0.157***
	(0.109)	(0.057)	(0.052)
First stage: Recall the war			
χ^2 excluded instruments [$p-$value]	60.53 [0.00]	59.83 [0.00]	70.89 [0.00]
Mean for individuals not recalling the war	0.55	15.72	118.91
N. observations	6794[(d)]	6745[(d)]	6794[(d)]

*, **, *** 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 computed with the `biprobittreat` STATA command as the average difference in the marginal probabilities of labour force participation when changing recalling the war status from zero to one. Standard errors are bootstrapped.

[(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 indicators. All models include the same controls as in the linear models of Table 2 and a measure of ADL limitations. Heteroskedasticity-robust standard errors (in parentheses) are clustered at the pre-war municipality of residence level. Income is expressed in Convertible Marks.

participation status, weekly working hours and net monthly income. 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 labour supply in response to the reduced working capacity of the ill member). However, it is also the case that some of these coping mechanisms are only temporary (WHO 2009), may not prevent more negative consequences in the long run (e.g., reduced investment in children's human capital) and that, in principle, negative spillovers on other healthy family members are also possible (e.g., healthy members might need to take care of the ill member and withdraw from the labour force).

In this section, we focus on the labour market effects of war trauma obtained from nonlinear models, from which it is possible to compute ATE. All models include the controls used in Table 2 and the number of days with ADL limitations as a proxy of an individual's physical ill-health, which is likely to negatively affect her labour market outcomes.

Column 1 of Table 5 shows that recalling the war reduces the probability of labour force participation by 28.3 p.p. ($z = -6.2$). This is a large effect, given that the average participation rate of individuals not recalling the war is 55% in the estimation sample: war trauma halves an individual's probability of participating in the labour force. In the following columns, we estimate the cost of war trauma in terms of weekly working hours and net monthly income losses. In both estimations, we include zero hours and zero income observations for those who either do not participate in the labour force or are unemployed.[26] As expected, given the very large effect on the extensive margin of labour supply, a significant effect emerges for the number of weekly working hours in column 2: individuals recalling the war work -12.2 ($z = -5$) hours less per week. When translated into monetary terms these negative effects amount to an approximately 68 ($z = -3.2$) Convertible Marks (KM) lower income (column 3). Computed at the sample means for weekly hours and incomes, these effects correspond to a reduction of 78% and 57% in labour supply and income, respectively.

To give an approximate idea of the aggregate cost of war trauma in terms of labour income losses, we do some back-of-the-envelope calculations. By multiplying the average income loss

[26] As shown in column 1, selecting the sample according to labour force or employment status (retaining only non-zero observations) would be non-random with respect to the treatment.

per individual (-68.17 KM) by the fraction of the population age 15 or older in 2001 (estimated at 3,105,544 in the World Bank's Development Indicators) who recall the war (3,105,544$\times$ 22%=683,220) and by 12 months, we obtain 530 million KM of total annual labour incomes six years after the end of the war,[27] corresponding to 4.4% of GDP in 2001 (12.6 billion KM according to the World Bank World Development Indicators).

All in all, our study points to large indirect costs of war mental trauma. Our estimates are, however, consistent with the assessment of the indirect costs of mental ill-health made by other studies. OECD (2012) reports, for instance, relative employment rates of poorly educated individuals with severe mental disorder typically around 0.5, and of medium educated individuals (i.e. with upper secondary education) between 0.60 and 0.83 in high income countries which were not recently exposed to war-related violence. According to some recent studies, the estimated total (direct and indirect) costs of mental illness in terms of lost output are equally large, 4.4% of GDP in Canada, 4.1% in England and 2.3% in France, with the indirect costs often being larger than the direct ones (OECD 2014).

8. 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. This is an important distinction to make when assessing the effect of war violence unevenly inflicted across the civilian population.

The IV estimates, which exploit differences in war intensity across BiH municipalities, suggest that war trauma causes an increase of 16 points (about one and half standard deviations) in the CES-D score (i.e., worse mental health) and a 61 p.p. increase in the likelihood of showing depression symptoms (CES-D score greater than 16). Sensitivity checks indicate that

[27] Precisely, 558,901,289 KM.

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 provides local estimates (LATE), we also estimate nonlinear models to recover ATE. ATE are smaller, and amount to -10.6 points (about one standard deviation) on the CES-D score and -47 p.p. on the probability of depression.

War trauma also has sizeable effects on individual labour market outcomes. Individuals who experienced a war trauma have a 52% lower probability to participate in the labour force, 78% lower weekly working hours, and 57% lower income. Using simple back-of-the-envelope calculations, we compute that the aggregate war-trauma effect may have been as large as to account for 4.4% of BiH's GDP in 2001.

Our findings point to 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, 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 victimised individuals to overcome the psychological distress caused by the conflict and mitigate the economic consequences of war trauma.

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Appendix A. Questions about mental health (CES-D depression scale)

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 of 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 the 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 like 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?'

Appendix B. Supplementary tables

Table B.1: Sample summary statistics

Variable	N. obs.	Mean	St. Dev.
CES-D score (mental health)	6796	9.703	10.239
depression (CES-D$\geq$16)	6796	0.215	
recall war (war trauma)	6796	0.220	
age	6796	45.507	17.469
age squared	6796	2390.473	1674.141
female	6796	0.529	
Education (elementary)			
general secondary	6796	0.028	
other secondary	6796	0.006	
technical secondary	6796	0.123	
vocational secondary	6796	0.297	
post-secondary non-university	6796	0.041	
university degree or higher	6796	0.056	
not reported	6796	0.107	
Ethnicity (Bosniak)			
Serb	6796	0.402	
Croat	6796	0.084	
other	6796	0.021	
not reported	6796	0.078	
Residence (capital)			
other urban	6796	0.406	
rural	6796	0.343	
Activities of Daily Living (ADL) limitations	6794	2.190	5.940
chronic condition	6796	0.295	
Pre-war municipality characteristics			
ELF (pre-war municipality)	6796	0.548	0.160
Excluded instruments			
casualty rate	6796	2.166	2.459
casualty rate $\times$ Serb	6796	0.872	1.458
casualty rate $\times$ Croat	6796	0.079	0.353
casualty rate $\times$ other	6796	0.038	0.365
casualty rate $\times$ unreported	6796	0.201	1.122
Economic outcomes (cost of war trauma)			
labour force participation	6794	0.518	
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 5 only for the Economic outcomes used to compute the costs of war trauma.

Table B.2: First stage of IV (GMM) estimates

Variable	Coef.
age	0.010***
	(0.002)
age squared	-0.000**
	(0.000)
female	0.024**
	(0.012)
Education (elementary)	
general secondary	-0.053
	(0.035)
other secondary	-0.062
	(0.055)
technical secondary	-0.042*
	(0.023)
vocational secondary	-0.030*
	(0.017)
post-secondary non-university (2-3 yrs)	-0.092***
	(0.033)
university degree or higher	-0.119***
	(0.024)
not reported	0.050*
	(0.026)
Ethnicity group (Bosniaks)	
Serb	0.026
	(0.043)
Croat	-0.098
	(0.087)
other	-0.090***
	(0.031)
not reported	0.052
	(0.034)
Residence (capital)	
other urban	-0.004
	(0.033)
rural	0.041
	(0.033)
ELF index (pre-war residence)	0.145
	(0.144)
buildings damaged (current residence)	0.001
	(0.002)
Excluded instruments	
casualties rate	0.017***
	(0.005)
casualty rate × Serb	-0.009
	(0.013)
casualty rate × Croat	0.000
	(0.049)
casualty rate × other	0.023*
	(0.012)
casualty rate × not reported	-0.007
	(0.008)
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 indicators. Heteroskedasticity-robust standard errors (in parentheses) are clustered at the pre-war municipality of residence level.