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in Ukraine and the Path for Rebuilding**

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ABSTRACT

The Effect of the War on Human Capital in Ukraine and the Path for Rebuilding*

In February 2022, Russia launched a full-scale invasion of Ukraine. The ensuing war has a devastating destructing impact in Ukraine. This article focuses on the humanitarian cost of war. The article develops a framework for the analysis of the effect of a war on country's human capital. We then identify the following key directions for rebuilding and further developing human capital in Ukraine: quantity and quality of schooling for children, quality of higher education, training and retraining programs for adults, assistance for people with disabilities, post-deployment re-integration into the civilian sector, population growth and fertility, and promotion of self-motivating mechanisms.

JEL Classification: I2, J24, O4

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1 Introduction

In February 2022, Russia launched a full-scale invasion of Ukraine, which has already caused a major destruction and loss of human life in the country. The war continues to have profound effects on the Ukrainian population. Rebuilding the Ukrainian economy and planning to revive the economic and social livelihood of Ukraine are of foremost importance. Following World War II, the economic growth literature has extensively analyzed the economic performances of various countries and identified accumulation of physical capital, human capital accumulation and technological catch-up as important factors for economic and social recovery (e.g., Christensen, Cummings, and Jorgenson (1980) and Gilchrist and Williams (2004)). This article focuses on the effect of the war on country's human capital and identifies key directions for rebuilding human capital in Ukraine.

We develop a simple framework to identify the key channels of the human capital consequences of the war. The war has direct and immediate effects on the size of the workforce because of the increase in deaths, injuries and military mobilization. In addition to these immediate adverse effects, there are various other channels that likely have long-lasting consequences. The disruption of schooling of younger cohorts, human capital depreciation due to loss of potential work experience and deterioration of health—all contribute negatively and persistently to the human capital stock of the country. Identifying these persistent effects is important since recovery critically relies on addressing them. Although our analysis is qualitative, we can combine our theoretical framework, findings from the existing literature and empirical evidence on the humanitarian impact of the war in Ukraine to develop directions for rebuilding human capital in Ukraine.

The rest of the article is structured as follows. Section 2 outlines a simple model of country's human capital and describes channels through which war impacts human capital. Section 3 describes the humanitarian situation in Ukraine. Section 4 qualitatively summarizes human capital losses using the framework outlined in Section 2. Section 5 outlines key directions for rebuilding of human capital. Section 6 concludes.

2 Theoretical Framework for the Effect of War on Human Capital

Human capital is the skills, knowledge, and experience possessed by an individual or population, viewed in terms of their value to a company or a country. Human capital encompasses education, technical or job-related skills, health, mental and emotional well-being, and other qualities. One of the first attempts to estimate the value of country's human capital was

made around 1691 by Sir William Petty (see Kiker (1966)). The concept was developed in Becker (1964), Schultz (1961), and Mincer (1958), among others. In this section, we lay out a parsimonious model of human capital to understand the possible channels of the impact of a war on country's human capital and, subsequently, the country's economic output.

2.1 Model of human capital

Consider an economy that produces output using two inputs—physical and human capital. We can write the economy's production technology as

$$Y_t = A_t K_t^\alpha H_t^{1-\alpha}, \quad (1)$$

where Y_t is the output in period t , K_t is the stock of physical capital in t , H_t is the stock of human capital in t , A_t is a technology index, and $0 < \alpha < 1$.

The stock of country's human capital is the sum of the human capital stocks of working cohorts in the economy,¹ i.e.,

$$H_t = \sum_{a=0}^T h_t(a) L_t(a), \quad (2)$$

where a captures cohort's age at time t , $L_t(a)$ is the number of workers in cohort a at time t , $h_t(a)$ is the level of human capital of each member of cohort a in time t , and T is some high terminal age after which cohorts are not productive. A cohort is uniquely identified by its age a at time t .

The number of workers in a cohort evolves according to the following law of motion

$$L_t(a) = (1 - d_t(a)) L_{t-1}(a - 1), \text{ for } a > 1 \text{ and given } L_t(0) > 0, \quad (3)$$

where $d_t(a)$ is the outflow rate of cohort a in t and $L_t(0)$ is the size of the newborn cohort in t . $d_t(a)$ encompasses death rate as well as an outflow of individuals from civilian to military sector.²

Human capital of each cohort evolves as follows

$$h_t(a) = 0, \text{ for } a < s(t, a) \text{ and } a \geq T(t, a) \quad (4)$$

$$h_t(a) = f(t, a), \text{ for } a = s(t, a) \quad (5)$$

$$h_t(a) = (1 - \delta_t(a)) h_{t-1}(a - 1) + i_t(a), \text{ for } a > s(t, a), \quad (6)$$

¹The cohort approach is used by, for example, Bils and Klenow (2000).

²The model does not incorporate migration out of the country and a return of people from abroad. The model can be extended to incorporate such migration. Those who emigrate do not lose their human capital so those losses should be treated differently. Moreover, there could be direct returns to the country-of-origin through remittances of these emigrants.

where $\delta_t(a)$ is the depreciation rate of human capital of cohort a in t , $i_t(a)$ is the investment in human capital of cohort a in t , $f(t, a)$ is the human capital from schooling, $s(t, a)$ is the years of schooling, and $T(t, a)$ is the retirement age of the cohort defined by a in t . Note that $s(t, a)$, $f(t, a)$, and $T(t, a)$ remain fixed throughout the life of the cohort uniquely defined by (t, a) .

Eq. (4)-(6) show that a cohort starts contributing to the aggregate human capital after completion of schooling. Once schooling is complete, at the cohort-specific age $s(t, a)$, each member of the cohort contributes $f(t, a)$ units of human capital. $f(t, a)$ captures the quantity and quality of schooling that cohorts receive. The quality of schooling might depend on the quality of teachers, curriculum, resources devoted to schooling and other factors.

Cohort's human capital depreciates at an annual rate $\delta_t(a)$. The depreciation captures both deterioration of skills and deterioration of the cohort's health. Deterioration of skills can be due to, for example, the emergence of new technologies that require new skills and render the existing skills obsolete.

Human capital building does not stop with schooling. Cohort a can continue building its capital by investing in it, which is captured by term $i_t(a)$. Investment in human capital can take a form of higher education, job training, investment in physical and mental health.

Finally, after some age $T(t, a)$, a cohort retires and no longer contributes to country's aggregate human capital.³

2.2 Channels of the effect of war on human capital

Our model of human capital helps map out various channels through which a war affects country's human capital, and subsequently, the aggregate output. A war affects country's human capital through two main channels: the size of country's population and the productivity of its members:

- Size of workforce:
 - cohort outflow rate, $d_t(a)$, which encompasses the cohort death rate,
 - size of the birth cohort, $L_t(0)$,
 - age at which cohorts retire, $T(t, a)$,
- Productivity:
 - years of schooling, $s(t, a)$,

³The model can be extended to allow the retired cohorts contribute to schooling of the newborn cohorts (see, for example, Bils and Klenow (2000)).

- quantity and quality of schooling, $f(t, a)$,
- investment in human capital, $i_t(a)$,
- depreciation rate of human capital, $\delta_t(a)$, which captures loss of skills as well as deterioration of physical and mental health.

All the effects of the war are negative. More importantly, given the dynamic nature of human capital, any impact in period t has long-lasting consequences for future human capital and, consequently, output.

While we setup a model in terms of an aggregate output, one can think of various ways (objective functions) of why a country values its people and their human capital.

In this article, we focus on human capital. The war impacts human capital as well as physical capital and the country’s technology index (see eq. (1)). For a parsimonious measurement framework for valuing output losses from the lost potential growth, see, for example, Tsyrennikov (2022). For a discussion of rebuilding and investments in both human and physical capital, see Blinov and Djankov (2022). KSE (2022) provides calculations of the direct damage caused to Ukraine’s infrastructure during the war.⁴

3 Humanitarian Situation in Ukraine

Since the start of the war, a large number of Ukrainian people have been killed or wounded. The Office of the UN High Commissioner for Human Rights (OHCHR) reports that the actual figures are considerably higher than the official statistics because the receipt of information from some locations where intense hostilities have been going on has been delayed and many reports are still pending corroboration. As of June 9th, OHCHR recorded more than 9.5 thousands civilian casualties in Ukraine — 4,302 killed and 5,217 injured (see Table 1 for the data sources in this section). Among those killed, 272 are children.

The civilian casualties and destruction of civilian infrastructure forced people to flee their homes seeking safety. Since the start of the war, more than 4.9 million refugees has fled Ukraine.⁵

As of the end of April, a further 7.7 million people were displaced internally within Ukraine and 13 million people in Ukraine were estimated to be stranded in affected areas or unable to leave due to heightened security risks, destruction of bridges and roads, as well as lack of resources or information on where to find safety and accommodation.

⁴For the analysis of the effect of the Russian invasion from 2014 to February 2022, see Aslund (2018), Melnyk, Pavlyuk, Petrov, and Glushko (2019), Havlik, Kochnev, and Pindyuk (2020), Kharitonov (2020).

⁵As of June 9th, OHCHR recorded recorded 7,363,623 border crossing from Ukraine and 2,387,834 border crossings to Ukraine. These figures reflects cross-border movements (and not individuals). Source: <https://data2.unhcr.org/en/situations/ukraine>

Table 1: Humanitarian Situation in Ukraine

	Number (1)	Reference period (2)	Source (3)
Total population	43,467,000	2021	1
Killed	4,302	02/24-06/09 2022	2
Injured	5,217	02/24-06/09 2022	2
Individual refugees from Ukraine recorded across Europe	4,904,207	02/28-06/09 2022	3
Internally displaced	7.7 million	02/24-04/29 2022	4
Stranded in affected areas	13 million	02/24-04/29 2022	4
Forcefully evacuated to the invading country	1.2 million	02/24-05/09 2022	5

Sources:

1. <https://data.un.org/en/iso/ua.html>
2. <https://ukraine.un.org/en/185529-ukraine-civilian-casualties-9-june-2022>
3. <https://data2.unhcr.org/en/situations/ukraine>
4. <https://data2.unhcr.org/en/documents/download/92353>
5. Jewers (2022).

Additionally, more than 1.2 million individuals were forcefully evacuated to the invading country against their will (Jewers (2022)).

Summing up all the displaced populations (using data available as of June 9th—4.3 million, 7.7 million, 13 million, and 1.2 million, brings the total count to of displaced individuals to at least 26.2 million individuals. This constitutes more than 60 percent of the entire population of Ukraine. And this figure does not take into account non-civilian losses.

4 The Effect of the War on Human Capital in Ukraine

Using the framework outlined in Section 2, we identify the following channels via which the war affects human capital in Ukraine:

1. Quantity—loss of human life
2. Quality—impact on productivity of human capital through
 - (a) Schooling of children
 - (b) Adults’ skills
 - (c) Physical and emotional health
3. Growth—impact on accumulation of human capital

4. Reallocation from civilian to military sector

Below, we describe a few of these channels in some detail. This qualitative analysis will help us lay out key directions for rebuilding, which we discuss in the next section. We leave the quantitative analysis for future work.

4.1 Schooling of children

During the war, children experience a disruption of schooling from being stranded in war-affected areas, from being displaced—either internally or to other countries, or from disruptions to schooling without displacement. A long-standing literature documents that even small disruptions to schooling have large negative effects on learning.

The loss of schooling has an impact on an individual and on the aggregate level (Hanushek and Woessmann (2020)). On an individual level, a loss of schooling decreases life-time earnings. For example, Hanushek and Woessmann (2020), summarising research on the economics of education, find that each additional year of schooling increases life income by an average of 7.5-10%. On an aggregate level, a loss of schooling lowers accumulation of aggregate human capital, thereby lowering aggregate output growth.

Justino (2011) describes how the level and access to education of civilian and combatant populations affected by violence has the long-term human capital consequences. Ichino and Winter-Ebmer (2004) study the loss of human capital suffered by school-age children who receive less education during the World War II. They find that Austrian and German individuals who were 10 years old during the conflict, or were more directly involved through their parents, received less education than comparable individuals from non-war countries. They also show that these individuals experienced a sizable earnings loss some 40 years after the war, which can be attributed to the educational loss caused by the conflict. Akbulut-Yuksel (2022) presents evidence from WWII and the Vietnam War of how childhood war exposure had detrimental effects on education, physical and mental health, and labour market outcomes, even decades after the conflicts. Akbulut-Yuksel suggests that resources available during wartime are essential to reduce the enduring effects of war. Bruck, Maio, and Miaari (2022) discuss negative effect of a war on academic achievement, concluding that governments of war-affected countries should focus on maintaining as much as possible appropriate social infrastructures and by trying to counteract the psychological burden of experiencing violent events on children.

Furthermore, the impact of the war on schooling is layering on the impact of the pandemic on schooling. Hanushek and Woessmann (2020) find that a loss of one-third of a year in effective learning for just the students affected by the closures of early 2020 of the pandemic

will, by historical data, lower a country's GDP by an average of 1.5% over the remainder of the century.

4.2 Human capital of adults

Massive internal displacements, reallocation to other countries, and civilians being stranded in the zones of active war actions cause adults to lose their jobs.

Pindyuk (2022) reports that according to a representative survey conducted in Ukraine by Info Sapiens during March 24-28, 2022 unemployment in Ukraine reached 29%. Of those who have not lost their jobs, only 37% received their March salary in full, while 26% did not receive any salary at all. Astrov, Ghodsi, Grieveson, Holzner, Kochnev, Landesmann, Pindyuk, Stehrer, and Tverdostup (2022) reports that economic activity has practically ceased in the regions that have come under attack, apart from the maintenance of public utilities, basic retail trade and medical services, where possible. Astrov et al. (2022) report that Finance Minister of Ukraine estimates that by mid-March 2022, the war had forced 30% of the economy to stop working, and that according to the Ministry of Economy, the losses from the war so far could amount to between a third and a half of the country's GDP in 2022. International Labor Organization estimates that as of May 2022 4.8 million jobs have been lost with respect to the pre-war situation, equal to 30 per cent of pre-war employment in Ukraine (ILO (2022)).

There are at least two ways in which human capital of the adults who lose their jobs deteriorates. First, human capital might deteriorate when people are not working. Although there is some variation in the estimates of how quickly human capital depreciates, Blundell, Dias, Meghir, and Shaw (2016) and Dinerstein, Megalokonomou, and Yannelis (2020) suggest that a year without work reduces human capital by 4 to 8 percent. Second, the post-war economy might require different set of skills.⁶ The evidence from the China shock in the U.S. and other countries suggests that labor adjustment may be slow and costly (see Autor, Dorn, and Hanson (2016) for a survey).

4.3 Reallocation from civilian to military sector

The number of deaths and injuries reported in Section 3 refers to civilian population. The war has lead to a large reallocation of civilians to the military sector. The losses reported in Section 3 do not take into account losses and injuries of the military. This is an important part of the country's human capital and future human capital building strategy; we leave this direction for future research.

⁶For example, because coal mines in Ukraine may not be operational after the war, miners will need to re-skill for another jobs.

5 Directions for Rebuilding of Human Capital

The parsimonious model of human capital in Section 2 allows perfect substitution between the number of people in each cohort and their level of human capital as well as substitution of human capital from different cohorts. While in the data the substitution is not perfect, we outline directions for rebuilding both the size of the population and, importantly, the level of human capital of each its member.

We identify the following directions for rebuilding of human capital in Ukraine:

1. Quantity and quality of schooling for children
2. Quality of higher education
3. Training and retraining programs for adults
4. Assistance for people with disabilities
5. Re-integration into civilian sector
6. Population growth and fertility
7. Promotion of self-motivating mechanisms

5.1 Schooling

Quantity and quality of schooling are one of the key inputs into human capital growth. Quality includes the development of relevant curriculum and providing resources for teachers and schooling infrastructure.

Heckman (1998), summarizing a large body of the literature, concludes that economic theory demonstrates that the returns to human capital investment are greatest for the young because, first, younger people have longer horizon over which to recoup the return on their investments, and, second, because skill begets skill. Heckman (2006) summarizes evidence on the effects of early environments on child, adolescent, and adult achievement and concludes that life cycle skill formation is a dynamic process in which early inputs strongly affect the productivity of later inputs.

Hanushek and Woessmann (2016) argue that the key determinant of GDP growth is not the years of schooling but the quality of schooling, e.g., the skills developed in schools. Specifically, their empirical model that includes years of schooling accounts for 25% of the variance in country growth rates, compared with 79% when test scores, which measure quality of schooling, are included.

Angrist, Djankov, Goldberg, and Patrinos (2022) list a number of policy implications for providing education for temporarily displaced children during the war in Ukraine: (1) opening classes for Ukrainian refugees in selected schools in neighbouring countries, as well as expanding schools in parts of Ukraine where many internally displaced families have moved; (2) online, by-phone, or in-person tutoring; (3) adapting curricula – including printing textbooks in Ukrainian – in countries receiving refugees so that a large number of refugee children can regain access to standard schooling.

5.2 Quality of higher education

Quality of higher education is one of the factors that help build country’s human capital. Special attention should be paid to the skills of the future (see, for example, Brynjolfsson and Mitchell (2017)).

5.3 Training and retraining programs for adults

The large-scale displacement suffered by the Ukrainian population as a result of the war (see Sections 3 and 4.2) led to loss of jobs. In the post-war economy, some jobs will return but some jobs will be replaced by new jobs. The goal is to identify occupations and, more specifically, skills for the post-war economy and established training and retraining centers for the displaced adult population. Construction, civil engineering, health, information technology are the industries that will likely be the key industries in the post-war economy, as well as the pre-war agricultural export industries.

5.4 Assistance for people with disabilities

Health is one of the factors contributing to the quality of human capital. The number of people physically injured during the war continues to grow. In addition, while the statistics on the emotional and mental impact of the war are scarce, a negative impact of war on overall health is large. Murthy and Lakshminarayana (2006), reviewing research findings on mental health consequences of war, find that among the consequences of war, the impact on the mental health of the civilian population is one of the most significant. They write that studies of the general population show a definite increase in the incidence and prevalence of mental disorders.

Disability-inclusive infrastructure and workplace policies can empower and make it easier for people with disabilities to be part of rebuilding and development. See, for example, ICED (2019) for an outline of key challenges and opportunities in legislating for, designing and financing disability-inclusive infrastructure.

5.5 Re-integration into civilian sector

A separate focus should be devoted to re-integration of the individuals serving in the Armed Forces of Ukraine or participating in the Territorial Defence Forces (e.g., the military reserve component of the army) into civilian life after deployment or for those who choose to return to the civilian life. This re-integration requires tailoring occupational training and health programs to the specific needs of the individuals who participated in the combat activities (Angrist (1990)).⁷

5.6 Population growth and fertility

The policies that focus on fertility can help boost human capital by increasing the size of new birth cohorts. Such policies can include lump-sum payments for having a child and help with childcare costs.

5.7 Encouragement of self-motivating mechanisms

The country can encourage human capital building by developing policies that motivate individuals' investments in their human capital. These incentives can be fiscal as well as non-fiscal (see, for example, Heckman (1998)).⁸ Self-incentives could be amplified by easier access to retraining, better labor markets and regulation, improved working conditions and other mechanisms that enhance quality of life. Justino (2022) argues that evidence from other wars, the economic, social, and political recovery of Ukraine will be dependent not only on bringing refugees back and reconstructing markets and infrastructure, but also on ensuring that social cohesion and trust in institutions is rebuilt so that any Ukraine post-war government is able to succeed in maintaining a united population.

6 Conclusion

The war in Ukraine has led to catastrophic economic and humanitarian losses—deaths, injuries, displacements, negative impact on physical and mental health. The country's human capital has suffered substantial negative impact that has a potential to last for a long period of time. As the war continues, the losses will continue to mount.

⁷See, for example, Dunigan, Gore, Kidder, Schuille, Cherney, and Sladden (2020) for a review and analysis of practices across U.S. federal agencies.

⁸Becker, Grosfeld, Grosjean, Voigtlae, and Zhuravskaya (2020) study the long-run effects of forced migration of Poles after World War II on investment in education and find that Poles with a family history of forced migration are significantly more educated today than other Poles. The authors argue that these results are driven by a shift in preferences away from material possessions toward investment in human capital.

We outline possible directions for human capital rebuilding and development. A work along these directions requires a strategic plan for the development of the post-war economy in Ukraine and a quantitative assessment. The plan requires an agenda for development of industries and occupations as well as for general institutional and regulatory environment. Some work has already started in the Blueprint for Reconstruction of Ukraine (Becker, Eichengreen, Gorodnichenko, Guriev, Johnson, Mylovanov, Rogoff, and di Mauro (2022)).

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